THE CAMBRIDGE HANDBOOK OF

CREATIVITY

Edited by James C. Kaufman
and Robert J. Sternberg

SECOND EDITION

The Cambridge Handbook of Creativity

This second edition of the renowned *Cambridge Handbook of Creativity* expands on the classic text with over two-thirds' new material reaching across psychology, business, education, and neuroscience. It introduces creativity scholarship by summarizing its history, major theories and assessments, its development across the life span, and suggestions for improving creativity. The book then tackles how creativity is manifested in the world by exploring the biological, cognitive, and affective underpinnings of creativity, while noting the impact of individual and group differences. The chapters cover the cutting-edge topic of the genetics and neuroscience of creativity in addition to the relation between creativity and mental illness. The sociocultural influences are also examined by looking at how creativity in the classroom or workplace can be increased or impeded by a person's behavior, community, or environment. The breadth and detail of this edition expertly summarizes creativity's relationship with cognition, intelligence, personality, and motivation.

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For our wives and children, with love:

Allison, Jacob, and Asher – JCK

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Contents

Figures

Tables

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Foreword

The Rewards of Creativity

Very few creative ideas or products are the result, in my opinion, of a rational cost–benefit calculation. None of the highly creative individuals I interviewed for my book on that topic (*Creativity, Flow and the Psychology of Discovery and Invention*, 1996) became interested in the work that bought them fame and occasionally fortune because they figured it would make them rich. Even though some of them became world-famous, their lifestyle remained simple and largely unchanged, and in some cases not much more affluent than it had been when the scientist or artist was a hardworking student.

Of course, the fact that extrinsic rewards are not very salient in creative persons' lives does not mean that there are no rewards in being creative. On the contrary, their lives are rich and enviable; but usually not for material reasons. The rewards of a creative life tend to be experiential; in other words, they are not valued on the market, yet they contribute mightily to a life that is worth living.

So what rewards does creativity bring? One cannot answer that question from a strictly materialistic, or behavioristic, understanding of the human condition. But if we realize that people do have what Maslow called "higher order" needs, then the answer is rather obvious. We like to discover things, to make things – from a good meal to a pleasant drawing, from a good joke to a beautiful dress. More than seven centuries ago, Dante Alighieri described Odysseus trying to recruit shipmates for his plan to sail where no man had sailed before with the words: Fatti non foste per viver come bruti, ma per seguir virtute e conoscenza. In other words: You were not made to live like the beasts live, but to pursue virtue and knowledge.

In many ways, Dante might have been more right about this than many contemporary psychologists recognize. All it takes is to watch an infant explore his or her crib, then the room around it, and the genuine joy on his or her face when they find something new or when they achieve what Jean Piaget called "the pleasure of being a cause," like learning how to bring light to a dark room by using the switch on the wall, or making water appear by operating the bathroom faucet. Actually, Dante might have underestimated the importance of the rewards that mastery provides. As we now know, even beasts – monkeys and rats – will expend much effort in order to see something new or to explore their environments.

The rewards for creative people are based on the simple joy all living things experience when they can use whatever skills they possess – in other words, when they can fully be themselves and express their unique beings. This is the condition that I have called the flow experience – an experience that most people have occasionally had in their lives, though few are able to find it in their work, and have to look for it in leisure activities or, if they are lucky, in personal relationships. Creative individuals are fortunate in that they are able to find flow in activities that, in addition to providing them with the intrinsically enjoyable experience of flow, also provide a professional identity and financial compensation.

People in flow describe their most enjoyable experiences in similar terms. They pay attention to a restricted set of stimuli – the artist to his canvas, the musician to her instrument, scientists to the problem they are tackling – and within that narrow field of vision they can achieve a sense of control as well as a feeling of freedom that is hard to achieve in ordinary life.

When describing how he feels when working in his research lab, George Klein, a leading cancer biologist had this to say: “I feel like a young deer gamboling in a meadow full of flowers.”

Another respondent in the study of creative people, a research biologist known for several important breakthroughs in her discipline, expressed succinctly sentiments that many others used to describe their lives: “I have been married for some forty-four years to someone I adore. He is a physicist. We have four children, each of whom has a PhD in science, each of whom has a happy life.”

Of course, there are also many people who, while they achieve great creative breakthroughs in a specific field of art or science, neglect other fundamental aspects of their selves – e.g., relationships, family, or health. If these are indeed important components of a person’s self, then neglecting them for the sake of creative work in one discipline might in the long run be a source of regrets and misery.

Creative people, like everyone else, have limited time to experience life and limited energy to do so. Some are able to make choices that by the end of life add up to a harmonious whole. Others, even though they may have achieved worldwide renown in their field of action, do not. How to achieve the first result rather than the second is still a largely unexplored topic in our understanding of creativity.

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An Introduction to the Second Edition

Divergences and Some Convergences

James C. Kaufman and Robert J. Sternberg

This is the second edition of the *Cambridge Handbook of Creativity*, but in many ways it is a fourth edition. In 1988, Cambridge published Sternberg's *The Nature of Creativity*, a book of essays reflecting diverse perspectives and approaches to creativity. The authors included some who are in this volume (such as Beth A. Hennessey and Dean Keith Simonton) and some legends no longer with us (such as Frank Barron and E. Paul Torrance). It was a handbook in all but title. Sternberg's (1999) *Handbook of Creativity* followed, again featuring chapters from the top investigators in the field. This handbook has been cited over 2,500 times. Most chapters in that book have been cited hundreds (and some, thousands) of times as well.

The senior editor was introduced to the field of creativity by the then in-press 1999 volume (reading it as a stack of computer printouts) and was honored to coedit the first official *Cambridge Handbook of Creativity* (J. Kaufman & Sternberg, 2010). The goal of this new volume is to continue the growth and expansion shown by its predecessor volumes. The first *Cambridge Handbook of Creativity* had twenty-four chapters; this second edition has thirty-six. We have reached out to many new contributors so that this new edition is not simply an updated version of the Handbook but a new creation in itself.

This handbook is arranged as a growing tree. Across its four parts, we begin with core concepts, move on to underpinnings, then to individual and group differences, and then to how creativity is manifested in the everyday world. The authors of the chapters include leaders in the field, noted authorities, and rising stars who will be the leaders of tomorrow. This volume, although a large undertaking, has been a pleasure. We hope it is informative, useful, and enjoyable to those well-versed in the field and also to those who are first discovering scholarship in the field of creativity.

Part I, "An Introduction to Creativity," has a section on the nature of creativity. We begin with a chapter that presents a historical perspective on creativity theory and scholarship, tracing back its roots to ancient times (Glăveanu & J. Kaufman). Next, this narrative continues with a focus on key theories of creativity (J. Kaufman & Glăveanu). Creativity assessment (Plucker, Makel, & Qian) is another fundamental topic; indeed, most subsequent chapters will refer to the assessments discussed here. We move to examining how creativity develops over the life span (Hui, He, & Wong) and conclude this section with an overview on how individuals can improve their creativity (Sternberg).

Part II focuses on the underpinnings of creativity. The first section, biological underpinnings, has chapters that take an evolutionary approach (Kozbelt), present and evaluate a genetic approach (Barbot & Eff), and provide an overview of the neuroscience of creativity (Vartanian). The second section emphasizes cognitive underpinnings. We begin with a discussion of creative cognition (Ward & Kolomyts), proceed with the relationship between creativity and cognitive control (Benedek & Jauk), and conclude with an overview of divergent thinking. The final section, affective underpinnings, starts with chapters on mood (Baas) and emotions (Ivcevic & Hoffman) as they impact creativity. We then move on to the often controversial relationship between creativity and mental illness (Carson) and conclude with a chapter on the healing power of creativity (Forgeard).

Part III examines creativity's differential bases, individual and group. In the first section on individual differences, creativity is examined as it compares to other key constructs. We start with intelligence and wisdom (Sternberg, J. Kaufman, & Roberts), proceed to personality (Feist) and motivation (Hennessey), and finish with the growing area of creative self-beliefs (Karwowski, Lebuda, & Beghetto). The next section looks at group differences. First is an overview of cultural perspectives on creativity (Lubart, Glăveanu, de Vries, Camargo, & Storme), followed by a more specific examination of how Eastern and Western views of creativity align and differ (Niu). We move on to a chapter exploring creativity's role in society (Simonton) and finish this part with a framework for examining how the physical environment can influence and shape creativity (Dul).

Part IV looks at creativity in the world. We start with a first section on collaborative creativity. First up is a chapter focusing on how organizations can utilize research to increase creativity (Reiter-Palmon, Mitchell, & Royston). We then discuss how to lead for creativity (Mumford, Martin, Elliott, & McIntosh) and then review individual and group creativity (Sawyer). The second section examines contexts for creativity. We start with the classroom (Beghetto) and then play (Russ & Doernberg). Next is an examination of what makes a city creative (Florida) and an overview of everyday creativity (Cotter, Christensen, & Silvia). Our final section encompasses the many ways that creativity manifests itself. We begin with creative genius (Simonton) and then move to malevolent creativity (Cropley & Cropley). We next explore aesthetics, or how people perceive creative works (Tinio) and conclude with an overview of imagination (Gotlieb, Hyde, Immordino-Yang, & S. Kaufman). Finally, we offer an integrative conclusion (J. Kaufman, Glăveanu, & Sternberg).

Although the authors in this volume cover different topics, there are three basic ideas upon which they all seem to agree. First, creativity can be studied scientifically. For a long time, creativity was viewed as ineffable – something that could be understood only through exemplars, such as of great artistic, literary, or musical works. But today, researchers have shown that creativity can be approached in as scientific a way as can be any other psychological construct. Researchers can come to understand commonalities and differences of creative works and creators, regardless of field.

Second, creativity is one of the most important constructs studied by psychology and related disciplines – it represents the future of humankind. Although other fields (e.g., social cognition, memory) receive much more attention in the psychological literature, there are few constructs more important than creativity to the future of the world. At one time, major cultural, social, or technological global changes occurred over periods of decades or centuries. Today, it seems, the world is unpredictable from one day to the next. If we are not creative in dealing with the new array of problems that seem to spring up daily, we risk getting swallowed up by it.

Third, creativity is not an inherited ability that is fixed at birth. It comprises a set of skills and attitudes that all people can develop, in greater or lesser degree. Much of what we all need to do in our lives is figure out how optimally to develop our own creativity. This volume will help anyone who reads it not only better understand creativity as a construct but also figure out how to develop their own creativity.

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PART I

An Introduction to Creativity

The Nature of Creativity

1 Creativity

A Historical Perspective

Vlad P. Glăveanu and James C. Kaufman

We are all creative, at least potentially. To create means to bring new ideas or things into existence. Being creative is not a luxury but a necessity in today's changing world. Creativity is the key to success in almost all areas of life, personal and professional. Creativity can and should be educated. You can never have enough of it in most civilized societies.

The statements above will probably sound familiar. They capture contemporary views of creativity that circulate widely within scientific research, in societal debates, and within policy documents. They all express the generally shared belief (at least in the West) that creativity is universal, important, and that it defines who we are as human beings and societies. When considering these statements from a historical perspective, though, we might be struck to discover that they represent an exception rather than the norm, both in the past and nowadays. Indeed, it is not only the case that our ancestors lived and prospered for centuries without the word "creativity" but also that the phenomena we designate with this term today have often been – and in many ways continue to be – seen as strange, undesirable, and even dangerous.

A deeper understanding of history reveals the fact that creativity is a modern concept and a modern value (Mason, 2003; Reckwitz, 2017; Weiner, 2000). It both grows out of and reinforces our general belief in things such as the power of individuality and the capacity to bring about novelty (Negus & Pickering, 2004). Far from reflecting a "normal" state of things, our contemporary interest in, and admiration for, creativity needs to be understood in its social, scientific, technological, economic, and political context. In other words, it needs to be understood historically. What history teaches us is the fact that, just like our societies are in constant state of flux, so too is our conception of creativity and creative people. Realizing the capriciousness of our understanding of creativity should encourage us to wonder about why we have arrived where we are and how our beliefs might shift in the future. In this sense, engaging with the history of creativity sheds new light not only on our species' past but also on its present and beyond.

At the same time, it is impossible to study the history of creativity outside of the history of civilization and ideas. If creativity is a "child" of the current era, its older incarnations – genius, talent, invention, discovery, and imagination – were also understood differently than today (for a discussion of imagination, see Glăveanu, 2017a). These meanings connected to the social, political, and economic conditions at the time, which makes writing about history, particularly the history of ideas, a challenging task. Such attempts are always vulnerable to the dangers of presentism (interpreting the past through the lens of the present). For example, from the standpoint of the present, medieval societies seem excessively traditional, closed, and stable; in other words, they would not be considered nurturing of creativity. Yet many of the cathedrals, icons, and jewels we admire today in cities and museums originated during those times (see Davids & De Munck, 2016). Are these not examples of creativity? They are, of course, but such "creativity" was not labeled or understood in the same manner as today. It was highly unlikely, for instance, that the creators of these historical artifacts were considered the actual "authors" of their productions (for a literary illustration of this practice in medieval times, see Pamuk's (2002) celebrated novel *My name is Red*). The idea of the individual as the locus of creativity is a much more recent development (Hanchett Hanson, 2015).

These inconsistencies make any historical account necessarily selective and incomplete. This chapter will be no different, as we aim to take a historical perspective on creativity without exhausting the richness of the events, people, and ideas that contributed to its development (interested readers are invited to consult Glăveanu, 2019; Mason, 2003; Pope, 2005; and Weiner, 2000). Importantly, we start with the premise that there is no single, unitary, and final history of creativity to be told. Instead, there are multiple "histories" of creativity with their own angles and perspectives; each one would tell its own narrative. In this chapter, we will thus focus on the historical development of key debates that resonate up to the present day within creativity research. But before engaging with these issues, there is another, more basic question that needs to be addressed.

Why History Matters

For many, the history of creativity research is very recent (eighteenth- or nineteenth-century) and the history of scientific creativity research is even more so (mid-twentieth-century) (see M. Becker, 1995; Runco & Albert, 2010). Because of this relatively short past, more attention is paid to the study of historical creations and creators and the manifestation of creativity across time (i.e., Simonton, 2003; Chapter 31, this volume). The history of the notion of creativity is often overlooked. Yet we argue here that one cannot fully disentangle the former from the latter. A full appreciation of acts of creativity from the past can be achieved only by considering how they were perceived at the time, including in reference to their "creativity" (or whatever concepts were used to designate creative phenomena).

A great example of why history matters – especially old histories – is offered by taking a closer look at the word "creativity" itself. The term's etymological roots take us back to the Latin verb *creare*, which meant bringing something forth – making or producing something. However, this notion was not applied to human creativity for several centuries. Instead, the idea of "creation" was associated with God and the generative powers of nature. Different terms, *ars* and *artis*, more similar to today's notion of art, were applied to human forms of making, both technical and artistic (Weiner, 2000). As such, the earliest, thirteenth-century, uses of "create" were in the passive past participle (was created). It is only in the fifteenth century that the present tense (to create) and present participle (creating) of the verb began to be used (Pope, 2005). Thus, for hundreds of years, creativity was associated with the divine as opposed to the human. This conception was first challenged in the Renaissance and replaced more or less entirely during the Enlightenment.

The word "creativity" came into being, or at least was first documented, in 1875 in Adolphus William Ward's *History of Dramatic English Literature*, in reference to Shakespeare's "poetic creativity" (see Weiner, 2000, p. 89). The use of the word marked a radical change in our understanding of creating: from something that already happened and was out of reach to an ongoing process and, finally, a more generalizable trait or phenomenon. The word "creativity" was not very popular at first. It took more than fifty years and such significant societal transformations as World War II for it to enter standard dictionaries and infiltrate languages other than English.

This brief story of the word creativity teaches us several things. First, the history of a phenomenon does not start with the moment it is named; it can (and should) be traced back to other times, words, and belief systems. Second, although we retroactively apply the word "creativity" to great works of the past, the creators and their audiences would likely not understand this concept (Hanchett Hanson, 2015). Third, current studies of creativity should consider the field's proper historical context, as the "hallmark of our modern, secular, democratic, capitalistic society" (Weiner, 2000, p. 1).

In summary, there are at least three reasons why history matters, briefly summarized as follows:

1. A historical approach to creativity helps us put things "in perspective" and understand the roots of both old and new debates.
2. This historical study is not only about the past; it is just as relevant to the present and the future. Knowing history allows one to see where a field is and where it is going.
3. History is said to have a tendency to repeat itself. Given the current rate at which the field of creativity research is expanding, a historical perspective can help us detect the difference between old wine being sold in new bottles and actual advances in scholarship.

The Main Historical Narrative

Before focusing on different "histories" of creativity in relation to key debates within the field, it is important to acknowledge that we do have a main narrative about the historical evolution of the idea of creativity. This narrative is rather straightforward (see Dacey, 1999; Kearney, 2009). From antiquity to the Renaissance and through the Middle Ages, creative acts were believed to be the outcome of divine inspiration. The Renaissance marked the beginning of the long "transition" from God to human beings as the locus of creativity. This movement culminated during the Enlightenment and Romanticism in the image of the genius.

After World War II, the scientific study of creativity intensified, eventually leading to a better balance between individualistic and social approaches to this phenomenon. The history of creativity reflects a long search for suitable explanations for how and why we create. Initially, the answers pointed outside of the person, to God or gods; gradually, the focus became more and more internal (within the abilities and characteristics of the person). In today's global age of connectivity and communication, there may be another great shift slowly underway in how we understand creativity.

It is easy to view creativity's historical narrative as having only two main stages: before and after Guilford's (1950) landmark American Psychological Association (APA) address calling for more psychological research into creativity. This watershed marks several key differences: the increased scientific lens used on creativity scholarship; the specific focus on creativity proper as opposed to related phenomena; and the convergence on an accepted common vocabulary (Dacey, 1999; Kaufman, 2016a; Runco & Albert, 2010). Others adopt a more "inclusive" approach, as noted by Simonton (2001), in which not only the period after 1950 but also the century before it are included within the era of creativity research (see also Glăveanu, 2019). Building on the work of Weiner (2000), we will adopt an even wider approach, starting as early as prehistory.

In the Beginning

There is little we know about the nature, value, and meaning of creative acts during prehistoric times. What is certain is a fundamental contradiction: Despite a general view of societies at the time as being primitive, static, and averse to change, some of the most important inventions in the history of humanity date from that period. These include the domestication of animals, the invention of the alphabet, the creation of cities, and art that lasts to this day. Importantly, it is clear that people at the time saw some creations as valuable enough to be kept and transmitted. It is harder to discern how these achievements were credited or attributed. Most probably, given the first records we have, the very first acts of creativity were seen as divine manifestation. This conception is well established in the Hebrew Bible, which starts with an account of how God created heaven and Earth out of nothing (ex nihilo), certainly a supreme and unparalleled creative power. The story of the first act of creation had a great impact on Western thinking, as noted by Weiner (2000), inspiring reverence for the Creator. Since people were made in the image of God, they could participate in His creativity by following the commandment to be fruitful and multiply. Human creativity was, in this sense, derivative and limited to strictly following God's instructions (Weiner, 2000, p. 26).

Interestingly, the early Greeks, who are credited with some of the greatest creative feats during antiquity, were equally reserved when it came to human creativity. Consider the legend of Prometheus. He stole fire to give to humankind and, according to some versions, also taught people the basic concepts of the arts and sciences. His daring, benevolence, and ingenuity are not celebrated; instead, he is eternally punished by the gods for his disobedience. Prometheus's fate warns of the danger and potential ramifications of being too "creative" and disturbing the universal order. Greek tragedies often emphasized the same message and warned their audience not to take risks or offend the gods. In exchange, the gods were able to inspire people. Homer, for instance, attributed his poetry to the divine, and Plato often pointed to the Muses. In the end, a great ambivalence toward creativity emerges from ancient times: worshipped and dangerous, moral and immoral, harmonious but also possibly disastrous (Mason, 2003).

This legacy was carried over to the Middle Ages when, at least in Western Europe, it was widely believed that human beings could not truly create; this ability was a prerogative of God only. And yet, paradoxically, the Church was often a patron of what are today considered to be great creative achievements in sculpture, painting, metalwork, and architecture. The purpose of most of these was the glorification of God and any signs of individuality and authorship were discouraged, but such practices may have been in place to reflect the collaborative nature of the work, which was often performed in guilds by communities of craftsmen or artisans. Medieval societies were not static but rather in a state of constant transformation, as can be seen by the rapid expansion of cities, technology, and trade.

The heights of this cultural progress were reached during the Renaissance, the first historical era to celebrate the creative ideal and relocate it from God to men (unfortunately, women remained excluded). The spirit of this time blurred the line between the human and the divine. Several key inventions, such as the printing press, led to an unprecedented ability to transmit ideas and gain new knowledge. It was also a time of invention and exploration (e.g., the discovery of the New World), of ingenuity and trade (anticipating the birth of capitalism), and one that encouraged individual thinking and hard work (through the Reformation). The Renaissance made it possible for creators to be acknowledged and paid for their services. As such, it cultivated creative productions in the arts and beyond. Unsurprisingly, some of the greatest creators at the time, such as Leonardo da Vinci, were polymathic geniuses. A new conception of genius, as we will discuss later in this chapter, had its roots in this period. Yet even during and after the Renaissance, human creativity was still regarded with suspicion; this attitude is reflected in such sources as Shakespeare's plays, for instance (see Pope, 2005).

The Enlightenment radically changed the landscape for creativity. A new belief in the power of human reason and capacity to change the world offered the foundation for a much more individual notion of creativity. "Largely taken for granted in our society today, this belief represented quite a radical thesis at the time" (Weiner, 2000, p. 66). The idea of progress, in particular scientific progress, became very popular and this alimented the Industrial Revolution and the major technological and societal breakthroughs that accompanied it. At the same time, the accumulation of wealth, even if acquired through the exploitation of others or of natural resources, became seen as a virtue. The ideology of individualism gained currency. Problem-solving became a paradigmatic way of expressing one's creativity; the authority of the Bible and its views of creation were fundamentally challenged (Dacey, 1999). However, the celebration of reason, order, and progress left many people at the time unsatisfied. This discontent gave birth to the current of Romanticism, arguably one of the eras that had the deepest impact on modern conceptions of creativity. In contrast to the rational "light" of the Enlightenment, Romanticism brought torment, unhinged fantasy, and disorder (Negus & Pickering, 2004). It also established the genius as a natural category that was soon pathologized, an issue we will revisit in this chapter.

Contemporary culture is much more skeptical about glorified images of the genius. In fact, in an age of mechanical reproduction, the expression of creativity can be more associated with the mixing and remixing of existing cultural elements. The relatively easy access to culture led to a much wider "democratization" of creativity than at any other time in history. The distinction between "low" and "high" culture became blurred and multiculturalism brought us much closer in contact with others and otherness (not necessarily turning us into more tolerant or inclusive beings and societies, however, as many events of the early twenty-first century illustrate). Speed, connectivity, and travel define this day and age and require new, more distributed and participatory ways of conceptualizing creativity (Clapp, 2016; Glăveanu, 2014). "The Internet has reinforced the contemporary idea of creativity coming from anyone, anywhere, at any time" (Weiner, 2000, p. 107). At the same time, the internet legitimized the phenomenon of ephemeral popularity or instant fame, as audiences themselves became global and, to a large extent, anonymous. Creative work is recognized today as highly collaborative, not always out of preference but necessity. Consider, for example, the many different ways that the average person may be creative in day-to-day life, such as adding a witty comment to a Facebook post, creating a variant on an existing meme, or posting an original photo on Instagram. These creative acts (most equivalent to mini-c, that is, personal creativity that may not be valued by others; Beghetto & Kaufman, 2009, 2014) build off of existing cultural expressions and shared language.

Above all, the association between creativity and economic gains raised the popularity of this phenomenon to a new level. Creativity research has rapidly expanded since 1950, moving through different stages, from an early interest in creativity as an outgrowth of intelligence to a shift to personality and exceptional creators to new paths emphasizing both cognitive and social perspectives to current sociocultural, interdisciplinary approaches (Sawyer, 2012).

Before ending this brief, chronological presentation of the "main narrative" it is important to stress that this history is fundamentally Western and, to a large extent, European and American. We are not implying that Eastern cultures are either not creative, not interested in creativity, or did not contribute to its history. Some Asians propose they are less creative (Ng, 2001), but it is more commonly accepted that Eastern cultures are creative in ways that may not be valued by Western standards (Kaufman & Sternberg, 2006; Niu & Kaufman, 2013). However, in agreement with Weiner (2000, p. 20), we should stress the fact that the West gave birth to the word "creativity," shaped it in its image, and "exported" it to other cultural spaces around the world. Unfortunately, in constructing themselves as "inventors" of creativity and its special heirs, Western societies deliberately depicted other people and other cultures as noncreative, traditional, or stuck in time. If creativity is a modern value, as we noted at the start of the chapter, it is also a sign of power to be able to decide who and what is "creative." Eastern histories are waiting to be written, especially in ways that don't immediately reduce local conceptions and practices of creativity to Western standards and views. (For differences between Western perspectives on creativity and those coming from the Global South, see Glăveanu & Sierra, 2015.)

Histories of Creativity

Historical narratives about creativity are neither unitary nor singular. In fact, there are many other "stories" that could be told about the ways in which past ideas and practices feed into today's conceptions. A careful study of different historical strands could shed new light on the many debates embedded within creativity research (see Glăveanu, 2013, 2016). Among them, three dichotomies stand out due to their implications for how we define, measure, and enhance creativity

1. Creativity: individual and/or social?
2. Creative artifacts: novelty and/or value?
3. Creative action: ideas and/or action?

Although they constitute points of tension in the field today, each one of these dichotomies has their own histories, which often intersect. We will consider each in turn, pointing to the continuities (and discontinuities) between past and present thoughts on these issues. Our conclusion will look toward the future.

Individual and/or Social

The question of whether creativity originates "within" the individual or comes from "beyond" the person is as old as the history of human civilization. Scientific research into the creative process, carried out after World War II, is based on the assumption that creativity emerges from within the person, more specifically from a dynamic interaction between cognition, affect, and purpose (see Gruber, 1988). This dynamic is shaped by the environment, particularly social relations, but largely from the outside. A crucial component of what we call creativity today is this individual, intrapsychological conception. And yet, as argued before, this widespread belief would have made little sense a few centuries ago. Indeed, as mentioned, the first conceptions of creativity saw it as originating completely from outside of the person, within the realm of the divine.

How did we come to prioritize the individual over his or her environment? The history of thinking about creativity can be largely seen as one of gradual individualization, starting from the Renaissance, accelerating during the Enlightenment and the Romantic period, and peaking within the neoliberal, capitalist societies of today. This process has been marked, in recent centuries, by macrosocial changes (e.g., the emergence of an individual rights doctrine enforced during the American and French Revolutions) and the gradual establishment of individual recognition practices (e.g., granting copyright as a personal economic incentive to create). This individualization is matched, in recent decades, by a certain degree of democratization of creative potential. We have evolved from a world in which only God creates to one that glorified creative geniuses to our current common belief that everyone has the potential to be creative in some way (Weiner, 2000, p. 257).

These debates about whether or not human beings create and, if they do, whether all or only a few are destined to be creative, are crystallized in the history of genius. This notion, used today to designate eminent forms of creativity (or intelligence or leadership; see Simonton, 2009), represented for centuries a way of speaking about creativity before the term was invented. Indeed, some of the first scientific works on creativity were by intelligence researchers who wanted to learn about genius, such as Francis Galton and Alfred Binet (A. Kaufman, 2009).

Geniuses were historically revered due to their evidenced capacity to almost single-handedly revolutionize society and transform culture. From the eighteenth century onward, geniuses became associated with "individuality, insight, outstanding ability and, in particular, fertility" (Mason, 2003, p. 111). Just as with creativity, this (radical) individualization was, however, a recent historical invention.

The roots of genius are in the Latin word *genio*, which translates to creator or begetter. Interestingly, though, the creator was not a person but rather a guardian spirit (daimon) assigned to the person and meant to govern his fortunes and protect the family home (Negus & Pickering, 2004). "A man worshipped his genius as a household god, and the Genius of the emperor, as well as the Genius of the Roman people itself, were made idols in the Forum and worshipped" (Weiner, 2000, p. 41). Thus, genius was initially connected to individuals and families but did not belong to the individual. The internalization of this notion was gradual and aided in the seventeenth century by the linguistic proximity between *genio* and *ingenium* or innate talent (Negus & Pickering, 2004). Indeed, by the nineteenth century, especially through the work of Galton (1874), genius became a hereditary category (nature) and the role of the environment (nurture) was minimized. Not all scholars at the time agreed with this assessment; William James was one of the first scientists to argue for an interaction between genetic heredity and environment in the makeup of geniuses (Dacey, 1999). Calls to consider genius in more social terms and as an ideological category (used to promote an elitist view of certain people or groups within society) continue to this day (Negus & Pickering, 2004).

Another factor pointing toward the internalization of genius has historically been the close connection between this phenomenon and madness. Mental illness was often used to account for the creative achievements of great artists, musicians, and writers, primarily by nineteenth-century authors such as Benedict Augustin Morel, Cesare Lombroso, and Max Nordau (G. Becker, 2014). Once more, the history of these associations is much older since, as Eysenck (1995) noted, there was no distinction made in Latin between madness and inspiration, which was often seen as a form of demonic possession. Romantics associated the individual genius with mental illness to such an extent that some Romantic poets and artists were known to embrace madness in part because they felt compelled to do so (Sawyer, 2012); how else could they demonstrate their creativity? G. Becker (2014) also attributed the image of the mad genius to Romanticism. He argued that the connection between creativity and mental illness is not entirely fabricated and a good amount of current research today connects genius with manic-depressive symptoms or mood disorders.

Although we acknowledge some studies supporting the mad genius stereotype (Simonton, 2014a, 2014b), much past research has been strongly challenged (Schlesinger, 2009, 2012). The general consensus is that the connection between creativity and mental illness is slight at best (Kaufman, 2016b; see also Carson, Chapter 14, this volume)

How does this issue impact the question of whether individual factors predetermine genius or, more broadly, creativity? The Zeitgeist of the 1950s proposed a much broader conception of creativity as a widespread process and a personal trait that can and should be educated. Guilford's (1950) APA address emerged at a time in which the scientific and political climate in the United States was ripe for studies of little-c creativity (i.e., everyday creativity; Kaufman & Glăveanu, Chapter 2, this volume; Kaufman & Beghetto, 2009) and creative potential. Although there were earlier attempts to measure creativity with divergent thinking (Chassell, 1916), advances in psychometrics enabled the development of much stronger assessments (see Plucker, Makel, & Qian, Chapter 3, this volume). Meanwhile, the sociopolitical climate in the United States, with the Cold War and competition with the Russians to explore space, led to an emphasis on giftedness and creativity in the educational system (Cropley, 2015). As creativity became more egalitarian and moved away from belonging only to the elite, the association with mental illness became weaker (Kaufman, 2014; Silvia & Kaufman, 2010). Further, more attention was paid to possible positive mental health benefits of creativity (Barron, 1963). Creativity grew to be celebrated not only as an individual quality but also as a personal responsibility. People are implicitly expected to cultivate their creative potential to live a successful life and contribute to society. This discourse fits the broader cultural landscape in the United States, defined by the values of individualism, industriousness, and the image of the self-made man.

However, this democratization of creativity did not take into account the role of the social environment except as something to be confronted and defied (for more on creativity as defiance, see Sternberg, 2018). The idea of the creative process naturally incorporating other people can be found in two different strands of scholarship from the beginning of the twentieth century: Russian activity theory (e.g., Vygotsky, 1930/2004) and American pragmatism (e.g., Dewey, 1934). It was not until the 1980s that more systemic or distributed conceptions of creativity began to flourish (e.g., Csikszentmihalyi, 1988). Today's interconnected world offers a new opportunity to address this dichotomy and "socialize" not only our practices of creativity but also our theories of it (see Kaufman & Glăveanu, Chapter 2, this volume).

Novelty and/or Value

After 1950, creativity started being defined more or less consistently in terms of novelty/originality and value/appropriateness (see Runco & Jaeger, 2012). These two dimensions are considered equally important although, in practice, there is a tendency (at least within Western societies) for novelty/originality to be the object of more research studies (Kaufman, 2016a) and more closely aligned with lay beliefs (Sternberg, 1985) than value/appropriateness. Of course, there is a high degree of domain specificity in this regard.

The arts and the sciences have been considered two different cultures (Snow, 1959). They are two broad domains of creativity that offer distinct views of the creative process and its products. Consider the arts – they are based on divergence and self-expression, are highly likely to produce novelty, and can be messy and unpredictable. The sciences are more likely to gravitate toward convergence and effective problem-solving, practical outcomes, functionality, and orderliness (Cropley & Cropley, 2010; Kaufman & Baer, 2002). The historical debate between Romanticism and the Enlightenment continues to play out in our understanding of artistic and scientific creativity.

If we move further back in time, we can notice that the first question that animated this debate was whether creating anything new was even possible. As mentioned earlier, the dominant conception during antiquity and the Middle Ages was that God (or the gods) is the true source of novelty and that human activity is merely a reproduction of His creation. For Aristotle, arts and crafts are essentially imitative; his teacher, Plato, went even further by postulating that art is a copy of a copy since it tries to imitate nature, which already imitates eternal ideas (Weiner, 2000). These views make the biblical feat of God, of creating the world out of nothingness, even more extraordinary. In contrast, human activity was reduced to a derivative form. There is "nothing new under the sun," claims the Ecclesiastes (1:9), and striving to produce novelties only reveals our "vanity."

In contrast, today "making the new is our culture's agenda" (Weiner, 2000, p. 98). So how exactly did we get from believing novelty is impossible to placing it as the cornerstone of our societies? The key to understanding this resides in the notion of self-expression and its glorification during the Romantic period (Negus & Pickering, 2004). Romanticism exalted the human capacity to imagine and, above all, the possibility of a creative – not only reproductive – imagination (Glăveanu, 2017a). Self-expression was infused by both imagination and affect and was considered essential for creativity in the arts. Later on, at the dawn of Modernism, this focus on self-expression gave way to novelty; for example, Impressionist painters started being concerned with the novel aspects of their work and with visibly breaking with the old traditions of the Academy.

More contemporary echoes of these concerns can be found in the work of Maslow (1943) and his ideas about self-actualization. The actualized self experiences life fully, spontaneously, and independently of others' opinions and views. It is, ultimately, a person who embraces novelty, lives a psychologically healthy life, and is capable of acting creatively in relation to both self and others.

More contemporary associations with creative value move us away from the sphere of individual well-being and health and toward capitalist concerns for production and consumption. Much of creativity's current popularity is its perceived contribution to the economy and rapidly evolving technology (see Florida, Chapter 29, this volume). A great deal of current creativity work is conducted by business or organizational researchers (Agars, Kaufman, & Locke, 2008; see Reiter-Palmon, Chapter 24, this volume). This market orientation is interested in novelty inasmuch as it can attract interest and produce tangible rewards – in other words, as long as it sells. The whimsy or process-orientation of mini-c creativity is of much less interest to most companies given its indirect connection to more tangible products (Beghetto & Kaufman, 2013). The creativity that leads to innovative breakthroughs is a more advanced level. Further, creative contributions that are highly original run the risk of being ahead of their time and only appreciated in retrospect, whereas small incremental advances can be more profitable in the short term (Sternberg, Kaufman, & Pretz, 2001; Sternberg, Pretz, & Kaufman, 2003).

The increased focus on value/appropriateness is only one of many shifting perspectives of the creative product throughout history. The Age of Enlightenment promoted all (rational) actions aimed at conquering nature and transforming it. It is no coincidence that the Industrial Revolution occurred toward the end of this period. The scientific method and the use of experimentation were also hallmarks of the Enlightenment, which encouraged the production of useful knowledge and practical innovations. "Enlightenment thinkers were focused on change, the emergence of the new, through ordered progress, rather than through spontaneity" (Weiner, 2000, p. 71).

Why do these historical considerations matter? It is because our contemporary definition of creativity is not accidental and neither are the measures we use to evaluate creative work (see Glăveanu, 2017b). Two of the most popular tasks in this regard mirror Guilford's (1950) parallel constructs of divergent thinking (e.g., Torrance, 2008) and convergent thinking (e.g., Remote Associations Technique; Mednick, 1968). These two approaches draw on different conceptions of creativity, as we have argued, and reflect different histories. Divergent thinking is quintessentially a task aimed at revealing self-expression and spontaneity. Converging thinking tasks (as well as related insight and problem-solving tests) take a more orderly and oftentimes logical approach. It should not surprise us, then, if the creativity we measure with one differs from the creativity we identify with the other. The key question, from a historical perspective, is which "legacy" are we actually continuing and with what consequences?

Ideas and/or Action

The biblical story of Genesis begins with God creating the world through the power of His word. This story illustrates on the one hand the divine prerogative of creating something out of nothing; it further points to the importance of speech for the act of creation itself. God's word precedes his actions in His creative process. Indeed, although in a completely different context, we still uphold that creativity starts from an idea and is usually communicated through language. The popular metaphor of the lightbulb, often associated with creativity, is based on this assumption: Creativity begins in one's mind in the form of insight. To reach creative achievement, this insight needs additional components, such as the knowledge and experience to nurture the idea and the actions required to implement and produce the idea. These other components are essential to the creative process; from Wallas (1926) to the modern day (Sawyer, 2012), the inspiration/generative phase is buffered by a preparation/problem recognition phase and a verification/implementation phase. It is the inspiration that often captures layperson attention; yet more and more creativity researchers see knowledge and implementation as intertwined with ideation – some suggest they are the actual origin of creative ideas (see studies of improvisation; Montuori, 2003).

This debate between prioritizing ideas versus embodied action – between head versus hands – can be traced back to centuries-long discussions about arts and crafts. The arts have long been considered to depend on the power to generate creative ideas or perspectives (think, for example, about the cubist visions of Picasso), whereas crafts are traditionally associated with the skillful making of objects, oftentimes repetitive or unimaginative. Similar comparisons can be seen in music (the composer versus the orchestra musician) or dance (the choreographer versus the ensemble member) and even in the workplace (one work orientation is craftsmanship; Amabile & Pratt, 2016). In European cultures, the arts – particularly the fine arts – have been considered superior, whereas craft objects are seen as less worthy and certainly not very creative (Sawyer, 2012). This hierarchy, however, is a product of the past couple of centuries. It does not reflect how the relationship between art and craft has been conceived for much of Western history.

The story again begins in antiquity, in the discussion about novelty and imitation referred to in the previous section. It is not only that arts and crafts were all imitative (like any other form of human creativity) but that both relied on craftsmanship or technique. The Greek word *techne*, which can be roughly translated as making or the making of things according to rules, referred to both types of activities. In other words, there was no distinction between artists and artisans, at least not in the way we make it today (Nelson, 2010). Art was not about creative ideas but "a practice that could be taught and learnt" (p. 55). It was a notion applied by the Romans to any kind of masterful activity. This meaning is rare in contemporary culture but not altogether gone (e.g., references to the art of cooking or the art of management).

In medieval times, "art was still defined as skill, and imitation was fundamental to it" (Weiner, 2000, p. 47). Weiner notes that Saint Anselm made an analogy between God creating the world and the craftsman doing his work, yet was quick to recognize the flaws in his analogy "for God is the first and sole cause and creates through himself alone, while the artisan follows external models and is not the originator of himself or his works" (p. 44). The divine idea remained primordial compared to human acts of imitation.

Once more, the Renaissance marked a shift in this conception by considering the great artists of the time as more than craftsmen and separating artistic creativity from mere technique. It was by appealing to this superior status that artists were able to claim and receive the support of rich patrons interested in cultivating "real" creations. It is then no surprise that, when the word "creative" appeared, it was first associated with the arts, in the middle of the nineteenth century (Pope, 2005). The Romantic elevation of art to a superior status was done at the expense of craft activities, which became mundane and considered less (or not) creative. The distinction between "fine" and "applied," "folk," or "decorative" arts dates from this time and continues to be popular today, despite other efforts to consider both within an integrative framework (see, for instance, the Arts and Crafts movement). Interestingly, this distinction is being deliberately blurred today, with craftsmen aspiring to be recognized for their art and artists relinquishing their status and trying to go beyond "intentional" and "conceptual" art with the help of craft techniques (for a discussion of this process, see H. S. Becker, 2008).

How are these shifts reflected in creativity theory? Building on historical preference for ideation over action, the field has developed many models focused on the way in which people get and evaluate ideas. Examples of this include the Geneplore model (Finke, Ward, & Smith, 1992) and the Blind Variation and Selective Retention (BVSR) theory (Simonton, 2011) (see also Kaufman & Glăveanu, Chapter 2, this volume). Although both models cover the concept of action (the preinventive structures in Geneplore need to be invented and well-executed variations are more likely to be retained in BVSR), their primary focus is on the ideation process.

Materiality and the body are still hard to integrate within psychology (Moro, 2015), including the psychology of creativity. However, with the resurgence of craft in popular culture – reflected, for example, in the Do It Yourself (DIY) movement – one can expect more interest in the future for the craft dimensions of creativity (see Glăveanu, 2017c).

Conclusion

We started this chapter with a few arguments for why the study of history matters in creativity studies. We argued that it is of great value for contextualizing and understanding the roots of today's ideas but also that it can, paradoxically, shed light on the future. In the end, all predictions of the future are grounded in past experience (Schacter, Addis & Buckner, 2008). So what does creativity's lineage and long history tell us about its present state and current directions?

First, it shows how conceptions about creativity and its many facets – individual and social, based on novelty and on value, grounded in ideation and action – are intertwined with our conceptions of human beings, God, society, and culture. More than most phenomena studied within psychology, the way we define and study creativity has deep implications for how we see ourselves – as more or less agentic beings, as determined by our society and culture or actively shaping it, as different from or similar to the divine. How we answer each of these questions has an impact on how we measure, nurture, and utilize creativity. Do we emphasize inspiration? Do we pay equal attention to the craft and quality of a creative product? Are creators challenging the gods and inviting potentially negative perceptions and traits (Yahn & Kaufman, 2016), or is their creativity reflecting a deeper greatness? A careful reading of history can inform our current beliefs of creativity, as well as make us aware that our thoughts and perceptions can continue to evolve and change (as they have in the past).

Second, taking a longer view of the history of creativity should make us suspicious, or at least cautious, of propagating modern "myths of origin" (Nelson, 2010; de Saint-Laurent, 2015). Joy Paul Guilford, E. Paul Torrance, and Frank Barron are often credited as the founding fathers of the field. Current researchers who want to go back to before 1950 may point to Francis Galton, John Dewey, Graham Wallas, Sigmund Freud, or many other scholars who thought about creativity. Both perspectives are correct, at least according to the criteria they use. However, origin stories do more than establish a date from which something emerged. Through the choices made, they prioritize certain dimensions of creativity and disregard others.

For instance, Guilford's (1967) Structure of Intellect model made a significant contribution to our understanding of several cognitive processes, including creativity. But as much as it advanced the field, it also reduced creativity to only being part of everyday cognition. What other stories of how creativity emerged as a modern value could be told? What would be their consequences? At a time when creativity is a popular topic yet remains underfunded (Runco, Hyeon Paek, & Jaeger, 2015), these questions matter both in the big picture and in the practical, everyday need to continue studying this topic.

Finally, studying the history of a field makes us more aware of our own contributions to it. Indeed, as Hanchett Hanson (2015) notes, we are actors that maintain and construct certain ideologies of creativity (understood here as systems of belief rather than biased or manipulative conceptions). How are we using this agency? What kind of agendas do we promote or continue through our work? And what kind of visions of individuals and society are associated with them? The questions we ask help guide the field as much as the answers to them.

Bakhtin (1929/1973) famously mentioned, from the perspective of dialogism, that the final word about reality had not been spoken and that human beings and their society are always in the making and open to change. This thought applies even more to a topic such as creativity, which is deeply grounded in notions of change and transformation. As the world faces unprecedented challenges – environmental, economic, social, and political – the stakes are higher than ever for creativity researchers and practitioners to understand the history of their field and to continue writing it.

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2 A Review of Creativity Theories

What Questions Are We Trying to Answer?

James C. Kaufman and Vlad P. Glăveanu

Creativity is such a vast topic that trying to capture classic, contemporary, and cutting-edge theories in a single chapter seems foolhardy. Like love or happiness, creativity is everywhere and nowhere in academia. Everyone has an opinion, yet scholarly work can still provoke a raised eyebrow. Phenomena associated with what we call creativity today have been discussed since antiquity (see Glăveanu & Kaufman, Chapter 1, this volume), with the first systematic investigations dating back to the nineteenth century (Glăveanu, 2019). It is only comparatively recently (Guilford, 1950), however, that creativity research became its own area of study in psychology.

There is reasonable consensus regarding the definition of creativity, which is that it is something both new and task-appropriate (Barron, 1955; Hennessey & Amabile, 2010; Simonton, 2012). There are many possible additional components to this definition, such as high quality (Sternberg, 1999a), surprise (Boden, 2004; Bruner, 1962; Simonton, 2012), aesthetics, authenticity (Kharkhurin, 2014) and the creation of a product (Plucker, Beghetto, & Dow, 2004).

Going beyond a basic definition, however, it gets more complicated. Creativity can mean so many different things that simply cataloging the most cited theories would be as coherent as learning modern cinema by seeing a minute-long clip of every Oscar-winning movie. We will therefore err on the side of covering fewer theories but trying to outline some of the key questions that are being asked. There is, of course, a certain amount of subjectivity in our synthesis. Many other possible frameworks could have been selected. For example, Kozbelt, Beghetto, and Runco (2010) selected ten categories of theories as an outline and Beghetto and Kaufman (2016) used a Who/How/Why/What framework.

In addition, there is the question of what exactly constitutes a theory. Some areas of creativity are filled with effects, studies, and patterns. Sometimes these accumulate into consistent patterns (openness to experience is pretty consistently linked to higher creativity; see Feist, Chapter 17, this volume); other topics are more prone to debates. The absence of a dominant theory does not mean a field is barren (see also Glăveanu, 2015a). Similarly, there are many theories that exist as a way of explaining how creativity relates to another construct. In most cases, these theories are covered in detail in the relevant chapters, such as the Shared Vulnerabilities Model (Carson, Chapter 14, this volume), the Creative Self-Regulation Model (Ivcevic & Hoffmann, Chapter 13, this volume), and the Mood Activation Model (Baas, Chapter 12, this volume).

With these caveats, here are our interpretations of how creativity theories answer different core questions, from the underlying structure of creativity, its prerequisites and drivers, to how we create alone and together, and what makes creative works last.

What Is the Underlying Structure of Creativity?

Some theories aim to uncover the underlying structure of creativity. Even within these parameters, there are diverse approaches. Is it how creativity is studied or conceptualized? Perhaps it is how creativity evolves within a person or how the domains of creativity align together.

One of the foundations of creativity research is the Four P framework proposed by Rhodes (1961), who reviewed the existing literature to see how creativity was being studied. He synthesized everything into four primary categories, which are known as the Four P's: Person, Product, Process, and Press (i.e., environment). The Four P's represent four possible questions: What type of person is creative? What is considered to be creative? How do we create? How does the environment shape creativity?

More recently, Glăveanu (2013) updated this basic vocabulary by proposing a Five A framework including Actors, Audiences, Actions, Artifacts, and Affordances. This framework not only recognizes the "double" nature of the environment (both social and material) but raises new questions about the interrelation between different elements of creativity: How do actors relate to their audiences in creativity? How does creative action make use of sociocultural and material affordances? And do creative actors use existing artifacts in producing new ones?

If the Four P's and the Five A's are theories that explore the underlying structure of how creativity is operationalized, the Four C's are more focused on the individual. The Four C theory is an expansion of the distinction between little-c (everyday creativity) and Big-C (eminent creativity). It is a developmental trajectory that begins with mini-c (Beghetto & Kaufman, 2007), which occurs when someone has an insight that is personally meaningful and new to that person. It is consistent with the recent theory of Creative Learning (Beghetto, 2016; Chapter 27, this volume), which suggests that creativity and learning can be interdependent. Mini-c can evolve into little-c with appropriate feedback and guidance, to the point that something is recognized as being creative by other people. Years of deliberate practice can improve one's creativity to the point that she or he is considered a true creative professional or expert; this stage is called Pro-c (Kaufman & Beghetto, 2009). Finally, if someone's creativity is so genius that it continues to be a legacy for years after his or her death, then it can be considered Big-C.

Finally, an assortment of theories consider how creativity can manifest itself across many domains. Although not specifically focused on creativity, the most well-known theory of this nature is Gardner's (1993, 1999) concept of Multiple Intelligences. The different intelligences he suggests are interpersonal (interacting with others), intrapersonal (self-insight), visual-spatial, naturalistic, linguistic, logical-mathematical, bodily kinesthetic (movement), and musical. He has also debated adding existential intelligence (Gardner, 2006). These intelligences can be considered as being potential domains of creativity. Some connections are obvious and could apply to all levels of creativity, from mini-c to Big-C. For example, linguistic intelligence could translate into creative writing, from a child's haiku to the great American novel. Others are less perfect fits; naturalistic intelligence might evoke Pro-c or Big-C creativity in botany or biology, but lower c-levels (a child using their imagination in the woods) may stretch the comparison.

A theory specifically focused on creative domains (and how they relate to a more generalist perspective of creativity) is the Amusement Park Theoretical (APT) model of creativity (Baer & Kaufman, 2005, 2017; Kaufman & Baer, 2004; see also Plucker, 2005; Plucker & Beghetto, 2004). The APT model uses the metaphor of choosing an amusement park to how people might narrow down their creative expressions. Starting at the top, there are initial requirements that must be in place before anything else can happen. These initial requirements for going to an amusement park might be access to transportation, an admission ticket, and spending money. For creativity, they might include a specific level of intelligence and motivation, as well as a supportive environment. So, for example, it is absolutely possible to be creative with low levels of intelligence, but there is a bottom level of basic cognitive abilities that are required to formulate an idea (e.g., Karwowski et al., 2017). Next are the general thematic areas. For an amusement park, the equivalent would be selecting the genre of park you want to visit (one with exciting roller coasters or water rides or cartoon mascots). In creativity, the general thematic areas are broad categories in which one might be creative. There are some relevant dichotomies, such as art vs. science (Snow, 1959) or aesthetic vs. functional (Cropley & Cropley, 2009). Larger arrays might echo Gardner's Multiple Intelligences or perhaps follow a structure derived from self-report and include everyday, scholarly, performance, mathematical, and artistic creativity (Kaufman, 2012).

To continue the amusement park metaphor, once a type of park has been selected, the next step is to choose an actual park (e.g., Six Flags, Cedar Point, or Busch Gardens). Similarly, under each general thematic area are multiple domains; artistic, for example, might encompass painting, sculpture, or graphic design, whereas performance might cover dancing, singing, or acting. Finally, once you've chosen a park, you still need to select a first ride (the Millennium Force or the Top Thrill Dragster). In creativity, domains beget microdomains, which are even more specific topics. For example, the domain of poetry might include the microdomains of haikus, sonnets, and free verse.

The structural models presented in this section map up the field and encompass many of its core issues. They offer useful lenses through which to study concrete acts of creativity. However, if the Four P's/Five A's or the Four C's can be applied to any situation, we still need to reflect on what is required for creative action to actually take place.

What Is Needed to Be Creative?

Another category of theories thus focuses on the ingredients necessary for creativity. What attributes, abilities, and circumstances must unite for creativity to emerge?

These are sometimes called componential approaches and, indeed, one of the leading ones is the Componential Model of Creativity (Amabile, 1983, 1996; Amabile & Pratt, 2016). In the original model, Amabile proposed that three interconnected variables were the key to individual creativity (and organizational creativity; Amabile, 1988). The first is domain-relevant skills, which are technical skills and talents and specific knowledge. Creativity-relevant processes are broader, such as being tolerant of ambiguity and willing to take appropriate risks. Finally, she included intrinsic motivation, taking part in an activity because it is enjoyable or meaningful (see Hennessey, Chapter 18, this volume). Extrinsic motivation, in contrast, is when someone is driven by an external reason, such as money, grades, or praise.

Four additional pieces have been added for the revised model (Amabile & Pratt, 2016). Intrinsic motivation is now paired with synergistic extrinsic motivation, which occurs when external motivators are present yet either add to or are consistent with a person's knowledge, competence, values, and engagement (Deci & Ryan, 1985). Work orientation (which can include, among others, seeing work as a job, a career, a calling, or a passion; Pratt, Pradies, & Lepisto, 2013) can impact one's motivation. Affect (specifically positive affect) plays a role as a creativity-related process and can enhance motivation, and finding meaning in one's work can increase both motivation and affect.

Also noteworthy is the Investment Theory of Creativity (Sternberg & Lubart, 1995), which uses a central analogy of a creative person being comparable to a financial investor. To be creative, one may buy low and sell high in the world of ideas – so the successful creator can recognize undervalued ideas, convince others of their worth, and then move on to the next project. They propose six different components that need to be consistent with creative values: motivation, intelligence, knowledge, personality, thinking styles, and environment. So, for example, an ideal pattern for a creative person might be someone who is intrinsically motivated, has relevant cognitive strengths and appropriate domain knowledge, is open to experiences (see Feist, Chapter 17, this volume), has a legislative (creative and self-directed) thinking style (Sternberg, 1999b), and develops within a nurturing (or at least tolerant) environment. This aspect is based on Sternberg's (1988) earlier theoretical work on a three-facet theory of creativity (cognitive style, intelligence, and personality/motivation).

Part of being a successful creator according to this theory is the willingness to defy the crowd. Sternberg (2018) expanded and developed this concept in his Triangular Theory of Creativity. Creative people need to not only defy the crowd (such as other people) but also be able to defy their own beliefs and values and to defy the current Zeitgeist (the existing shared presuppositions of a domain). The matching of different defiances (or lack thereof) can lead to eight different types of creativity. Someone who defies nothing is likely not creative, whereas someone who can defy all three can reach consummate creativity. Another expansion of the Investment Theory is the Multivariate Approach (see Botella et al., 2013; Lubart et al., 2003).

There are many other models that have a componential framework of core intersecting variables, such as Piirto's (2004) Pyramid, but in the interest of space, we will move on to our next question. One commonality in both Amabile's and Sternberg's evolving theoretical models is that motivation is essential. Amabile places motivation at the heart of her model, and Sternberg's idea of defiance requires a strong drive and will. What makes people feel they need to be creative?

What Drives People to Be Creative?

The desire to create goes beyond creativity research; it is a core human need (Lifton, 2011). Yet what are the mechanisms behind this need? Given the many obstacles and challenges faced by those who create (Sternberg & Kaufman, 2018), not to mention basic inertia and the many other demands for one's time, why do people continually make the choice for creativity?

One of the psychologists who stressed the importance of purpose as a driver of creative work was Gruber (1988; Gruber & Wallace, 1999). His Evolving Systems Approach considered the creative person as a whole and his or her activity as a network of enterprise motivated by the need to answer questions that triggered the creator's curiosity. By studying the development of creative work over time, this approach allows us to consider the dynamic between knowledge, affect, and purpose in creativity and understand what exactly makes creators passionate about what they do.

One conceptualization of this passion is Csikszentmihalyi's (1996; Foreword, this volume) optimal experience, better known as Flow. When people are intensely engaged in a favorite (yet still challenging) activity, they may enter an exhilarating, pleasurable moment of complete absorption. This sensation, called Flow, is rewarding by itself; as a result, people may be creative simply to experience these feelings without worrying as much about a specific end goal or external reason.

The enjoyment of Flow can be considered akin to experiencing intrinsic motivation (see Hennessey, Chapter 18, this volume). One theory that builds off the intrinsic–extrinsic distinction is the Reciprocal Model of the Creative Process (Forgeard & Mecklenburg, 2013). It is rooted in the idea of prosocial motivation, which refers to the situation in which people want to help others (not all conceptions of creativity are so benevolent; see Malevolent Creativity, Cropley & Cropley, Chapter 32, this volume). The Reciprocal Model integrates the intrinsic–extrinsic dimension along with a dimension representing the intended audience: one's self or someone else. This interaction results in four types of motivation, which they call the Four G's. Gain is being creative for yourself and for external reasons. Growth is being creative for yourself because the activity is enjoyable and meaningful (see also Kaufman, 2018). When the audience is other people, it becomes more complex. Guidance is being creative in mentoring others to help them become in touch with their own creativity. The intersection of extrinsic motivation and an audience is called Giving, which is using your own creativity to help others in a tangible way. It is the presence of a specific (and often physical) end goal that is present in Giving that leads it to be classified as extrinsic motivation.

A different motivational theory is the Matrix Model (Unsworth, 2001) from industrial/organizational psychology, which focuses on the reason (comparable to intrinsic–extrinsic) and context (whether the problem is open or closed) for being creative. The corresponding matrix suggests four types of creativity. Responsive creativity (extrinsic, closed) involves doing a specific task for an extrinsic reason. Expected creativity (extrinsic, open) is being asked to be creative; there is more freedom but the impetus is still someone else. Contributory creativity (intrinsic, closed) is being engaged and interested but focused on a specific, often more narrow problem. Finally, Proactive creativity is creating for your own reasons and to your own specifications (and is likely the most comparable to most conceptions of creativity).

A common theme of these theories is that our reason for being creative is important, and the way that this reason intersects with the specific situation (such as the desired audience or the context of the problem). Although having an internal, personal reason for creating is usually associated with better outcomes, it is not so simple (for a thorough discussion, see Hennessey, Chapter 18, this volume). In many ways, motivation is the spark that enables creative action. Once this action is underway, however, the focus shifts to the actual process of being creative.

How Do We Create?

Once someone has the needed components and has the drive to be creative, what is the actual process like? Some of the earliest theoretical work in creativity scholarship has tried to answer this question. Wallas (1926), in his book *The Art of Thought*, tackled these ideas with a model of the cognitive creative process. Inspired by the writing of physicist Hermann von Helmholtz, his five-stage model is still used today. Wallas's first stage was preparation, in which the problem solver begins to study and gather knowledge. Next comes incubation, in which the mind keeps thinking about the question even if the person is doing other tasks. This stage may be brief or last a long time. His third stage, intimation, is often dropped from modern perspectives on his work; it is the moment of realizing a breakthrough is imminent. In the illumination phase, the person has the "aha" moment – the awaited insight in which the solution appears. Finally, the verification phase is when the idea is tested, expanded, and implemented.

Wallas proposed a stage or phase model of creativity. However, in time, and especially following the cognitive revolution, a new interest developed for mental processes underpinning the entire creativity cycle (see Lubart, 2001). An example of an early and influential model in this regard is Guilford's (1950, 1967) Structure of Intellect model. Although primarily an intelligence theory, creativity figured prominently; it was not until Sternberg's (1985) Triarchic Theory and modified theory of Successful Intelligence (Sternberg, 1996) that another intelligence framework so heavily featured creativity (Kaufman & Plucker, 2011). Two of Guilford's proposed thought processes were divergent and convergent thinking. Divergent thinking is the ability to think of as many different possible solutions as possible to an open question or problem, whereas convergent thinking is choosing which idea or answer is most worth pursuing. These two thinking processes are sometimes called idea generation and idea exploration. The concept of divergent thinking is the central concept behind most creativity tests, such as the Torrance Tests of Creative Thinking (Torrance, 1974, 2008).

Some current conceptions of the creative process have roots in Wallas and Guilford's scholarship. There are many different models of creative problem-solving, such that examining each one in detail is beyond the scope of this chapter. (Sawyer, 2012, presents an excellent synthesis.) These stages have also been linked to how people appreciate creative work (see Tinio, Chapter 33, this volume). Many of these models include variants of preparation, idea generation, idea evaluation, and validation. Perhaps the most notable addition has been problem construction (Mumford et al., 1991; Reiter-Palmon & Robinson, 2009). This early stage (often the first step to be taken) requires one to understand the exact problem that needs to be solved. In exercises or tests, the problem is often presented explicitly; in life, the nature of the problem is not always clear. If you are losing money each month, for example, you might perceive the problem to be either not having enough income or having too many expenses. Your understanding of the problem would greatly influence your selection of solutions.

Two current and widely used models of the creative process are expansions of Guilford's original concept of idea generation and evaluation. The Geneplore (Generate-Explore) model (Finke, Ward, & Smith, 1992) is one of the founding blocks in the field of creative cognition (see Ward & Kolomyts, Chapter 9, this volume). In the first generative phase, the problem solver develops mental representations of possible solution, called preinventive structures. In the second explorative phase, these different preinventive structures are evaluated for how well they would fit within the constraints of the desired goal. Several different cycles may occur before a workable and creative solution is found.

Taking a larger approach (over potentially several centuries), the Blind Variation and Selective Retention (BVSR) theory was originally proposed by Campbell (1960) and then expanded, refined, and explored by Simonton (2011). According to BVSR, ideas are blindly generated; they may come unplanned and without insight into their quality. Over time, some ideas are selectively retained. It is the retained ideas that last and have a true impact.

There are, of course, theories of the creative process that are not based on Wallas and Guilford. One prominent one is Mednick's (1962) Associate Theory, which emphasizes the ability to make connections between remote concepts. When presented with a word, according to this theory, a more creative person could generate related words that would be less commonly associated. For example, the word "milk" might inspire most people to say "cow" or "white," but more remote associations might include "mustache" (as in a milk mustache) or "Jersey" (a breed of cow). Notice, however, that this ability is heavily reliant on knowledge, intelligence, and culture (Kaufman, 2016; for the similar concepts of homospatial and Janusian thinking, see also Rothenberg, 2014).

Lastly, Galenson (2005, 2009) proposed an interesting way of characterizing the creative process in the case of eminent creators (but one that can be expanded to more mundane forms of creativity). He distinguished between two types of creators: conceptual creators (such as Picasso), those who start from an idea and try to find the best way of putting it into practice, and experimental creators (such as Cézanne), who continually looked for the best way of perfecting their practice through trial and error and plenty of experimentation. It is worth noting, however, that empirical support for this theory has been notably mixed (Durmysheva & Kozbelt, 2010; Simonton, 2007).

The models of the creative process presented in this section call our attention to a wide range of phases and processes within and across them. Despite this variety, they nonetheless all focus exclusively on the individual creator and his or her intrapsychological dynamic. However, in real life (particularly as technology continues to advance), we are more likely to create in implicit and explicit collaboration with other people. Such scenarios mean that modern creators are apt to also consider and integrate other people's ideas and perspectives (Barron, 1999). How can we understand the mechanisms and implications of such collaborative creativity?

How Do We Create Together?

There are at least two ways to conceptualize this question. The first way focuses our attention on the creative outcomes of groups. Such work, often in laboratory settings, strives to understand what dynamics enable successful groups and how creativity differs between teams and individuals. The second way considers the interaction and communication processes that occur within real-life collaborators or teams. The former is well represented by the literature on group creativity, whereas the latter is addressed by studies of collaborative creativity (Glăveanu, 2011).

The interest in how people create together is very old, which makes sense given that most human activities are performed together with others. This observation made Alex Osborn (1957) wonder how we could harness the creative potential embedded within groups. He invented brainstorming and claimed that people can produce twice as many ideas when working together than when they are alone. Although his method remains popular up to this day, his claim has been repeatedly proven wrong (dating back generations; see Taylor, Berry & Block, 1978). Indeed, we all have times when we have worked in groups that fail to be creative or even efficient. What are the reasons behind these experiences? Many explanations have been proposed in the literature, ranging from social loafing and groupthink to production blocking, referring to ideas being lost because people take turns when speaking in groups (for an extensive review, see Paulus & Nijstad, 2003).

Although these studies may make us cautious when it comes to overstating the power of group work, they do not address the role others play in cocreation. The literature on collaborative creativity sheds new light on this by drawing on sociocultural scholarship, dating back to Lev Vygotsky (1978). Vygotsky suggested that children, as they grow, internalize knowledge and acquire skills in interaction with others. Moreover, through this interaction, they are capable of performing tasks they could not do alone. He called this idea of not merely studying what children can achieve but also what they are capable of doing with others (which also includes mentorship or teaching) the zone of proximal development. John-Steiner (1992) studied this potential of social interaction to foster learning and creativity in relation to real-life, long-term collaborations. She found that productive collaborations are characterized by tensions, complementarity, and emergence.

But what exactly do we internalize when we collaborate with other people that is useful for the creative process? Glăveanu (2015b) proposed that we acquire the perspective of others on the situation or the problem at hand. In his Perspectival Model, creativity is conceptualized in terms of dialogues between different perspectives and the capacity to reflect on one's position from the standpoint of another person. These processes – perspective-taking and reflexivity – are cultivated within social interactions and, when fostered within group interactions, they can make the difference between low and high productivity. The two processes operate in a comparable way to how wisdom enables people to use their creativity in Sternberg's (2003) Wisdom, Intelligence, and Creativity Synthesized (WICS) model.

Other factors that intervene and play a crucial role when creating together with other people are uncovered within the social-cognition literature. For instance, De Dreu and colleagues (2011) discuss the Motivated Information Processing in Groups Model, which sees group creativity and innovation as a function of both epistemic motivation and prosocial motivation. The former refers to the degree to which group members systematically process and disseminate information, while the latter refers to whether they seek a collective gain rather than a personal one. Different conditions are considered to play a part in this dynamic, including time constraints, openness to experience, and the existence of a shared identity. Other authors considered the complex conditions requires for teams to innovate. Reiter-Palmon, Wigert, and de Vreede (2012), for example, reviewed the effects of group composition, social processes, and cognition on achieving team creativity and innovation.

Another important work-related factor is climate. Karwowski (2011, Karwowski & Lebuda, 2013) postulates three primary factors that contribute to a creative climate: task and interpersonal cohesiveness and dynamic-energetic components that, together, balance the need for stability and flexibility and encourage risk-taking among members. Finally, there are elements of the context that go beyond team or organizational climate and relate to the general culture within which people create. There are marked differences, for example, between Western forms of creativity, which emphasize individuality, risk-taking, and the rupture between the new and the old, and Eastern conceptions, highlighting the need for continuity, adaptation, and renewal of traditions (Niu & Kaufman, 2013; see also Lubart, Glăveanu, de Vries, Camargo, & Storme, Chapter 20, this volume and Niu, Chapter 21, this volume). These macroelements shape both individual and social forms of creativity and raise the final question: What makes certain creative outputs last whereas others – in fact, most others – are either not recognized or ultimately forgotten?

What Makes Creative Work Last?

Thinking back to the Four C model, what is that quality that separates Pro-c from Big-C? Which creative works lasts generations and which fade away? The BVSR theory expands from how we create to the question of what is retained over time. The research literature on genius (see Simonton, Chapter 31, this volume) is also devoted to this topic. In addition, several broader creativity theories address this issue.

One influential approach is Csikszentmihalyi's (1999) Systems Model, which looks at the relationship between the person, field, and domain. The person is the creator and his or her creative work remains constant. The collected contributions of a Mark Twain or Louis Armstrong do not change; it is current perceptions of their work that evolve over time. The field, sometimes called the gatekeepers, represents the people who are in positions of authority to promote, evaluate, or recognize creativity. The field might include critic groups, associations that bestow awards, tenure committees, publishers, or mentors. The domain (comparable to the Amusement Park Theory) is the area of the study and the consumers or practitioners in that area.

These three components interact and the field and domain can change over generations. A singer (the creator) may become a star or unknown in part depending on whether gatekeepers in the field recognize his or her creativity. These particular gatekeepers might include studio executives, concert bookers, disc jockeys, music critics, currently well-known singers, and many others. Sometimes the field can value a creator but the members of the domain do not agree; think of the singers who are heavily promoted but never reach an audience. With current technology and social media, creators have an easier time reaching the domain without getting the approval of the field (Gangadharbatla, 2010). Singers can now market themselves on social media, sell their music on digital platforms, and reach a much larger audience than would have been possible even a few decades ago. As time passes, so can the field and domain change. Creative work can stay meaningful and influential, or else it can be forgotten. For many reasons, from sociocultural movements to shifting values, some creators (such as Mozart or Shakespeare) continue to be promoted by the field and enjoyed by the domain for centuries. Occasionally, creators may be ignored in their own lifetimes but recognized posthumously. More commonly, once-acclaimed creators end up minor footnotes, dubbed irrelevant by the field and uninteresting by the domain.

Another way of considering which creative contributions last is to analyze different products as to how they change their domain. The Propulsion Model of Creativity (Sternberg, 1999a; Sternberg & Kaufman, 2012; Sternberg, Kaufman, & Pretz, 2001, 2004) outlines eight different types of creative contributions that are categorized by how they propel the domain forward. Four types maintain the existing paradigm. Perhaps the most straightforward are conceptual replications, which simply reproduce or reinforce past creative work. Redefinitions stay within the same domain but have a new angle or perspective. Forward incrementations push things slightly forward on a small scale. Advance forward incrementations go further to advance things, to the point of sometimes being too far ahead of their time to be appreciated.

The remaining four types are ways of either rejecting or replacing the existing paradigm. Redirections try to alter the direction a domain is moving. Reconstructions/Redirections not only want to alter the direction but to go back to a past period of time and ignore recent developments. Integrations aim to merge two different areas together to synthesize into a new domain. Finally, Reinitiations want to dramatically alter and reinvent a domain, virtually creating their own starting point and end goal. People who try to reinitiate a field are likely those who (in Sternberg's Triangular Theory) are willing to defy the crowd, themselves, and the Zeitgeist.

The core distinction between those who want to create within a paradigm versus those who want to change a paradigm is represented in many other related theories. These include similar dichotomies such as Incremental vs. Radical creativity (Gilson & Madjar, 2011) and Adaptors vs. Innovators (Kirton, 1976).

Conclusion

Certainly, the future will bring additional theoretical development (and empirical work) that continues to explore, expand, and attempt to answer these questions. An interesting thought to also consider is, which new questions will be asked? How can we anticipate what we do not know? One of our ongoing projects (e.g., Glăveanu & Kaufman, in preparation) is to align creativity theory in a matrix of the Five A's and the Four C's to see which areas are amply represented and which ones are rife for further exploration.

There are several possible questions that could be addressed by theory. There has been extensive thought given to the personal requirements for creativity (such as the Componential and Investment Theories). In contrast, consider the question, *What are the resources and support systems needed to be creative?* Instead of personal attributes, what affordances (action possibilities) of material objects are needed? How can mentors, access to materials, social networks, and new technologies help nurture someone's creativity? There have been empirical studies on these issues (Eubanks et al., 2016; McKay, Grygiel, & Karwowski, 2017), but there is room for theories that connect existing research and suggest new directions.

Another possible question is *How does a novice become a creative expert*? There are several concepts from the expertise literature, such as the importance of deliberate practice over many years, that can and have been applied to creativity (e.g., Ericsson, Roring, & Nandagopal, 2007). But creativity has its own nuances. This transition is part of the Four C model (Kaufman & Beghetto, 2009); one way that creators can advance from little-c to Pro-c is by increasing their creative metacognition (Kaufman & Beghetto, 2013; Kaufman, Beghetto, & Watson, 2016). Creative metacognition is composed of two components: understanding your creative strengths and weaknesses and being able to determine the best times to share your creative ideas. There remains much more theoretical work that could be done to outline the different pathways that one can take toward professional-level creativity (Beghetto & Kaufman, 2013).

Last but not least, there is a pressing need to raise the question of *How can creativity contribute to positive societal change*? Over time, our ideas of what domains are creative have grown from the arts and sciences to include business, education, everyday life, and many others (Kaufman, Glăveanu, & Baer, 2017). What would it mean to consider society as its own domain? What is the relation between creativity and social change? How can it help us, individually and as groups, address collective challenges such as climate change, immigration, and the need to build more open and inclusive societies (Glăveanu, 2015c)? How can creativity be used to foster social justice and equity (Kaufman, 2010, 2017; Luria, O'Brien, & Kaufman, 2016)? How can we ensure that future generations are able to use their creativity (and intelligence) to make wise, benevolent decisions (Sternberg, 2016)? Answering these questions will require us to adopt a more systemic, distributed, and participative model of creativity and reflect more consistently on the ethical dimensions of both creating within society and engaging in creativity research.

There is no (successful or widely accepted) grand theory of creativity that takes into account every possible question, variable, or approach (Baer, 2011). Nor, truly, is there any particular need for one. Creativity is so complex and multifaceted that any theory that tried to explain everything would be unwieldly to the point of being incomprehensible. What we do hope, however, is that creativity theorists will think carefully about what underlying question they are trying to address. A good theory tells a story that is consistent with existing empirical research and suggests interesting questions that can be tested. A good theory will make the often contradictory scholarship easier to understand, instead of further muddying the waters. We hope to be able to include new such theories in future editions.

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3 Assessment of Creativity

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Few topics within the study of creativity and innovation incite as much passion as assessment or measurement. This appears to be especially true when the topic is discussed among nonacademics who work in creative fields: A colleague once shared a story concerning his speaking about creativity with designers at a major entertainment company. He offhandedly mentioned measurement and . . . suffice it to say that he did not find the kingdom to be so magical from that point forward. The conventional wisdom that creativity is too difficult to measure is a by-product of definitional issues that have plagued the field, and many educators and researchers are surprised to learn that creativity assessment has a long, rich history.

The predominance of the psychometric approach likely stems from researchers who originally became interested in creativity only after having already investigated other cognitive phenomena using similar methods – they simply extended their methodological preferences to the study of creativity (see Cramond, 1993; Gardner, 1993). For example, in 1958, when the Minnesota Bureau of Education Research began studying the factors associated with variance in ability, aptitude, and intelligence test scores, its director at the time, E. Paul Torrance, chose to focus on creativity (Cramond, 1993).

Guilford's 1950 American Psychological Association (APA) presidential address is traditionally considered the formal starting date of scientific creativity research within psychology. But the psychometric tradition, and creativity research in general, dates from much earlier. For example, the 1883 publication of Galton's *Inquiries into Human Faculty* discussed the measurement of creativity (Taylor & Barron, 1963), leading to several investigations into creativity and imagination in subsequent decades. Torrance (1982) found evidence of significant efforts by Guy M. Whipple around the turn of the century (i.e., tests of imagination and invention) and in the Human Engineering Laboratories during the 1930s and 1940s, while Barron and Harrington (1981) noted that divergent thinking (DT) tests were developed by Binet and Henri before 1900.

Unlike this largely forgotten early work, the ideas generated in the quarter-century after Guilford's famous address had a tremendous and continuing influence on the field, and the vast majority of the work from this era was conducted from a psychometric perspective. However, over the last thirty years, psychometric work has grown beyond the traditional cognitive and personality approaches. This expansion has been based largely on the work of Amabile (1983) and researchers and theorists who have promoted more encompassing systems and sociocultural theories of creative development (e.g., Csikszentmihalyi, 1988; Glăveanu, 2013; Sternberg & Lubart, 1995). The argument can be made that the field of creativity assessment has never been as active and dynamic as it is currently experiencing (Sternberg, 2010, 2018; Sternberg, et al., 2012).

Traditional Areas of Psychometric Study

Psychometric methods in creativity research are typically grouped into four types of investigations: creative processes, personality and behavioral correlates of creativity, characteristics of creative products, and attributes of creativity-fostering environments. Unlike the more recent development of systems theories and multi-disciplinary approaches, which consider varied perspectives, the psychometric approach generally studied each of the four aspects in isolation. This section reviews seminal and recent work in each of these areas and concludes with a comparison among the specific areas of psychometric investigation.

Creative Processes

Researchers have used psychometric measures of creative process extensively for decades, and they remain a popular measure of creative process and potential. Assessing creative processes is also evident in our schools (Sawyer, 2015). Nevertheless, a majority of criticism directed at creativity measures is primarily (but not exclusively) directed at "creativity tests." These "tests," used to quantify the creative process, have often been DT batteries and have been a lightning rod for criticism of the psychometric study of creativity. These DT assessments ask participants to use "cognition that leads in various directions" (Runco, 1999, p. 577). In contrast to most standardized achievement or ability tests, DT tests require individuals to produce several responses to a specific prompt.

The emphasis on quantity of responses is often referred to as ideational fluency, or simply ideation. The idea that "more is better" is a key component of ideation but is clearly not the sole component of the creative process. DT is often contrasted with convergent thinking, in which cognitive processes are used to produce one or very few possible solutions to a given problem (such as on most standardized tests).

Kaufman, Plucker, and Baer (2008) have noted that it is one of the great ironies of the study of creativity that so much time and energy have been devoted to the use of a single class of assessments. In fact, not only has the most energy been expended on DT tests but almost all of the earliest tests of DT remain in wide use in creativity research and education to this day. These include Guilford's (1967) Structure of the Intellect (SOI) divergent production tests, Torrance's (1974, 2008) Tests of Creative Thinking (TTCT), and Wallach and Kogan's (1965) and Getzels and Jackson's (1962) DT tasks. Even more recent DT measures, such as Hu and Adey's (2002) scientific creativity test, are clearly based on these earlier efforts.

Although the content and instructions of DT tests vary, how responses are categorized remains largely consistent. In general, DT tests ask for multiple responses to either figural or verbal prompts, and responses are scored for fluency, flexibility, originality, and elaboration of ideas. Fluency is operationally defined as the number of responses to a given stimulus. Originality is operationalized as the uniqueness of responses to stimuli. Flexibility is operationalized as the number and/or uniqueness of categories of responses to stimuli. Elaboration is operationalized as the extension of ideas within a specific category of responses to stimuli, "to fill [ideas] out with details" (Guilford, 1967, p. 138). For example, if a person were trying to decide what to buy as a birthday present for her brother, she could come up with as many ideas for presents as possible (fluency), presents that no one else would think of (originality), a list of different types of presents he may like (flexibility), or a list of the different basketball-related presents he might like (elaboration). However, in this example, as in life, choices have to be made eventually, and evaluative (convergent) thinking must be done to select the actual gift to be purchased.

Building on some of Guilford's original conceptions of different types of originality, Acar and Runco (2015) created thirteen dimensions in which responses to DT tests could be categorized (e.g., impractical, infeasible, playful), which they termed literal divergent thinking (LiDT). LiDT differs from the traditional flexibility assessment in that these dimensions are meant to generalize across different DT items whereas traditional flexibility categories vary across DT items (Runco, 1985). These dimensions were created to assess actual "divergence" of responses in terms of them going in different polar directions. This was to help assess underlying processes that may be occurring when developing answers on DT tests. Although these dimensions were found to be used to varying degrees, many were quite common and were often positively related to traditional originality and fluency scores, LiDT should be further explored to determine if it will be a better predictor of creative thinking than the traditional DT indices.

Major approaches to DT assessment. Guilford's (1967) SOI model proposed twenty-four distinct types of DT: one type for each combination of four kinds of content (Figural, Symbolic, Semantic, Behavioral) and six categories of product (Units, Classes, Relations, Systems, Transformations, Implications). For example, the SOI DT battery consists of several tests that ask participants to exhibit evidence of divergent production in several areas, including divergent production of semantic units (e.g., listing consequences of people no longer needing to sleep), of figural classes (finding as many classifications of sets of figures as possible), and of figural units (taking a simple shape and elaborating on it as often as possible).

Tasks on the SOI are characterized by the need for trial-and-error strategies and flexible thinking. One well-known example of an SOI task is the Match Problem (divergent production of figural transformations). There are several versions of the Match Problem but each is a variation on the basic theme of using seventeen matches to create a grid of two rows and three columns (i.e., six squares). Participants are asked to remove three matches so that the remaining matches form four complete squares. By asking participants to transform objects visually and spatially, Guilford was assessing flexibility. Other examples include the Sketches task (fluency with figural units), in which participants draw as many pictures as possible given a specific shape, such as a circle; the Alternate Letter Groups task (flexibility with figural classes), which requires participants to, given a set of letters, form subgroups of letters according to the figural aspects of the letters; and the Associations I task (originality with semantic transformations), in which a person, given two words, finds a third word that links the two (e.g., movie and fishing are linked by reel). Guilford's entire SOI divergent production battery consists of several dozen tests of the various DT components of the SOI model.

Guilford and his colleagues gathered enormous amounts of assessment data to validate the SOI model. Results are generally supportive of the SOI model (e.g., Chen & Michael, 1993). Although some researchers have suggested revisions to the model or concluded that the model has serious weaknesses (Chen & Michael, 1993; Horn & Knapp, 1973; Sternberg & Grigorenko, 2001), it inspired the development of more recent DT tests such as the TTCT.

The TTCT are based on many aspects of the SOI battery and are by far the most commonly used DT assessments. Over the course of several decades, Torrance (1974) refined the administration and scoring of the TTCT, which may account for its enduring popularity. The battery includes Verbal and Figural tests that each include a Form A and Form B that can be used alternately. Verbal subtests include Asking, Guessing Causes, Product Improvement, Unusual Uses,[1] Unusual Questions, and Just Suppose. The first three verbal subtests provide a picture to be used as a stimulus. For example, the image might be an elf gazing at the reflection in a pool of water with participants asked as many questions as they can about the image; guess causes for what made the image come to be; and guess the consequences that will result from the image.

The other four verbal subtests are independent and do not rely on an external stimulus. For Product Improvement, participants are given a toy and asked for different ways it could be improved. The Unusual Uses test requires participants to list different uses for an everyday object such as a cardboard box. A slight variation on this is the Unusual Questions tasks, which asks participants to ask as many questions as possible about an object. The final verbal subtest, Just Suppose, calls for participants to imagine what would happen if an improbable situation took place, such as if people no longer had to sleep.

There are three Figural subtests consisting of Picture Construction, Picture Completion, and Lines/Circles. Picture Construction requires participants to make a picture out of a basic shape whereas the Picture Completion subtest provides a partially complete picture and asks participants to finish and name the drawing. The Lines/Circles subtest provides participants with a either a set of lines or circles to modify and shape.

[1] This subtest does not appear in later editions.

Administration, scoring, and score reporting of the TTCT are standardized with detailed norms. Although Torrance recommended that scorers be trained, he found that cursory levels of training (i.e., reading and understanding the scoring manual) allowed novice raters to produce scores associated with acceptable reliability estimates. His one caveat was that untrained raters tend to deviate from the scoring system when assessing originality, injecting their own personal judgments on the scoring of individual responses.

The original test produced scores in the traditional four DT areas of fluency, flexibility, originality, and elaboration. The streamlined scoring system introduced in the 1984 revision made significant changes, including the Figural tests being scored for resistance to premature closure and abstractness of titles in addition to the familiar scores of fluency, originality, and elaboration. Flexibility was removed because those scores tended to be largely undifferentiated from fluency scores (Hébert et al., 2002).

Although the SOI and TTCT may be the best known DT batteries, there are several others that have been used for decades. Getzels and Jackson (1962) and Wallach and Kogan (1965) developed DT batteries that are similar to the SOI tests. For example, the Instances Test requires that students list as many things that move on wheels (things that make noise, etc.) as possible (Wallach & Kogan, 1965), and on variations of the Uses Test students provide responses to prompts such as “Tell me all the different ways you could use a chair” (newspaper, knife, tire; Wallach & Kogan, 1965, p. 31) or use bricks, pencils, or toothpicks (Getzels & Jackson, 1962). The most appreciable difference between the batteries lies in the conditions in which students take the tests. Wallach and Kogan (1965) supported gamelike, untimed administration of DT tasks that they believed allows creativity to be measured distinctly from intelligence as a result of the creation of “a frame of reference which is relatively free from the coercion of time limits and relatively free from the stress of knowing that one’s behavior is under close evaluation” (p. 24). This constraint-free administration is in contrast to the testlike, timed procedures used with most other DT measures. Admittedly, much of this foundational work on creative assessment is old. However, it is important to keep in mind because it serves as the foundation of current practices.

Psychometric evidence. Evidence of reliability for the SOI, TTCT, Wallach and Kogan, Getzels and Jackson, and similar tests is fairly convincing (e.g., Torrance, 1981; Williams, 1980), but the predictive and discriminant validity of DT tests has mixed support (cf. Bachelor, 1989; Clapham, 1996; Cooper, 1991; Thompson & Anderson, 1983). However, the perceived lack of predictive validity (Baer, 1993, 1994; Gardner, 1993; Weisberg, 1993) has led some researchers and educators to avoid the use of these tests and continues to serve as a lightning rod for criticisms of the psychometric study of creativity. However, one important caveat is that it is not universally accepted that psychometric measures of creative processes have poor predictive power. In fact, several studies provide at least limited evidence of discriminant and predictive validity for DT tests (Milgram & Hong, 1994; Torrance & Safter, 1989; Yamada & Tam, 1996). The evidence becomes more positive under certain sampling and assessment conditions recommended in the literature (e.g., samples of high IQ children, utilizing content specific DT measures; see Clapham et al., 2005; Hong, Milgram, & Gorsky, 1995; Milgram & Hong, 1994; Runco, 1986). Plucker (1999a), in a reanalysis of Torrance data using more sophisticated statistical techniques, found evidence that DT test scores were three times better than IQ test scores at predicting adult creative achievement. Regardless, some have also criticized DT as being largely irrelevant to modern conceptions of creativity (e.g., see Baer, 2011a, 2011b; Kim, 2011a, 2011b).

The conditions under which tests are administered (e.g., gamelike vs. testlike, timed vs. untimed, online vs. paper, individual vs. group, specific instructions to "be creative" vs. generic instructions) also influence originality and/or fluency scores (Benedek et al., 2013; Chand & Runco, 1992; Hass, 2015). Some have also noted that scores on divergent production tests are susceptible to training and intervention effects (e.g., Clapham, 1996; Torrance, 1988).

A final concern with the psychometric measurement of creative processes involves how these batteries are scored. There is some evidence that alternatives to the traditional frequency tabulations of fluency, flexibility, originality, and elaboration should be considered, including the calculation of summative scores (i.e., totaling fluency, flexibility, and originality scores), uncommon scores (answers given by less than five percent of participants), weighted fluency scores, percentage scores, and scores based on the entire body of each participant's answers as opposed to scoring individual responses in a list of ideas (Plucker, Qian, & Wang, 2011; Plucker, Qian, & Schmalensee, 2014; Runco & Mraz, 1992; Silvia, 2011; Silvia et al., 2008; Silvia, Martin, & Nusbaum, 2009). Moreover, both quantity and quality of student responses should be included as outcome variables (Runco, 1986). Studies that have included both quantity and quality factors have provided support for the predictive validity of DT tests (e.g., Davidovitch & Milgram, 2006; Plucker, 1999a).

Although many other strategies have been suggested as ways to control for fluency effects, an especially intriguing technique was created by Snyder and colleagues (2004). They proposed the calculation of a Creativity Quotient (CQ) to score DT test responses, a formula that rewards response pools that are highly fluent but also highly flexible. Although readers are referred to Snyder and colleagues (2004) or Kaufman, Plucker, and Baer (2008) for a more detailed explanation of the CQ, it has been extended and the technique finetuned since its original development (e.g., Bossomaier et al., 2009; Lucas et al., 2013), which appears to be a promising line of DT assessment research.

In summary, DT tests occupy nearly the entire spotlight on research of the creative process. Although the ability to generate ideas is only one aspect of the creative process, its predominance implicitly devalues the role of creativity in the solving of problems. Although old habits die hard (and slowly), the field is starting to include both quantity and quality of outcome variables.

The Creative Person

A second major area of activity involves assessments of creative personality. Measures focusing on characteristics of the person typically focus on self-report or external ratings of past behavior or personality characteristics. In a meta-analysis on personality and creativity research, Feist (1998) categorized research on the creative person as either a between-group (e.g., comparing scientists with nonscientists) or a within-group (e.g., creative vs. less creative scientists) comparison.

Personality scales. Instruments intended to measure personality correlates of creative behavior are generally designed by studying individuals already deemed creative and then determining their common characteristics. These traits are then used as a reference for other children and adults under the assumption that individuals who compare favorably are predisposed to creative accomplishment. Such measures are quite common in creativity research and include the Group Inventory for Finding Talent and Group Inventory for Finding Interests (see Davis, 1989), the Self Report of Creative Traits (Runco, Acar, & Cayirdaga, 2017), NEO-Five Factor Inventory (McCrae & Costa, 1997), work undertaken at the Institute of Personality Assessment and Research (Hall & MacKinnon, 1969; MacKinnon, 1978), specific scoring dimensions of the Adjective Check List (Domino, 1994; Gough, 1979), the Sixteen Personality Factor Questionnaire (Cattell, Eber, & Tatsuoka, 1970), and the Creative Personality Scale (Kaufman & Baer, 2004) which consists of twenty items selected from the International Personality Item Pool (Goldberg, 1999). After analyzing research that relied on these and related instruments, Davis (1992) concluded that personality characteristics of creative people include awareness of their creativity, originality, independence, risk-taking, personal energy, curiosity, humor, attraction to complexity and novelty, artistic sense, open-mindedness, need for privacy, and heightened perception. Similarly, Feist (1998) found consistently that creative people tend to be "autonomous, introverted, open to new experiences, norm-doubting, self-confident, self-accepting, driven, ambitious, dominant, hostile, and impulsive" (p. 299), with openness, conscientiousness, self-acceptance, hostility, and impulsivity having the largest effect sizes. These studies mirror the results of other, recent studies and reviews of the literature (e.g., Batey & Furnham, 2006; Qian, Plucker, & Shen, 2010).

Additionally, within the personality psychology research field, the Big Five (McCrae & Costa, 1997) has become more accepted as explaining human personality. Within creativity, a meta-analysis has found that Big Five personality traits have stronger correlations to domain-general measures of creative self-beliefs than domain-specific (Karwowski & Lebuda, 2015). Of the Big Five personality traits, openness to experience was the most strongly related to creative self-beliefs; only neuroticism had a negative correlation (although this was weak, −0.124). Additionally, openness to experience has been found to predict creative achievement, behaviors, and performance (Beaty, Nusbaum, & Silvia, 2014; Kaufman, 2016; Silvia et al., 2009), although DeYoung (2015) points out that openness to experience itself has at least two distinct yet related factors: intellect and openness. These can also be broken into intellectual engagement, explicit cognitive ability, affective engagement, and aesthetic engagement factors. Such granularity may assist in making more precise predictions of different types of creativity across different domains.

Activity checklists. In addition to personality traits, past behavior of creative individuals is also often examined to determine whether experience is associated with creative production. As a result, self-reports are relied on for information about an individual's past behaviors and accomplishments that may reflect creative potential and achievement. Based on the assumption that "the best predictor of future creative behavior may be past creative behavior" (Colangelo et al., 1992, p. 158), several self-report biographical or activity inventories have been developed, such as the Creative Behavior Inventory (Hocevar, 1979), or other checklists (An & Runco, 2016; King, McKee, & Broyles, 1996; Milgram & Hong, 1994). Hocevar and Bachelor (1989) and Plucker (1998, 1999b) believe self-reports of activities and attainments to be the preferable technique with which to measure creativity, and Silvia and colleagues (2012), after a comprehensive analysis, recommended self-reports as a promising creativity assessment technique.

Three examples of this type of instrument include the Creativity Achievement Questionnaire (CAQ; Carson, Peterson, & Higgins, 2005), the Runco Ideational Behavior Scale (RIBS; Runco, Plucker, & Lim, 2000–2001), and the Kaufman Domains of Creativity Scale (K-DOCS; Kaufman, 2012). The CAQ (Carson et al., 2005) assesses creativity with ninety-six items across ten domains that load onto an Arts (Drama, Writing, Humor, Music, Visual Arts, and Dance) and a Science factor (Invention, Science, and Culinary). A respondent indicates the extent to which given items describe her or his creative achievements in each area. For example, within the Humor scale, items range from "I do not have recognized talent in this area" to "I have created jokes that are now repeated by others" to "I have worked as a professional comedian" to "My humor has been recognized in a national publication." The CAQ is associated with high levels of evidence of reliability and with acceptable evidence of concurrent validity.

The RIBS was developed in response to a perceived need for a more appropriate criterion in studies of predictive validity for DT tests. Runco reasoned that a more appropriate criterion would be one that emphasizes ideation: the use of, appreciation of, and skill of generating ideas. Sample items include "I think about ideas more often than most people," "Friends ask me to help them think of ideas and solutions," and "Sometimes I get so interested in a new idea that I forget about other things that I should be doing."

Runco and colleagues (2001) examined the psychometric integrity of the RIBS, with results suggesting adequate evidence of reliability and construct validity. Plucker, Runco, and Lim (2006) subsequently used the RIBS as a criterion measure in a study of DT and time-on-task, with positive conclusions about the ability of DT assessments to predict ideational behavior; Runco and colleagues (2014) recently developed a brief version of the RIBS and gathered evidence of concurrent validity.

The K-DOCS (Kaufman, 2012) consists of fifty items measuring creativity in five broad domains: Self/Everyday, Scholarly, Performance (encompassing writing and music), Mechanical/Scientific, and Artistic. Participants are asked to rate themselves on a Likert scale from 1 (much less creative) to 5 (much more creative) with regard to various creative behaviors such as "creating a tasty meal out of scattered leftovers" and "finding new ways to motivate myself to do something unpleasant." The K-DOCS is associated with acceptable internal consistency reliability and test–retest reliability (Kaufman, 2012). Sizable correlations between the five creativity domain scores and the Big Five personality traits, especially openness, also provided solid evidence of convergent validity (Kaufman, 2012).

One weakness of this approach is that the administration of self-report scales may not be logistically feasible with all groups, such as very young children. In response to this need, several instruments have been developed to allow parents, teachers, other adults, and even peers to assess personality and past behavior correlates of creativity. Perhaps the most popular instruments, at least within educational settings, are the Scales for Rating the Behavioral Characteristics of Superior Students (SRBCSS; Renzulli, Hartman, & Callahan, 1981; Renzulli et al., 2002). Teachers rate specific students on a six-point scale ranging from *never* to *occasionally* to *always*, with creativity scale items such as "The student demonstrates . . . imaginative thinking ability," ". . . an adventurous spirit or a willingness to take risks," and ". . . the ability to adapt, improve, or modify objects or ideas." The SRBCSS has been found to be the most frequently used measure of creativity in gifted education screening procedures (Callahan et al., 1995; Hunsaker & Callahan, 1995), which is relevant given that twenty-seven states use definitions of giftedness that include creativity (McClain & Pfeiffer, 2012).

Validity evidence of both self-reports and ratings by "familiar others" are inconclusive – with respect to creativity and to talent in general – with evidence supporting both the presence of validity (Gagné, 1994; McKay, Karwowski, & Kaufman, 2017; Plucker, 1999b, 2004; Pyryt, 2004; Renzulli et al., 1981) and a lack thereof (Baer, 1998; Dollinger, Burke, & Gump, 2007; Lee et al., 2002; Priest, 2006).

Attitudes. The measurement of attitudes toward creativity is important because, as Basadur and Hausdorf (1996) describe in their attitude research within the business community, "Managers with more positive attitudes could be encouraged to participate in activities where these views can be optimized . . . Alternatively, managers with less positive attitudes could participate in training to improve their attitudes and skills. Thus, the understanding and measurement of these attitudinal concepts provides a pathway to increasing managers' and companies' success" (p. 23). Additionally, theoretical and empirical support exists for a connection between ideational attitudes and ideational thinking (Acar & Runco, 2015; Basadur & Finkbeiner, 1985). Although attempts to measure creative attitudes have not been widespread, considerable effort has been expended on the creation of attitude measures for the purpose of evaluating attitude toward interventions in business across cultures (Basadur, Pringle, & Kirkland, 2002; Basadur, Wakabayashi, & Takai, 1992) and identifying individuals who are predisposed to innovation or adaptation (Kirton, 2006).

For example, Basadur and colleagues have developed two scales that assess attitudes toward important aspects of DT, the six-item Preference for Active Divergence scale and the eight-item Preference for Premature Convergence (or premature closure) scale, with the former being indicative of positive DT attitudes and the latter being counterindicative (Basadur & Finkbeiner, 1985; Basadur, Taggar, & Pringle, 1999; Runco & Basadur, 1993). Items on the Active Divergence scale include "One new idea is worth 10 old ones" and "I feel that all ideas should be given equal time and listened to with an open mind, regardless of how zany they seem to be." Items representing Premature Convergence include "Lots of time can be wasted on wild ideas" and "wish people would think about whether or not an idea is practical before they open their mouths."

In the school setting, Runco, Acar, and Cayirdaga (2017) developed the Creative Attitudes and Values, a ten-item scale to measure students' attitude toward DT. A sample item is "Even if some method has worked well in the past, it is a good idea to question and perhaps change it on a regular basis." Every item has five response options: Never (0), Rarely (1), Sometimes (2), Mostly (3), and Always (4).

Tierney and Farmer (2002, 2011; Schenkel, Farmer, & Maslyn, 2015), building on the work of Gist and Mitchell (1992), proposed the concept of creative self-efficacy as representing a person's beliefs about how creative he or she can be. These beliefs are often rooted in a situational or narrow context (e.g., Jaussi, Randel, & Dionne, 2007). A broader view of creative self-efficacy examines creative personal identity, which is also reflective of how much someone values creativity (e.g., Randel & Jaussi, 2003). Measures of creative self-efficacy are often brief; as an example, Beghetto (2006) used a three-item scale: I am good at coming up with new ideas, I have a lot of good ideas, and I have a good imagination. In another study, Beghetto, Kaufman, and Baxter (2011) used a five-item scale to measure students' creative efficacy in science: I am good at coming up with new ideas during science class, I have a good imagination during science class, I have a lot of good ideas during science class, I am good at coming up with my own science experiments, and I am good at coming up with new ways of finding solutions to science problems.

Karwowski (2014) also developed two measures, the ten-item Creative Mindsets Scale that assesses participant beliefs regarding the fixed vs. growth nature of creativity, and the eleven-item Short Scale of Creative Self that measures an individual's creative self-concept, including both creative self-efficacy and creative personal identity. Sample items include "Some people are creative, others aren't – and no practice can change it" (Creative Mindsets), "I am good at proposing original solutions to problems" (self-efficacy), "I think I am a creative person" (identity), and "My creativity is important for who I am" (identity). All the items are answered using a five-point scale with 1 representing Definitely Not, and 5 being Definitely Yes.

All of these researchers have gathered evidence of reliability and validity, although the theoretical and psychometric distinctions between measures of creative self-efficacy and instruments such as the RIBS, which have similar items but are intended to measure different constructs, have yet to be clarified.

Creative Products

Assessment of creative products receives much less attention in the literature than assessment of personality, process, or even environmental variables, yet a case can be made that the ability to measure a product's creativity is among the most important aspects of creativity assessment. For example, if a company designs a new app or cell phone, being able to assess the degree of creativity in various designs may lead to substantial profit – and potential savings as resources are not wasted on noncreative designs. How does a teacher determine whether a student's product is truly creative? In a different vein, the creativity of artistic products is often hotly debated; those debates are almost always subjective in nature and perhaps need not be.

From a psychological and educational perspective, Runco (1989) noted that analysis of creative products may address the measurement problems caused by the inconsistent psychometric quality of other forms of creativity measurement. More to the point, Baer and Kaufman (see Baer, Kaufman, & Gentile, 2004), among others, believe that product assessments are probably the most appropriate assessments of creativity. (Several researchers have referred to such assessments as the "gold standard" of creativity assessment.) This logic is compelling: If one goal of creativity psychometrics is to predict who is most likely to produce creative works in the future, being able to create such products in the past or present is a key indicator.

Advanced techniques for the assessment of creative products clearly have a wide range of potential applications, and after some stagnation in the mid to late 1990s, several potentially fruitful efforts have emerged in recent years. Although a number of high-quality product assessments have been developed, including the Creative Product Semantic Scale (Besemer & O'Quin, 1999) and Student Product Assessment Form (Reis & Renzulli, 1991), the most active area is that of the Consensual Assessment Technique (CAT; for information on the early development of the methodology, see Amabile, 1983).

The CAT is an attempt to solve the "criterion problem" in creativity research: How do we know we are using the correct criteria of creativity when we design assessments? The criterion problem is a direct result of the field's difficulty defining its terms. Amabile (1982) hypothesized that "a product or response is creative to the extent that appropriate observers independently agree it is creative" (p. 1001). In other words, people know creativity when they see it, and the use of expert judges to evaluate a product's creativity should, theoretically, avoid criterion problems. Evidence of reliability has been found across a wide range of applications (Amabile, 1983; Baer et al., 2004; Conti, Coon, & Amabile, 1996; Hennessey, 1994), and the technique has been applied to assess the creativity of a broad range of products across diverse research contexts (e.g., Fodor & Carver, 2000; Hickey, 2001; Ruscio, Whitney, & Amabile, 1998).

However, the use of expert judges is not without controversy. Early in the development of the CAT, evidence suggested that determining the necessary level of expertise for judges depends on a variety of factors, including the skill of the subjects, the target domain, and the purpose of the assessments (e.g., Amabile, 1996; Runco, McCarthy, & Svenson, 1994; Runco & Smith, 1992). Although Amabile (1996) recommends that experts have "at least some formal training and experience in the target domain" (p. 73), several researchers have examined the level of expertise that is necessary when using the CAT or similar assessment strategies. Indeed, over the past decade, researchers have learned a great deal about the use of expert judges to evaluate creative products. In general, expert and novice judges tend to produce quite different ratings of product creativity, although the domain in which the product is created impacts the degree to which the groups' ratings overlap. For example, Kaufman, Baer, and colleagues (2008) found that expert and novice (e.g., college student) ratings of poetry barely correlated, yet Kaufman, Baer, and Cole (2009) found a higher correlation between the similar groups when evaluating the creativity of short stories. When using artistic products, Dollinger, Urban, and James (2004) found rather large correlations between artists and psychologists.

Recent research suggests that expertise, at least in this context, should be conceptualized as a continuum. When Kaufman, Gentile, and Baer (2005) compared expert judges and quasi-experts (gifted high school writers), they found appreciably higher correlations between the two groups' ratings of creative writing products than previous research would have predicted. Similarly, Plucker and colleagues (2009) found that the movie ratings of professional movie critics (experts), film website users (novices), and college students (laypeople) fall on a continuum, with lowest ratings from critics and highest ratings from college students, with novices firmly in between the other two groups. Other researchers (Kaufman & Baer, 2012; Kaufman et al., 2013) further pointed out that the level of expertise required to evaluate creative work might differ across domains. Specifically, Kaufman and colleagues (2013) asked experts, quasi-experts, and novices to rate short stories and an engineering product in terms of creativity and found high correlations between experts' and quasi-experts' ratings of short stories and low correlations between novices' judgments and those of experts, but a slightly different pattern was observed when comparing the creativity ratings of an engineering product (a mousetrap design), with the differences between experts, quasi-experts, and novices becoming larger and sharper. Overall, these studies have suggested that both the level of expertise and the nature of domains should be considered when it comes to selecting CAT raters, and novices do not appear to be the ideal CAT raters.

Three issues should be considered when evaluating the research on the CAT. First, the CAT, as it has been applied in various ways by researchers, is associated with convincing evidence of reliability, and recent efforts to modify the technique show promise for further improvement (e.g., Dollinger & Shafran, 2005). However, some researchers (e.g., Jeffries, 2017) have argued that the level of agreement among experts (i.e., interrater reliability) can be very low, and the results are also heavily influenced by the instructions raters are provided prior to their evaluation of the creative aspects of products. Moreover, evidence of validity is primarily found in the area of face validity, and several key aspects of validity such as generalizability and convergent and discriminant validity have not yet been examined. This concern leads to the second issue, which involves questions about the appropriateness of using external judges to evaluate creativity. Runco and his colleagues (Runco & Chand, 1994; Runco, McCarthy & Svenson, 1994; Runco & Smith, 1992; Runco & Vega, 1990) have long questioned why "expert" opinion would be more valid or useful than self-ratings or the evaluations of peers, teachers, and other groups that are not necessarily experts. This is not a trivial concern: Given the expense and difficulty often encountered when planning and implementing studies involving expert raters, determining the appropriate level of expertise (if any) required for valid results when using CAT-like assessment strategies should continue to be a priority for researchers. At least, peer and teacher evaluations are based on long-term observations and should be considered along with "expert" ratings.

Consumer product design models. As research on design has become more prevalent in the psychological and educational literature, the assessment of creative products from a design perspective has likewise become more common. As Christiaans (2002) has observed, "the result of a design activity is often expected to be original, adding value to the existing world of design. In the selection of designs for production in companies, for design awards, and in the field of design education, creativity assessment relies on human judgments" (p. 41). Although some researchers have used existing instruments and techniques (e.g., Christiaans used an approximation of the CAT and the Creative Product Semantic Scale), new models are also in development. A recent case in point is the research of Horn and Salvendy (2006a, 2006b), in which the researchers have questioned the applicability of existing product measures to the design context and propose an alternative model consisting of six components: Novelty (the newness of the product), Resolution (the ability of a product to resolve a problem), Emotion (the pleasure or arousal induced by the product), Centrality (ability to match consumer needs), Importance (importance to consumer needs), and Desire (how critical or desirable the product is). Then Horn and Salvendy (2009) reduced the six-dimensional model of product creativity to a more parsimonious three-dimensional model: Affect (emotional draw and feelings toward the product), Importance (importance or relevance to consumer needs), and Novelty (uniqueness and newness of a product). Although this work is relatively new, the increasing importance of design suggests this approach to creative product assessment could increase in importance.

Creative Environments

Hunter, Bedell, and Mumford (2007), in their comprehensive review of research on situational influences on creativity, identified a number of environmental variables suspected to be related to creativity, including intra- and intergroup interactions, leadership, organizational structure, leadership, competition, and cohesion, among many others. A casual review of research literature in business and management shows many studies of how creativity and work environments are related (or not). Sternberg (2000, 2016) also discussed different kinds of environments and the extent to which they allow creativity.

Much of this research examines the correlation between successful work and situational variables and does not focus on assessments of creative environments per se. For example, Forbes and Domm (2004), in an approach influenced by the work of Amabile and her colleagues, developed an environment survey that required participants to rate the importance of items related to a recent, successful, creative project on which they worked. Six factors emerged from the data: mental involvement, intrinsic motivation, time and resource constraints, extrinsic motivation, external control, and team management.

One exception to this trend is the work of Amabile and her colleagues. Based on extensive research on organizational creativity (e.g., see Amabile et al., 1994, 2004), Amabile and colleagues (1996) developed the KEYS: Assessing the Climate for Creativity instrument. Amabile and colleagues (1996) created the KEYS in order to examine employees' perceptions of aspects of their work environment that may influence creative work – especially creative work by teams. They note that the self-report instrument is designed to assess "individuals' perceptions and the influence of those perceptions on the creativity of their work" (p. 1157). This instrument is associated with evidence of reliability and validity and is widely used by researchers.

Strengths and Weaknesses of Creativity Assessment

In reviewing the extensive literature, several clear strengths and weaknesses of creativity assessment become obvious. The sheer depth of psychometric work is impressive, with decades of studies and instrument development available. Indeed, a case can be made that many of the foundational ideas of the field are based on this voluminous psychometric research; this work appears to be particularly influential outside of the United States. For example, psychometric methods provided the foundation for problem-solving programs in a variety of contexts (Basadur, Graen, & Green, 1982; Isaksen & Treffinger, 1985), school-based creativity training programs (Renzulli, 1976), remediation programs (Meeker & Meeker, 1982), and whole school talent development models (Renzulli, 1994).

Another strength is that, in certain contexts (e.g., samples of high IQ children, using content specific DT measures), evidence of validity – including predictive validity – is rather convincing. A related weakness, of course, is that many popular instruments are not associated with such convincing evidence or have been subjected to too little psychometric evaluation.

Third, criticisms of creativity assessment aimed at DT are probably overblown. Although the field's reliance on divergent thinking is a weakness, those researchers interested in creativity should consider Guilford's observation that, "Most of our problem solving in everyday life involves DT. Yet in our educational practices, we tend to emphasize teaching students how to find conventional answers" (1968, p. 8). This comment is as salient today as when Guilford first wrote it. However, a better way forward almost certainly involves strategies that move well beyond DT, such as multifaceted, multimodal assessment systems involving many of the other strong measures discussed in this chapter.

All of that said, many criticisms about creativity psychometrics are valid. Some should be relatively straightforward to address, others more difficult. First and foremost, for nearly half a century, scholars have been calling for more research on the criterion problem. As Cattell and Butcher (1968) noted, “obtaining a criterion score on ‘creativity’ to check the predictive power of our tests is going to present formidable conceptual and practical problems” (pp. 285–286). This is the area that has received the most attention from researchers in recent years, although the needed psychometric work mentioned above is conspicuous in its absence.

The traditional criticisms about lack of predictive, discriminant, and construct validity evidence still hold true, although as noted above, there are many caveats and exceptions. But creativity assessment researchers still do not conduct evaluations of psychometric integrity very often, which adds to the problem by both failing to gather needed data and giving the impression that this type of work is unimportant. This research is needed for every type of assessment, from DT tests to the CAT. For example, critics have hypothesized that the lack of consistent construct validity evidence for the TTCT is due to response set bias (i.e., the use of the same participant responses to derive multiple scores, which can lead to high score intercorrelations; see Heausler & Thompson, 1988). Other DT tasks not scored in this way (e.g., much of Guilford’s work) are associated with more positive evaluations of construct validity than the TTCT. A potential solution is obvious: Score the TTCT without response set bias and examine the resulting construct validity evidence. Yet we have not been able to find any such studies in the twenty to thirty years since this hypothesis was discussed in the published literature. In a completely different area, CAT research is marked by a distinct lack of predictive validity studies, which is surprising given that many CAT advocates have stridently criticized DT assessments for their purported lack of evidence of this type. Addressing these criticisms should not be difficult, yet this research remains uncommon.

Another common criticism is that the field is living in the past, methodologically speaking: the almost exclusive reliance on classical test theory, the use of traditional assessment strategies, and so on. These criticisms are not without warrant, and we would go further to call for explorations in the use of biometric and neurocognitive methods that are gaining popularity in other fields but have generally not been applied in the assessment of creativity. Applying these methods will be expensive and time-consuming but the potential benefits could be tremendous.

Such improvement in method, coupled with advancements in theory and reproducibility, will help lead creativity toward being more of a cumulative science (Makel & Plucker, 2014; Vartanian, 2014). Despite development, avenues for truly original approaches to creativity assessment remain. Psychometric limitations of creative assessment are likely what typically come to mind when considering limitations of assessment. But theoretical limitations are also important (Vartanian, 2014). Without developed theory, assessment is also stunted. Take, for example, the propulsion theory of creativity offered by Sternberg, Kaufman, and Pretz (2001), in which eight qualitatively distinct kinds of creativity are posited. The idea of propulsion stems from the concept that creative ideas propel a field forward. The eight types are grouped into three categories: those that accept current paradigms (replication, redefinition, forward incrementation, advance forward incrementation), those that reject them (redirection, reconstruction/redirection, reinitiation), and those that synthesize them (integration). The distinctions are meant to differentiate type, not amount of creativity. Such a unique approach to creativity appears to be a promising foundation on which to build a new series of creative product assessments, yet no one beyond Sternberg and his colleagues appears to be willing to take the bait.

Finally, a major limitation on the usefulness of creativity assessments is the lack of instruments and strategies that can be scaled to use with large groups. For example, most DT assessments are easy to administer but extraordinarily time-intensive (and if we are being honest, dreary) to score. This makes them less than ideal for classroom use, let alone use in statewide K-12 school accountability systems or college admissions. Rapidly advancing technology has been suggested as a potential solution to this scaling problem. Regardless, the ability to "scale up" creativity assessments may very well determine whether these important measures become highly influential alternatives to achievement tests or remain useful, small-scale research tools with limited impact.

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4 Understanding the Development of Creativity Across the Life Span

Anna N. N. Hui, Mavis W. J. He, and Wan-chi Wong

Creativity, a multifaceted construct, can be meaningfully conceived from a developmental perspective. Throughout the life course, creativity grows and declines and serves different purposes to individuals, making creativity development a dynamic process. A preschooler displays imagination by making up songs with interesting rhymes for self-expression. A school-age child develops a keen interest in digging deeper into topics such as planetology or paleontology out of curiosity. An adolescent experiments with new ideas in the pursuit of personal expression. A young adult shows independence in choosing his or her career to form a new identity. An established design engineer and his or her team create a new product to make a financial profit or to effect a social impact. An older adult engages in creative narrative expression to reinterpret the meaning of his or her life. Creativity engenders society's greatest achievements, business innovations, and personal meaning-making. Creativity is defined as novel and appropriate behaviors (Hennessy & Amabile, 2010) and also in terms of a continuum of impact in a field ranging from null to great (Piffer, 2012). Creativity is usually measured by well-established instruments or creative products (Kaufman, Plucker, & Baer, 2008) and self-reported measures or qualitative interviews (Plucker & Renzulli, 1999; Ramos & Puccio, 2014).

Lifespan developmental psychology studies the emergence of and change in attitude, behavior, and experience in terms of nurturing potential and growth, and of exploring the limits and decline of psychological functions (Heckhausen, 2005). Lifespan psychologists assume that development begins in childhood and extends across the entire life cycle with goals of growth, maintenance, and regulation of loss (Baltes, Staudinger, & Lindenberger, 1999). The development of cognition and behaviors is thought to be dynamic, with multiple dimensions and functions, and nonlinear (Baltes, 1997). Lifespan theory can be constructed in two ways: person-centered (holistic and life course) and function-centered (Baltes et al., 1999).

The person-centered approach to creativity development attempts to describe and connect states of creativity development in order to generate a knowledge base about

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the overall pattern of creativity throughout the life course. An example is Tegano, Moran, and Sawyer's (1991) developmental criteria for creativity: originality in preschool age, high quality in school age, and genuine significance in adulthood. Young children with creative potential display original and unusual ideas and achieve higher ideational fluency. Schoolchildren who are creative precursors propose high-quality and workable ideas in the process of discovering original solutions. Adults with creative behaviors contribute to society by translating their original ideas into products with social impact.

The function-centered approach to creativity development focuses on mechanisms and processes of creativity and their functions for the individual and for society. Mechanisms of creativity include a "be creative effect" instructing individuals to be inventive in various tasks (Niu & Liu, 2009; Nusbaum, Silvia, & Beaty, 2014), creativity judgment (Storme et al., 2014), and motivational mechanisms related to intrinsic motivation (Liu et al., 2016; Moon, Hur, & Hyun, 2017). The functions of creativity may include making an impact and effecting improvement in society (Moran, 2010), creating an author/originator identity in eminent individuals or professionals (Hanson, 2013), self-expression (Moran, 2010), and construction of self in ordinary individuals (Hanson, 2013). These mechanisms and functions develop and change across the life span.

When are individuals creative? Does it begin in childhood? How does creativity change across the life span? Does it optimize in adulthood? How does creative performance vary in quantity, quality, and form across time (Lubart & Sternberg, 1998)? This chapter adopts a lifespan developmental psychology approach to examine the emergence of and change in creativity as measured by psychometric assessment tools, and to discuss factors enhancing or inhibiting the development of creativity in individuals across different life stages. The lifespan developmental model of creativity argues that the types of creativity expressed, how they are measured, and how they are valued also vary in different life stages (Lindauer, 2003; Lubart & Sternberg, 1998; Stroebe, 2010) and domains (Baer, 2015; Runco & Cayirdag, 2012). Understanding the lifespan developmental perspective of creativity may enrich our knowledge of the critical factors that can facilitate and inhibit creativity.

Creativity Development in Childhood and Adolescence

Creativity can be developed at a very young age, and researchers have realized that, in the earliest stage of creativity development, "play" is closely related to the process. For example, many researchers have documented that the development of creativity usually begins and develops through active engagement in different forms of play, such as imaginative play (Vygotsky, 1967/2004), pretend play (Hoffmann & Russ, 2016), and child-directed play (Reifel & Sutterby, 2009). Play is understood as a universal, innate, and lifelong social behavior that is essential to the learning process (Pramling & Carlsson, 2008). Creativity manifests and proliferates as a result of new and personally meaningful interpretations of the play process (Kaufman & Beghetto, 2009). Research has shown that young children can engage in imaginative play as early as two years old (Singer, 2009), making meaningful learning connections and gaining insights. Creativity is demonstrated when a young child has the personal insight that a plastic toy banana can represent a cell phone or that a building block can be used as an imaginary cup (Beghetto et al., 2012). An abundance of research findings support the positive effects of play on imagination, problem-solving, and the thinking skills associated with creativity (e.g., Hoffmann & Russ, 2012, 2016; Kaugars & Russ, 2009; Russ & Schafer, 2006).

In studies on creativity development in children and adolescents, one common and interesting finding regards the discontinuity or nonlinear pattern of development (He & Wong, 2015; Runco & Charles, 1997). A considerable number of studies show convincingly that the process of creativity development is not a continuous, smooth one; rather, there are sudden drops (slumps) or increases (jumps) associated with different stages in childhood and adolescence (Alfonso-Benlliure & Santos, 2016; Torrance, 1963, 1968). One of the earliest and the most commonly recognized findings on slumps in the development of creativity in children was that obtained from Torrance's (1963, 1968) longitudinal study of a sample of a hundred participants (forty-five boys and fifty-five girls). Torrance (1963) found that the first slump in children's creative thinking occurs at approximately five years of age, when children enter formal schooling. A few years later, Torrance (1968) reported another sudden drop among fourth graders, the so-called "fourth-grade slump" or "fourth-grade crisis," which occurs at the age of nine or ten (Lubart & Lautrey, 1995; Rosenblatt & Winner, 1988; Torrance, 1968, 1977).

Following Torrance's initial findings, many other researchers have further reported a slump in creativity development during childhood and adolescence (e.g., Barbot, Lubart, & Bescançon, 2016; Cheung et al., 2004; Daugherty, 1993; He & Wong, 2015; Krampen, 2012; Urban, 1991). This subsequent research seems to agree in suggesting that the occurrence of a creativity slump is usually associated with entry into formal schooling (i.e., age six or seven; Krampen, 2012), promotion to the fourth grade (age nine or ten; Lubart & Lautrey, 1995), and the transition from primary to secondary school (i.e., age eleven or twelve; He & Wong, 2015; Kim, 2011). Furthermore, researchers also have observed individual differences in children's experiences of the slumps and jumps in their creativity development, with some individuals more vulnerable to a slump than others (Barbot et al., 2016). He and Wong (2015) identified negative appraisals of school life as the major detrimental factor leading to a creativity slump at school transition.

Other important factors that are critical for facilitating or hindering creativity development in childhood and adolescence have been summarized by Beghetto and Kaufman (2014). They organized such factors into two categories: individual and environmental factors. Empirical findings regarding individual factors have shown that key factors leading to the development of creativity include cognitive ability, such as divergent thinking (Kim, 2005) and possibility thinking (Craft, 2010; Craft et al., 2013), task motivation (Hennessey & Amabile, 2010), and personality traits such as openness to experience (Feist, 2010) and overexcitabilities (i.e., heightened sensitivity and intensity; He, Wong, & Chan, 2017). There are also empirical findings on the effective ways to foster a creativity-nurturing environment. Harrington, Block, and Block (1987), for example, showed that childrearing practices based on Carl Rogers' ideas (e.g., encouraging curiosity and exploration, letting children make decisions, and respecting children's opinions) lead to increased creative potential. Recent research findings suggest that enrichment activities such as arts education are effective in fostering creativity development (Hui et al., 2015). Moreover, stimulating activities that are effective for emotion regulation (e.g., pretend play; Hoffmann & Russ, 2016) or emotional arousal (e.g., listening to music; He, Chan, & Wong, 2017; He, Wong, & Hui, 2017) also support the development of creativity.

Empirical findings show that middle and secondary students perceive teachers' positive feedback on their creativity to be the strongest unique predictor of their belief in their own creativity development (Beghetto, 2006). There is also empirical evidence supporting the positive role of effective feedback strategies in promoting students' creativity and enhancing their confidence in creative tasks in adolescent samples (e.g., Deutsch, 2016; Visser, Chandler, & Grainger, 2017). Beghetto and Kaufman (2007) believed that the Goldilocks principle (i.e., feedback with an optimal level of encouragement) can be applied to guiding the use of appropriate feedback with the aim of facilitating the development of creativity in children and adolescents, and even in professionals and older adults. The Goldilocks principle proposes that effective feedback neither overencourages nor underencourages a student's creativity; rather, it should offer an optimal level of encouragement. Other researchers have also suggested that peer feedback should focus on the work (e.g., Kaufman, Gentile, & Baer, 2005) not the person (Dweck, 2002). Further research is needed to determine the "optimal level" of encouragement and identify further effective forms of feedback.

In childhood and adolescence, creativity emerges through play or through work at school. It is also present during leisure time as personal creativity manifests in everyday creative efforts that transform experience and give meaning and original interpretation (Runco & Cayirdag, 2012). Creativity serves as a means of self-expression of the individual's uniqueness (Paul & Kaufman, 2014) and gradually develops as a quality of character promoted in schools (Kieran, 2014; Kaufman, & Beghetto, 2009).

Creativity Development in Adulthood

Continuing development of creativity into adulthood has been shown in recent research, which suggests interesting patterns of development based on longitudinal studies of cross-sectional design. For example, in a forty-year longitudinal study that examined how creativity develops in adulthood within individuals from adolescence to adulthood, Cramond and colleagues (2005) found that the Torrance Tests for Creative Thinking (TTCT) explained 23 percent of the variance in creative achievement, showing that the development from creative potential (as measured by the TTCT) to creative achievement was relatively stable across four decades (Cramond et al., 2005). Similarly, Clapham and colleagues (2005) found that creative engineering college students continued to engage in creative activities at work and were submitting more patent applications fifteen years later. In another longitudinal study with a large sample of 307 British university students, Chamorro-Premuzic (2006) examined the relationship of creative thinking skills, personality traits, and academic performance over a period of four years. It was found that the creative thinking assessed in the first year significantly predicted the originality of final-year projects, which could be regarded as a creative outcome. In addition, the creative thinking assessed in the first year also significantly predicted certain creative personality traits, such as openness to experience.

Cross-sectional studies investigating age-related changes across young, middle, and late adulthood indicate peaks and slumps during the adult life stage (e.g., Jaquish & Ripple, 1981; McCrae, Arenberg, & Costa, 1987; Palmiero, 2015). An integration of these cross-sectional studies illustrates a general developmental trend from a peak in young and middle adulthood to a decline in late adulthood. For example, Jaquish and Ripple (1981) conducted a cross-sectional study with a sample of 218 participants aged between 18 and 84 and found that the three younger age groups – young adults (18–25 years), adults (26–39), and middle-aged adults (40–60) – significantly outscored the older age group (61–84 years) in fluency. However, there were no statistically significant differences among the three younger age groups. Palmiero (2015) investigated age-related changes in creativity among 150 participants in six age groups: young (20–29 years), young adult (30–39), middle-aged (40–49), adult-old (50–59), old (60–69), and old-old (70–80). The results of the study indicated that the development of creativity reached a peak before 40 and remained relatively stable from 40 to 70, followed by a decline. Such findings appear to suggest that creativity can be maintained after middle age up to the age of 70; the argument regarding age-related decline in creativity may be questionable.

McCrae and colleagues (1987) found significant declines in all fluency scores on divergent thinking tests in a sample of male participants. However, the longitudinal analysis of the same study found that the youngest age group (33–38 years) showed a significant improvement in total scores of fluency including associational, expressional, ideational, and word fluency while the oldest groups (69–74 years) exhibited a decline over the period of study. Interestingly, ideational fluency increased in all age groups, which may suggest that individuals of all ages have the potential to think divergently and their creativity could be further fostered through training. Environmental factors may account for the training effect on gains in creativity (Kientiz et al., 2014; Onarheim & FriisOlivarius, 2013).

Twin studies based on a behavioral genetic design have been shown to offer insight into the critical factors that may contribute to the development of creativity. Kandler and colleagues (2016) employed a multitrait-multimethod analysis with two twin samples (monozygotic and dizygotic pairs) to examine the effect of genetic and environmental factors on individual differences in creativity. They used multiple determinants as predictors of creativity (i.e., biological factors, personality traits, and intelligence), and adopted multiple measurements of creativity, including self-reported, peer-reported, and performance-based creativity (e.g., telling a joke, constructing a paper tower). The results of Kandler and colleagues' (2016) confirmatory factor analysis showed that a hierarchical structure of general creativity linked to two distinct types of creativity: perceived (self-reported and peer/other-reported) and objective creativity. Genetic variance in objective creativity could be explained by intelligence, openness to experience, and extraversion; genetic variance in perceived creativity could be explained by openness and extraversion only. Nonshared environmental factors could be used to explain genetic variance in perceived and objective creativity, indicating that individual-specific environmental fit appears to predict individual creativity (Kandler et al., 2016).

Expertise is a unique variable related to the study of creative development and achievement in adults. It is usually measured by accumulative products (Simonton, 2000), deliberate practice, or cumulative experience (Simonton, 2000, 2014), extensive knowledge (Vincent, Decker, & Mumford, 2002; Weisberg, 2015), or recognition as an expert in a specific field or domain (Baer, 2015; Ericsson, 1999). Simonton (2000) identified complex specialization ("overtraining") and versatility ("cross-training") as determinants of creative expertise. In his study of creative achievement, he examined the hypothesis of creative expertise with fifty-nine classical composers and found both inconsistency and consistency (Simonton, 2000). Contrary to the hypothesis, more cumulative products in the same genre brought lower creativity, which might be caused by overtraining. However, cumulative generic production (i.e., composing pieces in different genres) exerted a stronger effect on creativity than genre-specific production, which might be explained by cross-training. Simonton (2000) also found that cumulative experience in different musical genres explained 14–20 percent of variance in the aesthetic impact of opera composers for both prolific and unprolific composers.

The role of domain-specific expertise becomes increasingly salient in professional creativity as individuals engage in creative production (Baer, 2015; Simonton, 2014; Weinstein, Clark, & DiBartolomeo, 2014; Weisberg, 2015). Expertise has direct effects during the creative process. Reilly (2008) found that creative responses develop gradually alongside enhanced expertise through professional training in group facilitation: as participants gained expertise in group facilitation, they also raised more new questions, adopted more alternate perspectives, and generated more useful and novel redefinitions. Expertise in organizational leadership also had positive effects on both idea generation and idea implementation in a study with military experts conducted by Vincent and colleagues (2002).

Adult creativity requires other complex factors alongside the continuous development of intelligence, personality, expertise, cognitive style, motivation, and environment. Barbot and colleagues (2016) used an "optimal-fit" view of creative potential in development to explain individual difference in creativity. Optimal development is made possible under certain environmental factors and during the performance of specific tasks. Creativity in adults may flourish when individuals are in supportive social environments and in the presence of creative coworkers (Zhou, 2003), which enhance both extrinsic and intrinsic motivation to engage in creativity (Chen & Hu, 2008). An innovative personal style that is matched by an innovative work environment is also associated with novelty in creative products (Puccio, Talbot, & Joniak, 2000). Living abroad may be a contributory factor to adult creativity as bicultural individuals present integrative complexity in thinking (Tadmor, Galinsky, & Maddux, 2012).

Meaning-making plays an important role in influencing an adult's engagement in a creative process or creative action (Baumeister, 2005; Chang, Wang, & Lee, 2016). In an in-depth interview with sixty-five engineers, Unsworth and Clegg (2010) found that their interviewees' perception of the worthiness of creativity was the primary underlying mechanism that influenced their determination to invest time and effort in engaging in the creative process. Such a primary mechanism is mainly a sense-making and meaning-making process that affects one's willingness to engage in creative projects (Ford, 2000). According to Madjar, Greenberg, and Chen (2011), adults make sense and meaning by extracting cues from the environment and respond more positively to cues consistent with their personality. They found that individuals who are more willing to take risks tend to allocate more resources to creativity, present higher career commitment, and demonstrate more radical creativity (i.e., innovation), while the factors of organizational identification and creative coworkers are correlated with incremental creativity (i.e., adaptation). As an individual grows, the interpretation of contextual and personal factors influences intrinsic motivation and task commitment to professional creative tasks in young adults (Yeh & Lin, 2015), everyday creative behaviors in adults (Silvia et al., 2014), and leisure-time creative tasks in older adults (Carlsen, 1995).

Creativity in Late Adulthood

Studies that confirm a decline in creativity usually adopt a psychometric approach to creativity and administer standardized creativity tests to participants of various age groups, mostly divergent thinking tests, such as TTCT (e.g., Roskos-Ewoldsen, Black, & Mccown, 2008) and Wallach–Kogan Creativity Tests (e.g., Kogan, 1973). Older adults tend to score significantly lower in fluency, flexibility, and originality than young and middle-aged adults. However, recent studies yielded inconclusive findings. Urban (2004) found no significant age difference in creativity among 300 adults as measured by the Test for Creative Thinking – Drawing Production. After controlling for educational attainment, Shimonaka and Nakazato (2007) found no significant age difference among 412 adults aged 25–84 in fluency, flexibility, originality, or elaboration scores when using the S-A Creativity Test devised by the Society for Creative Mind originally formulated by Guilford (cited in Takeuchia et al., 2010). A prevalent criticism of the Peak and Decline Model is its failure to control certain confounding variables, such as cohort effects and the effect of years of education.

An age-related decline is evident in a general context – for example, divergent thinking skills (Reese et al., 2001; Roskos-Ewoldsen et al., 2008) – but no such decline is found in more specific contexts, such as everyday problem-solving skills (Artistico, Cervone, & Pezzuti, 2003; Blanchard-Fields, Mienaltowski, & Seay, 2007). The decline in creativity as measured by general divergent thinking tests could also arguably be seen not as a decline but rather a qualitative change toward specific domains in the creative process (Sasser-Coen, 1993). Older adults possess expertise in the pragmatics of life, such as life review and the everyday problems of life planning (Baltes, 1987). Adam-Price (1998) also pointed out that novelty and innovation may more often be associated with youthful creative thinking. Late-life creative thinking is characterized more by integrative or convergent ability, as is particularly evident in eminent creators (Gardner, 2011).

The lifespan developmental model of creativity nevertheless argues that the types of creativity expressed, and how they are measured and valued, also vary across life stages (Lindauer, 2003; Romaniuk & Romaniuk, 1981; Ruth & Birren, 1985; Stroebe, 2010). Creativity is expressed differently in various life stages. Scores on standardized creativity tests tend to favor children and adolescents, who are familiar with test-taking environments. Older adults, who are no longer used to taking tests, often perform poorly in standardized tests (Lindauer, 2003; Ruth & Birren, 1985). Studies examining qualitative change in creativity among older artists and architects have found continuous development as they age (Dudek & Croteau, 1998; Lindauer, 2003; Lorenzen-Huber, 1991). Binnewies, Ohly, and Niessen (2008) adopted the Consensual Assessment Technique developed by Amabile (1996) to evaluate the quality of creative ideas generated at work by young and older nurses and found no significant relationship between creative ideas and age. Expertise in pragmatics and domain-specific knowledge may compensate for the loss in fluency of divergent thinking as a mechanism of creativity.

Older adults even outperform young adults in everyday creativity when they must solve problems of daily life by adopting more problem-focused strategies, such as planful problem-solving and cognitive appraisal, to solve instrumental and interpersonal problems (Blanchard-Fields et al., 2007). With a view to examining perceived self-efficacy and solving ecologically relevant problems in adults, Artistico and colleagues (2003) enrolled a hundred adults (fifty young adults with a mean age of twenty-five and fifty older adults with a mean age of seventy) in their study. Based on the finding that older adults scored higher in perceived self-efficacy and actual performance in solving older adult problems (e.g., wanting to be visited by relatives more often), Artistico and colleagues (2003) concluded that self-efficacy perception varies as a function of the type of problem that participants are dealing with. A recent lifespan study on perceived creativity by Hui and colleagues (2014) further discovered that self-perception of creative personality was highest in older adults, compared with mid-life, early, and emerging young adults.

Meléndez and colleagues (2016) used education level, occupation, leisure activities, and the vocabulary scores of a standardized intelligence test as exogenous variables of cognitive reserve and found that significant predictors of creativity in older adults include cognitive reserve and openness to new experience. In another study with Chinese older adults, Zhang and Niu (2013) found two sets of critical factors for creativity: stable factors (e.g., education and general health status) and more changeable factors (e.g., daily activities and a positive attitude toward aging).

Creativity can be developed until late adulthood with no specific age limit as measured by self-perception of creative personality (Hui et al., 2014). Participation in creative and collaborative problem-solving programs, such as the Odyssey of the Mind, enables social engagement, intellectual engagement, and personal growth

(Parisi et al., 2007). Participants in the Odyssey of the Mind program also have shown significant gains in cognitive processing speed, inductive reasoning, and divergent thinking, but few differences in working memory or visual-spatial processing (Stine-Morrow et al., 2008). Older people who participated in creative and cultural activities – such as painting, poetry writing, jewelry making, and singing in choirs – presented higher ratings in health indicators, fewer doctor visits, lower depression, and more social activities (Cohen et al., 2006). Creative activities were also found to have positive effects for dementia patients in Great Britain, Sweden, Japan, and Brazil (Hannenmann, 2006). Hui (2013) found that participation in creative and culture activities, such as watching performing arts and taking part in visual arts, enhanced self-perceived creativity and quality of life in a group of community dwelling older sample. In a randomized controlled trial study on the effects of participation in a community arts program, Hui and Liang (2012) found significant gains in figural creativity and everyday problem-solving in the experimental group but not in the control group.

In addition to empirical studies on laypersons in late adulthood, some eminent creative professionals are known to continue producing legendary works and sometimes even their masterpieces in old age. To name a few, Verdi composed "Ave Maria" at eighty-five, Martha Graham performed until she was seventy-five and choreographed her 180th work at ninety-five, Michelangelo worked on the Rondanini Pieta until shortly before his death at eighty-three, and Grandma Moses had her first art exhibition at eighty (Hickson & Housley, 1997). The American architect Frank Lloyd Wright lived until the age of ninety-one and was creatively productive well into his eighties. The Guggenheim Museum in New York City, considered one of his masterpieces, was completed in the year of his death.

Creativity in late adulthood continues to serve the function of self-expression in laypersons and making contributions to society in eminent creative individuals. Creative participation and training may further strengthen personal creativity and enhance successful aging by providing new interpretations in life review.

Implications, Limitations, and Further Directions of the Lifespan Approach for Understanding Creativity Development

Owing to the uniqueness of each developmental period, it is understandable that creativity would have diverse expressions in childhood, adolescence, adulthood, and late adulthood. The factors facilitating or hindering the development of creativity can also vary during different life stages. A lifespan approach to understanding the development of creativity enables us to capture the patterns of possible growth and decline in human creativity through an interconnected time perspective. Such an approach also allows us to uncover the dynamics underlying the changes involved. The present chapter's review of the discourse and empirical evidence for the lifespan approach on creativity reveals that such an approach can be enriching and thought-provoking, leading to a more thorough understanding of creativity development, on which basis a better cultivation of creative potential across the life span is possible.

In its current form, the lifespan approach to studying creativity has its limitations. The patterns or trends in the capacity for creativity, as identified by previous cross-sectional and longitudinal studies, are mainly based on psychometric tests. In general, the evidence from research on creativity suggests a curvilinear relationship between age and creative performance, in which creativity increases from childhood to young adulthood, and then begins to decline from middle age onward (see Kogan, 1973; Reese et al., 2001; Roskos-Ewoldsen et al., 2008; Simonton, 1977). However, this "Peak and Decline Model" has been challenged by emerging empirical evidence, which suggests a relatively stable performance in creativity throughout adulthood (e.g., Palmiero, 2015; Shimonaka & Nakazato, 2007). Furthermore, it is worth noting the well-documented creativity slumps among children and adolescents indicated by empirical studies (He & Wong, 2015; Krampen, 2012; Torrance, 1968; Urban, 1991), which demonstrate discontinuities alongside continuities in the development of creativity. Clearly, these kinds of knowledge concerning developmental trends are valuable. However, we also need to acknowledge the limitations of creativity tests for capturing the multifaceted, dynamic, and subtle aspects of creativity. Furthermore, the issues of individual difference are not sufficiently addressed in the literature on the growth or decline of creativity. The question of whether individual differences may increase with age across the human life span suggests interesting and important possibilities that have not yet been seriously investigated.

Another limitation of the lifespan approach to studying creativity lies in its lack of thorough deliberation on the nature of creativity, particularly regarding the psychological processes involved. Research on creativity in different life stages might adopt diverse definitions of creativity. In this connection, it is of particular value to revitalize Wundt's ideas regarding the nature of creativity. Wundt perceived creativity and imagination as two highly affinitive concepts: In his view, creative acts are made possible by underlying psychological processes, which he termed "imagination" (Wundt, 1905/1919). In particular, it is worth noting Wundt's proposition that imagination is not a specific type of human ability. He formulated three principles to explain the mechanisms of human imagination (Wundt, 1905/1919). The first, "vital apperception," refers to elementary but complex assimilative processes that are empathetic in nature and relate to a person's consciousness of time and space. The second principle refers to the intense heightening of emotions that accompanies these assimilative processes. The third concerns the capacity for automatic effectivity in actualizing what lies in the realm of awareness (Wundt, 1905/1919).

These three elegantly formulated and complementary Wundtian principles appear to cast light on some of the observed phenomena concerning the lifelong development of creativity. For instance, the first fundamental principle might help to explain how it is possible for people to achieve an age-wise growth of imagination and creativity as they accumulate life experience. However, such a mechanism imposes a necessary but insufficient condition for creative activity: Without heightened emotions and automatic effectivity in the actualization of one's awareness, creative performance can hardly be achieved. Discerning how the above-mentioned mechanisms operate together might help us explain the individual differences in creativity that are found within each developmental period. Deficiencies in certain aspects of these mechanisms might account for the commonly observed declines of creativity in middle and late adulthood.

Creativity development can be conceived and analyzed from several different angles. Besides the lifespan approach, the cultural-historical perspective and the microgenetic/microdevelopmental perspective also appear to be valuable. The former highlights the sociohistorical foundations of higher psychological processes (see Vygotsky, 1931/1997). Vygotsky, one of the key figures of this field of inquiry, further elucidates the role of sign mediation in the formation of the human mind (Vygotsky, 1931/1997; see also Verso, 1999). The significance of this perspective is fully realized by Glăveanu (2014), who expounds a new concept of distributed creativity with three key dimensions: sociality, materiality, and temporality. In contrast, the microdevelopmental perspective involves a focus on examining moment-to-moment changes in psychological processes, within the paradigm of experimental psychology (see Granott & Parziale, 2002; Karmiloff-Smith, 1992/1999, 2013). It is evident that the cultural-historical and microdevelopmental approaches represent the two poles of macro- and microperspectives, which are complementary to the lifespan approach. The integration of these two approaches into the lifespan approach could widen our horizon in understanding the development of creativity.

Eminent creativity has been examined from the lifespan perspective (see Hickson & Housley, 1997; Simonton, 2000). Its investigations from the cultural-historical perspective could further illuminate the development of creativity and its underlying dynamics. For the purposes of illustration, we suggest a case study in Chinese cultural history: the manifestation of creativity presented by the artworks of the Dunhuang cave temples, which span over a thousand years (from the fourth century to the fourteenth). Based on Wundt's theoretical explication of imagination and creativity, meaningful questions can be gained in studying the Dunhuang artists and their creative mural paintings or sculptures. How did this community's vigorous cultural exchanges between China, other Asian countries, and the West foster an expansion of consciousness across time and space? How did the artists' religious faith and sentiment heighten the emotional sensitivity that is essential for such creative acts? How could the artists' mental resources be automatically actualized in an effective way? Was such effectiveness due to a kind of volition that was facilitated by a supportive environment? Such a case analysis of creativity over the course of cultural history could provide rich resources for understanding the sociohistorical foundations of the creative mind in the present. It could also help to identify the signs and cultural-historical factors involved in cultivating creativity at the individual level. The effects of sign mediation on the development of creativity across the human life span could constitute another important area of study.

Creativity is not yet on the research agenda of microdevelopmental studies, which focus on examining process-oriented cognitions that occur within a short time span. In applying Wundt's theoretical insights, an experimental design to investigate the microdevelopment of creative processes could first focus on the effects of temporal and spatial consciousness by manipulating the scope of conceptual and perceptual attention. Interventions such as arousing emotion and enhancing the fluency of bodily movement could be incorporated to examine the respective effects of Wundt's second and third principles regarding the underlying psychological mechanisms of creativity. A research paradigm of integrative microdevelopmental studies would not be incompatible with the lifespan approach. Rather, it would be desirable to incorporate microdevelopmental studies into the lifespan approach. A process-oriented, refined analysis could be systematically conducted within different developmental periods, thus enabling comparison across the life span, which might further pave the way for theoretical refinement of the underlying psychological mechanisms of creativity. In this way, it could be possible to better address some of the key questions on creativity from a lifespan perspective, such as: Are there any general principles governing lifelong development in creativity? What are the interindividual differences and similarities in the lifelong developmental process of creativity? What are the degree and conditions of individual plasticity or modifiability regarding creative development?

Enriched by the cultural-historical and microdevelopmental perspectives, the lifespan approach can provide new insights into the meaning and process of creativity development, opening new avenues for cultivating the potential for creativity across the human life span.

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5 Enhancing People's Creativity

Robert J. Sternberg

Creativity involves an individual's generating ideas that are novel, surprising, and compelling (Kaufman & Sternberg, 2010). Creative people are not only intellectually capable of coming up with such ideas. They also are people who have a creative attitude toward life (Sternberg, 2000) and approach problems insightfully (Davidson & Sternberg, 2003). They also are motivated to solve problems in a creative way (Dai & Sternberg, 2004). Although average levels of creativity may vary from one time or place to another (e.g., Niu & Sternberg, 2003), the major variable in creativity is simply a mindset toward thinking in novel, surprising, and compelling ways – and this mindset can be taught.

How do you teach individuals to be creative? In this chapter, I consider responses to this question. First, I review some of the major programs for teaching creative thinking. Then, I describe some techniques for teaching creative thinking that are consistent with a variety of theories of creativity. Then, I describe assessments for the success of teaching of creativity. Next, I describe prompts for teaching and assessing creativity. Then, I describe some impediments to teaching for creativity. Finally, I draw conclusions.

Programs for Teaching Creativity

Brainstorming

One of the earliest systematic attempts to develop creative thinking was a method called *brainstorming*, proposed by Osborn (1953, 1963). The idea behind brainstorming is simple: Give free rein to the imagination and don't criticize. Brainstorming is typically used in groups where members can bounce ideas off each other. Group members are encouraged to let their imaginations run wild and not to criticize each other. The idea is that people in a group will build off each other and come up with solutions that none would have come up with individually or if people criticized each other.

In the Creative Problem Solving program (Isaksen & Treffinger, 1985; Parnes, 1981; Treffinger, McEwen, & Wittig, 1989), there are three stages of brainstorming: understanding the problem, generating ideas, and planning for action. Understanding the problem itself involves three substages: mess finding, data finding, and problem finding.

There is some evidence that brainstorming can work (Meadow, Parnes, & Reese, 1959; Parnes & Meadow, 1963), at least in some circumstances. But brainstorming is a limited device. First, although it can be used by individuals, it primarily is targeted at groups. Second, if an idea is bad, it is not clear that it is always a great idea to say nothing right away, especially when the stakes of the decision to be made are high. Waiting until later may be too late, or "later" may never happen at all. Third, brainstorming is primarily a search device, not an evaluative device (Nickerson, 1999). So, if more alternatives are generated, there is all the more need for an evaluative phase to decide which idea is best. Fourth, the technique is rather nonspecific. It basically amounts to little more than telling people to "be creative" and let the ideas flow forth. It would be better, at the very least, to have one or more techniques that are more specific.

CoRT

CoRT stands for COgnitive Research Trust, an organization that was founded and also run by Edward DeBono, a Maltese physician, scholar, and educator. The CoRT program is designed to teach people to think better, not only creatively, but also critically.[1]

The goal of CoRT is to produce students who can think for themselves (DeBono, 1973). CoRT comprises six units, each in turn comprising multiple lessons. There are a total of sixty lessons. CoRT 1, Breadth, is designed to help students broaden their perception – to see things they may not have seen before. CoRT 2, Organization, shows students ways of organizing and systematizing their thinking. CoRT 3, Interaction, is about evidence – how to argue for a point and what kinds of evidence to present. Although all the units are relevant in one way or another to creativity, CoRT 4 is the unit devoted specifically to creativity. It is designed to help students break out of familiar concepts and to see things in new ways. CoRT 5, Information & Feeling, deals with our assessing what information we have, what information we need, how we can get that information, and the values and feelings we can apply to that information. CoRT 6, Action, covers how visual symbols can be used to direct thinking and how thinking can be translated into action.

DeBono (2015) has suggested *lateral thinking* as a way to be creative. Lateral thinking is essentially departing from the linear (vertical) mode of thinking, which is to take a concept and then make the usual associations to it. In lateral thinking, one departs from these usual associations and tries to see a concept in a new way.

DeBono has suggested several thinking "tools" that people can use to help them think laterally. Here are a few examples.

The first is *random entry idea generation.* The idea here is to think of an object or concept at random, say from a dictionary, and then try to find an association with the problem with which one is dealing. For example, if one is trying to decide whether to buy a car or continue to use public transport and one comes on the word "red," one might think about, on the positive side, what it would be like to have a red car or, on the negative side, of all the red lights one would have to face if one drove a car. Or if one

[1] See www.edwarddebonofoundation.com/Creative-Thinking-Techniques/CoRT-Tools.html

came across the word "tangible," one might think of the car as a tangible asset or as a possession one actually could touch.

A second tool is *provocation*. The idea of a provocation is to think of a false, impossible, or ridiculous statement about a problem one is dealing with then to ask whether somehow that provocation, despite its being false, might be useful in solving one's problem. Techniques for provocation include wishful thinking about, exaggeration of, reversal of, and distortion of reality.

A third tool is *movement*, or focusing on how to move from one place in creative problem-solving to another. The idea here might be to focus on positive or negative aspects of a potential solution, or to focus on differences, or to try to generate a general principle that might apply to the problem.

A fourth tool is *challenge.* Here, one challenges obvious things, such as that one drives with a steering wheel or that one eats with utensils. In fact, not all moving vehicles use steering wheels and not everyone eats with utensils. The idea is to challenge conventional ways of thinking.

A fifth tool is the *concept fan*, which involves thinking more broadly about a problem than one initially does. For example, one might sketch out a problem, draw a circle around it, and then draw lines radiating out with as many diverse and offbeat solutions as one can think of.

A sixth tool is *disproving*, which involves considering anything that people consider obvious and showing it is wrong. Many creative thinkers use this idea, defying the crowd by asking how what everyone else believes may be wrong (Lubart & Sternberg, 1995; Sternberg & Lubart, 1995).

DeBono (1999) further suggested that one can arrive at more creative and better solutions to problems by donning six different thinking hats. Either one person can alternately don the hats, or better, different individuals trying as a group to solve a problem can don the hats in a group discussion. The six thinking hats include

- *White hat* – thinking that is objective, neutral, and as unbiased as possible; it is concerned with facts, not with speculations or imaginings.
- *Red hat* – thinking that is emotional and heavily value-laden; it is concerned with how a problem or a possible solution affects oneself and others affectively.
- *Black hat* – thinking that is cautious and careful and that considers the possible problems with a potential solution; it involves playing the devil's advocate to any possible solution to a problem.
- *Yellow hat* – thinking that is positive, upbeat, and optimistic; it is sunny and bright and looking at the best possibilities that can emerge from a potential solution.
- *Green hat* – thinking that is associated with creativity and expanding one's range of ideas; it is green in the sense of the greenness of growing plants.
- *Blue hat* – thinking that is cool and unemotional; the blue hat often can serve as an organizing basis for the other hats.

Synectics

Synectics was proposed by George Prince and William Gordon, who were management consultants (see Gordon, 1961, 1966, 1981). According to Gordon, synectics involves three basic principles. First, creative thinking can be taught. Second, creativity in the arts and in the sciences depends on the same fundamental processes of thinking. Third, individual and group processes in creativity are largely analogous.

Synectics emphasizes the importance of emotion and of the irrational in creativity. Often, creative ideas come when one lets go of traditional and safe assumptions. Emotional responses to problems that at first may seem irrational may turn out to have kernels of useful ideas that later can be fashioned into viable solutions.

Springboarding in synectics is a way of starting out in the solution of a creative problem where people bounce ideas off each other without being critical. It builds on brainstorming and then goes on to fashion useful ideas and criticize them as necessary. It emphasizes the roles of imagery, analogy, metaphor, and emotion in generating creative ideas.

Productive Thinking Program

The Productive Thinking Program (Covington et al., 1974) is a general program for developing thinking skills with a special emphasis on creativity. The program comprises fifteen booklets aimed at children in the fifth and sixth grades of school. Results for the program have been mixed (Mansfield, Bussé, & Krepelka, 1978). The program is not widely used today.

Specific Techniques for Teaching Creative Thinking

There are a number of specific techniques that can be used to teach for creativity, which fit with varied models of creativity (see Sternberg, Jarvin, & Grigorenko, 2009; Sternberg & Williams, 1996, 2001). However, the techniques described here derive directly from the idea of creativity as an attitude toward life – as a seeking out for opportunities to think of solutions to problems that are novel, surprising, and compelling (Sternberg, 2000, 2003).

Redefining Problems

Redefining a problem requires a shift in perspective. During the course of a lifetime, people always have problems that they just don't see how to solve. They are stuck, as though they are in a box. Redefining a problem means, in essence, getting oneself out of the box. This process can be seen as the synthetic part of creative thinking. It is crucial to what DeBono (1973) has called "lateral thinking."

Teachers and parents alike can and should encourage students to define and then to redefine problems for themselves, rather than – as happens so often – doing the definition and redefinition for them. Teachers and parents can facilitate creativity by encouraging children to define and redefine *their own* personal problems. Adults will facilitate creative thinking by asking students to choose their own topics for papers, projects, or presentations. Children also should choose their own ways of solving problems. Sometimes, the children will have to choose again if they discover that their original choice was mistaken.

Adults cannot always offer students choices (e.g., of whether to take an examination), but offering choices is the only way for students to learn how to choose for themselves. Granting students latitude in making choices helps the children to develop both taste and good judgment. These elements are vital for creativity.

Somewhere along the line, everyone makes a mistake in choosing a project or in the procedures they select to complete the project. Teachers and parents need to keep in mind that an essential part of creativity is the analytic part, including learning to identify mistakes – and then provide students with the opportunity to redefine their choices as necessary.

Schools typically place great emphasis on the solving of problems but relatively little emphasis on the defining and redefining of problems. Yet, arguably, no single aspect of thinking is more important to creative individuals than redefining the problems that others see in one way into a new and more exciting way to see those same problems (Sternberg & Lubart, 1995).

Challenging Assumptions

We all make assumptions. Often, we do not know, however, what these assumptions are because they are universally shared among people. Creative individuals, on the other hand, question assumptions and also may prompt others to do the same kind of questioning. Questioning assumptions is a crucial part of the analytical thinking involved in creative work. When Copernicus concluded that Earth revolves around the sun rather than the sun revolving around Earth, the conclusion was viewed as preposterous because anyone could see that the sun revolved around Earth – all they had to do was to look up into the sky! Galileo's creative ideas, including the relative rates of falling objects of different weights, resulted in his being labeled a heretic.

Sometimes it is not until some years later that society recognizes the limitations or possibly the errors of their assumptions and embraces the creative individual's thoughts. The impetus of those creative individuals who question assumptions allows for cultural, technological, and other forms of advancement.

Teachers can model questioning assumptions by showing their students that what the students assume they know for sure they actually do not know. Of course, students should not question every assumption they make. There are situations when it is worthwhile to question and try to reshape the environment, but there also are situations to adapt to it. Some creative individuals question so many things and so often that others eventually dismiss them. Everyone, even the most creative individuals, must learn which assumptions are worth challenging and which battles are worth the trouble. Sometimes it is preferable for individuals to leave their unimportant assumptions alone so that they still have a receptive audience when they find their questioning worth the effort.

Mentors can aid students to further this talent for questioning by making questioning a part of their daily exchange with the students (Sternberg, 1987).

It is far more important for students to figure out what questions to ask – and how to ask those questions – than to learn the answers to the questions. Adults can help students to assess the questions the students ask by helping students rid themselves of the idea that only adults should ask questions and only students should answer those questions. Adults should not perpetuate the view that their primary role is to teach students a fixed set of facts, and instead help students to comprehend that what matters more than having facts is using those facts for good ends.

Society makes a pedagogical mistake when it emphasizes obtaining the so-called "right answer" rather than asking the "right" question, or at least, a good question (Csikszentmihalyi, 2013; Sternberg, 1994). The so-called "good student" is viewed as the one who rapidly provides the right answers to questions teachers ask. On this view, the expert in a given field unfortunately becomes an extension of the so-called "expert student" – the one who knows and can quickly spit back a lot of information. As John Dewey (1997) believed, how one thinks about issues often is more important and consequential in life than exactly what one thinks. Schools should teach students how to ask important questions (questions that are worth answering and that are interesting) and reduce their emphasis on rote learning of facts. And they need to reorient their emphases in diverse domains, not just in the arts (Gardner, 2011). Contemporary creativity research embraces a wide variety of distinct domains, from science to engineering to business to architectural design to the arts to athletics, all of which are ripe for creative investigation.

Selling Creative Ideas

Everyone would want to assume that their sparklingly innovative, original ideas will sell themselves to anyone who wants to listen. But they do not sell themselves. Rather, creative ideas usually are viewed with suspicion, skepticism, and distrust (Sternberg & Lubart, 1995). Moreover, individuals who propose such creative ideas may also be viewed as problematical. Most people are comfortable with and set in the ways they already think about things. They usually have a vested interest in their current perspectives on things. As a result, it can be extremely challenging to dislodge people from their current perspectives and ways of thinking.

At some point, students must learn how to convince other people of the value of their original ideas (Sternberg, 1985). This selling of ideas is an important part of the practical element of creative thinking. When students present a science project, for example, they need to show not only what they found but also why the project makes an important contribution. If students develop a working plan for a new form of government of nations, they need to be prepared to say why it is superior to existing forms of government. Just as students need to learn to defend their ideas, so do teachers. Teachers may find themselves needing to justify their ideas about, and practices in, teaching to their principal or other supervisor. Thus, everyone needs to think about how to explain and justify their creative ideas to others.

Generating Ideas

Creative people utilize what I have called a "legislative" style of thinking (see Sternberg, 1997; Sternberg & Grigorenko, 2001): They like to come up with new ideas. The environment for coming up with new ideas should be constructively critical, but it should not be destructively critical (see Beghetto, 2010). Students should learn to recognize that some ideas are better than other ideas. Teachers and students should work together in identifying and encouraging creative new ideas. When ideas do not seem to be of much value, teachers should not merely criticize the ideas and leave it at that. Instead, the teachers should suggest new approaches, preferably approaches that include at least some of the aspects of the earlier ideas that seemed, in and of themselves, not to be of much value. Students should receive praise for generating new ideas, regardless of whether some of the ideas seem, at the time, silly or unrelated to what was expected.

Knowledge as a Double-Edged Sword

Of course, one cannot think creatively in the absence of knowledge. One cannot go beyond the current state of knowledge if one is unaware of what that state is. Often, students have ideas that are creative but only with respect to themselves. The ideas are not also creative with respect to the current state of a given field because others previously have had the same ideas. Individuals with a more substantial knowledge base can show creativity in ways that others who are still acquiring the basic knowledge of the field cannot be.

Knowledge is not always helpful to creativity, however. People with an expert level of knowledge can display tunnel vision, a narrowed field of thinking, and just plain entrenchment (Adelson, 1984; Frensch & Sternberg, 1989). Experts can become trapped in a particular way of thinking. They may become unable to go beyond that way of thinking. The greatest risk occurs when an individual believes he knows all there is to know. He or she is unlikely ever to show truly meaningful creativity again.

The upshot is that teachers or any experts can learn as much from students as the students can learn from their teachers. On the one hand, teachers possess knowledge students lack; but students often have a kind of flexibility that teachers lack – precisely because the students do not have the knowledge that their teachers have. Teachers can enhance their own creativity by learning from their students, just as the students learn from them.

In most societies, those who are more senior, and thus who are more likely to be convinced of the truth of their ideas, land in positions of power and authority. Yet those senior people often are at risk for being less creative than the younger ones if they are too convinced of the rightness of their ideas.

Identifying and Overcoming Obstacles

Buying low and selling high requires an individual to defy the crowd – to think independently. Individuals who defy the crowd – who think creatively – virtually inevitably confront resistance. What is at issue is not whether they will confront obstacles – they will. Rather, what is at issue is whether the creative individual has the courage to persevere in the face of obstacles (Simonton, 1994, 1997, 2004, 2009). Why do so many individuals begin in their careers doing creative work, only later to disappear from view? The answer is that, at some point, they decide that their creative efforts are not worth the pushback and the punishments they encounter. Seriously creative thinkers must be willing to pay a short-term cost because they realize that they can make a positive difference over the longer term. But it may be a long time before the value of an individual's creative ideas is both seen and fully appreciated (Sternberg & Lubart, 1995).

Teachers can help students to prepare for rejection experiences by telling the students about obstacles that they have faced, or that famous people have faced while trying to express their creativity; otherwise, students may come to believe that they alone are confronted by obstacles. Teachers will want to include accounts of colleagues who were not supportive, about students who receive bad grades for creative ideas, and about unwelcoming responses to ideas they may have considered to be among their best. To assist students in confronting often unexpected obstacles, teachers can inform students about the large number of creative individuals whose ideas initially were rejected, and also help the students to develop an appreciation of the importance of creativity. Students also need to learn how to mitigate their concerns regarding what other people think is valuable. That said, it often is challenging for students to reduce their reliance on the views of their peers.

When students try to surmount an obstacle, the students should be rewarded for the attempt, regardless of whether or not they were successful. Having an entire class of students reflect on ways to surmount a particular obstacle can start the class members thinking about what strategies they can employ to confront and ultimately surmount obstacles. Some obstacles are inside oneself, such as self-sabotage or performance anxiety. Other obstacles are external to oneself, such as the negative opinions of others regarding one's actions. Whether the obstacles are internal or external, they must be surmounted.

Encouraging Prudent Risk-Taking

When creative people take on the crowd, they incur risks, much as do people who are good investors. Some investments just do not work out. Furthermore, taking on the crowd typically results in one's experiencing the crowd's wrath. Nevertheless, creative individuals are willing to incur sensible risks and to produce ideas and products that others ultimately may admire and regard as setting new trends. But, of course, in taking risks, creative individuals have to be ready to fail, and probably will multiple times.

A teacher should stress the importance of prudent risk-taking. (Sometimes, creative people cast prudence to the wind: They may risk their lives for creative ideas, such as in a revolution, peaceful or otherwise, of an oppressive government.) To assist students in learning to take prudent risks, adults can encourage the students to take some prudent risks with choices of courses and activities.

Almost every significant discovery or invention involved some degree of risk. Computers, televisions, video streaming, cell phones – almost every invention we use initially entailed risk. But if no one were willing to take the risk, we would have available to us none of the products.

Relatively few students are eager to take risks in the setting of the school, because students learn early on that risk-taking can be costly. What schools seem most to value are perfect test scores and paper grades for which students have done exactly what they were told to do. Such work receives praise and opens up expanded future possibilities. In contrast, failure to meet a certain level of academic performance may reduce futures opportunities. A student reasonably might query why he or she should risk, say, taking challenging courses or disagreeing with teachers when such actions may lead to lower grades or even the risk of failure? Many teachers may inadvertently send a message to students to "play things safe" when the teachers make assignments for which the teachers expect only a very limited set of answers to questions. In sum, teachers must not only encourage prudent risk-taking but also reward it in a highly visible way.

Tolerating Ambiguity

People often like to see things in black and white or as simply good or bad. For example, people often like to perceive a country as an ally or as an enemy. Or they may believe that a particular idea in education either does or does not work – end of story. The challenge is that there usually are a lot of middle grounds in creative enterprises (Sternberg & Lubart, 1995). Scientists often need to do experiments and then modify them to find out if they work. Artists often draw and redraw, design and redesign. All creative individuals must tolerate ambiguity and the uncertainty that results from it as they develop and refine their ideas.

Creative ideas typically develop slowly and sometimes fitfully over time. The period idea development stage of the creative process is likely to be uncomfortable. Lacking time or the willingness to tolerate ambiguity, some creators may reach a nonoptimal solution to whatever creative task they set out for themselves. When students have a near-miss topic for a paper or project, it is tempting for teachers and students alike to accept the near miss as good enough. But to support student creativity, teachers should encourage students to extend the period of time during which their ideas do not quite come together. This, in turn, requires students to start projects early rather than at the last minute. Students must learn that ambiguity and discomfort are inevitable parts of living any kind of creative life. In the end, students will benefit from the development of their tolerance of ambiguity by generating better ideas.

Self-Efficacy

Creative people often come to a moment at which they feel as if no one believes in them or their work. (I reach this point fairly regularly, feeling that no one cares about, values, or in the least appreciates what I am doing.) Because creative and especially highly creative work often receives a frosty reception, at least initially, it is essential that creative individuals believe in the value of their creative enterprise and in their ability to keep doing meaningful work. Of course, there is no one for whom it can be said that every idea he or she has is a good idea. Rather, creative individuals have to believe that, in the long run, they have the skills and perseverance to make a positive difference.

The principal limitation on what creative people can accomplish is what they think they are capable of accomplishing. All students, for example, are potential creators who could experience the joy that results from creating something new. But, first, the students must believe in themselves and their potential (Bandura, 1997).

Finding What One Truly Loves to Do

To encourage their students' optimal creative performance, teachers need to help students discover what excites them. Teachers (and parents!) need to keep in mind that what excites a student may not be what excites the teacher or parent. Individuals who truly excel in creative pursuits almost always are genuinely excited about what they are doing.

Helping students discover what they truly enjoy doing is often a difficult and frustrating job. Yet the job is worth it because it allows students to discover the creativity within themselves that otherwise might go unrecognized and undeveloped.

Sooner or later, a teacher will meet students who are pursuing a particular career path not because that path represents what they want to do with their lives but rather because the path represents what their parents or some other authority figures expect or even require them to do. Although the students ultimately may do satisfactory work in that field, they are very unlikely to do great work. It is difficult for people to do their best work in a pursuit that does not excite them (Amabile, 1996; Sternberg & Lubart, 1995).

Delaying Gratification

Part of living creatively means that one is able to work on projects or tasks for a long period of time without some kind of reward – intrinsic, extrinsic, or both. Students need to learn, however, that rewards often are not immediate and that there can be substantial benefits to delaying gratification (Mischel, 2015; Mischel, Shoda, & Rodriguez, 1989). Unfortunately, in the short term, people who do creative work are often ignored or even penalized for doing it.

Teachers may believe that they should immediately reward students for creative performance, or even any good performance. This belief about teaching (and parenting) emphasizes the immediate present and may come at the expense of what is best for the student over the long haul.

But students need to learn to wait for rewards (Mischel et al., 1989). The greatest rewards frequently are those that are delayed. Teachers can provide to their students examples of delayed gratification in the teachers' own lives and in the lives of famous creative people. Teachers also should try to help the students to apply these examples to the students' own lives.

The short-term focus of the majority of assignments in school does little or nothing to teach students how to delay gratification. Longer-term projects are clearly better in achieving this goal, but it is challenging for teachers to assign projects to be done at home if the teachers are not confident of the students receiving parental involvement and support. When students work on a task over an extended period of time, they learn the value of working toward long-term goals.

An Environment That Fosters Creativity

Teachers should provide an environment that nurtures creativity. The most compelling way for teachers to nurture creativity in students is to *role model creativity.* Students best develop creativity not when they merely are told to be creative but rather when they are shown how to be creative (Amabile, 1996; Amabile & Kramer, 2011). Many of us find that the teachers we remember best from our school days are not those who were the best lecturers but rather those who best role modeled creative thinking.

Teachers also can enhance creativity in students by helping the students *to cross-fertilize their thinking* across various disciplines (Sternberg & Williams, 2001). The traditional environment in the school often has separate teachers, classrooms, and classmates for each different subject. The lesson to students may be that learning occurs in discrete compartments – the mathematics box, the language-arts box, and the science box. Creative ideas and insights, however, often come out of the integration of material across diverse subject-matter areas.

Teaching students to cross-fertilize in their thinking draws on the students' individual skills and interests, regardless of the subject matter. If students are having difficulty in understanding mathematics, teachers might ask the students to create test questions related to their personal special interests. For example, teachers might ask the football fan to devise geometry problems based on the game of football. The cross-fertilization of contexts may promote creative ideas because the student likes the topic (football). Working with an enjoyable topic may lessen some of the anxiety arising from the geometry. Cross-fertilization can help motivate students who connect with subjects taught with concrete examples.

One way teachers can facilitate cross-fertilization in the classroom is to challenge students each to identify their academic strengths and weaknesses. Students then can be challenged to generate project ideas in a weak area based on ideas taken from a stronger area. For example, teachers can show students how they can transfer their interest in natural science to social studies by analyzing political trends in support of scientific research through agencies such as the National Science Foundation or National Institutes of Health.

Teachers also must give students *the time to think creatively.* Many societies today are in a rush. People eat on the run and hurry from one class or appointment to another. They value speed. Indeed, one way to communicate that someone is smart is to say that the person is *quick* or is a *quick study*. The emphasis in such expressions is on speed. In the same way, many standardized tests comprise large numbers of multiple-choice problems that students need to answer during a very brief period of time.

Most creative insights, however, do not unfold in a hurry. Creators need time to understand a problem, figure out how to solve it, and then come up with a solution that satisfies them. Students need time to be creative. If teachers pack too many questions into their tests, or give their students more homework than the students reasonably can complete within the time they have, the teachers are not giving the students the time to think creatively.

Teachers further should both *instruct* and *assess for creativity.* Basically, it does not work to ask students to think creatively and then assess them only for factual recall or analytical thinking.

Teachers also must *reward creativity.* It is one thing to talk about the need to be creative and another actually to reward creativity when it occurs. Students expect authority figures to require things to be done in a certain way. Surprise them!

Teachers also must *allow students to make mistakes.* Buying low and selling high in the world of ideas carries with it a risk. When all is said and done, many ideas are unpopular simply because they are bad ideas. Creators need to make their mistakes to reach the ideas that are not only novel but also compelling.

Although being creative usually involves making mistakes along the creative path, schools tend often to be relatively unforgiving of mistakes – or at least so the students think. For example, errors on schoolwork may be marked with a large red X. When a student gives the wrong answer, some teachers criticize the student for not having understood or perhaps even read the material. Classmates may then snicker. Through repeated experiences of this kind, students may learn that it is not acceptable to make mistakes. They then become afraid to risk the kind of independent and the sometimes flawed thinking that ultimately leads to creativity.

When students make mistakes, teachers should challenge the students to reflect on and find value in their mistakes. Often, mistakes or ill-formed ideas contain within them the germ of good ideas. Japanese teachers recognize this fact. In Japan, teachers devote significant class time challenging students to analyze their mistakes in mathematical thinking. Enabling students to explore mistakes can provide the students with an opportunity to learn and to grow.

A further aspect of teaching students to think creatively is in teaching them *to take responsibility for both their successes and their failures.* Students who always look to blame others for their mistakes – or to blame themselves – lose opportunities to learn because they are more concerned with assigning blame than with learning.

Teachers also should *encourage creative collaboration* (Sawyer, 2003, 2017). Creative performance sometimes is seen as a solitary pursuit. We may imagine an artist painting in a solitary workshop, a writer slaving away alone in a studio, or a musician unendingly practicing in a small stuffy music-practice room. In reality, people, and especially creative people, more often work in groups. Collaboration can and often does produce creative work.

Students further should learn how *to imagine things as seen from other viewpoints.* An essential aspect of maximizing the gains of collaborative creative work is to imagine oneself placed in other people's shoes. People can broaden their perspectives by seeing the world as others see it.

Teachers also should help students recognize the importance of person–environment fit. What products are judged as creative results from an interaction between a person and the environment in which the person functions. The product that is viewed as creative in one time or place may be viewed as pedestrian in another.

By developing an awareness of the need for person–environment fit, teachers can help prepare their students for selecting environments that are conducive to their achieving creative success. Encourage students to develop this same awareness, evaluate their environments, and to select and match with environments in which people appreciate their skills.

In sum, creativity is in large part a decision – a set of attitudes toward life – that teachers and parents can encourage in students or in themselves. Students can learn through assessment (Brown, Roediger, & McDaniel, 2014), but for the students to learn to be creative, the assessments must encourage the students to think creatively (Runco, 2013).

Prompts for Developing Creativity in Students

In this section, I first present some prompts to help develop creative thinking.

Students are creative when they (1) create, (2) discover, (3) invent, (4) imagine if . . . , (5) predict, or (6) suppose that . . . (Sternberg & Grigorenko, 2007; Sternberg, Jarvin, & Grigorenko, 2009, 2011; Sternberg & Lubart, 1995; Sternberg & Williams, 1996). Consider some examples of instructional activities that help students develop their skills in creative thinking.

1. Create *an alternative ending to a short story you recently have read that presents a different way things might have come out for the main characters in the short story. [Literature]*
2. Write *a dialogue between an American tourist from New York in Madrid and a Spanish woman he encounters on the street. [Spanish]*
3. Discover *a mathematical formula that will help to solve all of the following mathematical word problems. [Mathematics]*
4. Imagine if *the government of the United States keeps changing and advancing over the course of the next thirty years in more or less the same way it has been changing in recent times. What do you believe the government of the United States will be like in thirty years? [Government/Political Science]*
5. Suppose that *you were to add a new musical instrument to a symphony orchestra. What might that instrument look like and sound like, and why? [Music]*

Barriers to the Development of Creativity

There are many obstacles to teaching for creativity. Beghetto (2010; Chapter 27, this volume) described some of the barriers that interfere with the development of creativity in classrooms (as well as in other places). These include (1) convergent teaching practices, (2) suppression of creative expression, (3) pressures on teachers to teach in conventional ways, (4) accountability mandates, and (5) "either-or" thinking, whereby teachers think that if they teach for creativity, they are not teaching students to learn the material. Beghetto also points out flaws in teachers' thinking about creativity. First, they may confuse originality with creativity, believing that any novel idea is creative. Second, they may have a "Big-C" bias, believing that creativity is what people such as Einstein or Picasso do, not what students in a classroom can do. Third, they may have a "product bias," believing that creativity must result in a tangible product. These biases make it hard for them to teach effectively for creative thinking.

I believe the largest barrier to teaching for creativity is quite simple: Teachers do not know how to do it and have no incentive to learn. They have not learned how to teach for creativity in their training, and the standardized tests given to students on the basis of which the teachers, not just the students, will be evaluated place no emphasis on creativity. If we want teachers to teach for creativity, we have to remove the barriers. We could start by teaching teachers how to teach for creativity. Then we could encourage rather than discourage creativity on standardized tests.

Finally, it is important to temper creativity with wisdom. Creativity can be used for good ends or bad (Cropley et al., 2010; Gascon & Kaufman, 2010; Sternberg, 2010). Creativity in itself is morally and ethically neutral. It can be an enormous force for good but it also can be a force for evil. It is up to teachers to ensure that when they teach for creativity, they teach it in such a way that it will become a force for good rather than for evil.

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PART II

Underpinnings of Creativity

Biological Underpinnings

6 Evolutionary Approaches to Creativity

Aaron Kozbelt

Introduction

Creativity is a characteristically human capacity. Almost all other animals behave according to more-or-less fixed action patterns representing immediate responses to the environment. Only a few engage in novel adaptive behaviors, such as rudimentary tool use among chimpanzees, the ornate nests constructed by bower birds, and the changing vocalizations of Bengalese finches and humpback whales. But in assessing creativity across species (Kaufman & Kaufman, 2004), such instances pale in comparison to the achievements of *Homo sapiens*. This chasm in creativity need not imply a categorical discontinuity between humans and other animals. Indeed, a useful way to understand this gulf – and perhaps to shed light on the nature of creativity more generally – is via our evolutionary history: What appears now as uniquely human emerged via a long process characterized by a peculiar set of evolutionary pressures and accidents. This has engendered the remarkable creative abilities of our species, which, as far as we know, are unique in the entire history of life on Earth.

Surely some aspects of a comparison between humans and other animals are unfair. Modern humans live in incredibly complex social environments, with a heritage of centuries of cultural and technological development and powerful means of communication. These position us in a radically more artificial setting than even that of our direct ancestors as little as 10,000 years ago. Certainly, our prehistoric but anatomically and cognitively modern ancestors engaged in acts of creativity as impressive as any in the current day – inventing the bow and arrow, navigating oceangoing watercraft to settle the islands of the Pacific, and painting the caves at Lascaux. But rewind the evolutionary clock to earlier hominins and the differences between modern humans and other species diminish (Dawkins, 2004).

The *phylogenetic* emergence of creativity – that is, how creativity arose in the course of the evolutionary origin of the human species (rather than in the *ontogenetic* development of individual human beings) – seems closely linked to other aspects of human cognition. These include language, consciousness, and superior information processing more generally, which, like creativity, are as distinctly human as they are difficult to pin down in terms of discrete evolutionary origins. Indeed, the process of biological evolution has a close relation with manifestations of human creativity,

Table 6.1 *Hominin ancestors*

Genus and species	Approximate time period	Geographic distribution	Approximate cranial capacity in cubic centimeters	Manifestations of creativity
Australopithecus – *afarensis* – *africanus* – other species	4–2 million years ago	Africa	450	Virtually none, though this is disputed
Homo habilis	2.8–2.1 million years ago	Africa	610	Simple Oldowan stone tools
Homo erectus and *Homo ergaster*	1.9–1.4 million years ago	Africa, Eurasia	1,100	More complex Acheulian stone tools, intercontinental migration, domestication of fire, cooking meat
*Other *Homo* species, including: *H. antecessor* *H. rudolfensis* *H. heidelbergensis* *H. floresiensis* *H. neanderthalensis*	1.2 million–24,000 years ago	Africa, Eurasia	400–1,600	Still more complex stone tool technology, including spears, possible use of pigment, and burial of dead
Homo sapiens	200,000 years ago–present	Worldwide	1,500	Look around

* The variability in this entry is due to the bushiness of the hominin clade at that time, uncertainty about relations among the species (and to modern humans), and archaeological evidence that is often difficult to interpret. Cranial capacity for *H. floresiensis* was only about 400 cubic centimeters, while that of *H. neanderthalensis* was about 1,600 cubic centimeters (greater than that of modern humans); however, the cranial capacities of the other species listed here follows the ascending trajectory apparent in the other entries of the table.

since both generate novelty within contexts of high complexity. In taking up the challenge of understanding the relation between evolution and creativity, it makes a great deal of sense to focus on *Homo sapiens*. Although our creative capacity is anomalous within the biological panorama, it is of undeniable real-world significance.

In this chapter, I begin with some general considerations about evolution that are relevant to the study of creativity. I next consider the phylogenetic history of our hominin ancestors, particularly the archaeological evidence of stone tool use and other overt manifestations of creativity. I then discuss evolutionary mechanisms that may have given rise to our creative capacity. Next, examining psychological aspects more directly, I discuss how evolutionary metaphors have played into contemporary theories of creativity, including some links to cultural evolution. I end by considering the value of an evolutionary approach to creativity, in terms of potential research directions and a richer understanding of creativity more broadly.

General Considerations About Evolution

Several overarching themes are prominent in the evolution of modern humans. One is the nonteleological nature of evolution. In considering any ostensibly human-specific capacity, one ought to avoid an unduly brain-centric account, which regards the emergence of humans as the inexorable result of a ladder-of-progression evolutionary narrative. A corollary of this point is the bushiness of the hominin clade over the last few million years, with many species and multiple geographical migrations; indeed, only in the last few tens of thousands of years, with the disappearances of *Homo neanderthalensis* in Europe, *Homo floresiensis* in Indonesia, and the Denisovan hominin in Siberia, has there been only one species of human on Earth. A related cautionary point is the incompleteness of the archaeological record, for both fossils and artifacts – particularly for artifacts made of perishable materials, as well as behaviors. Moreover, there is considerable ambiguity in interpreting some ancient artifacts (see Morriss-Kay, 2010), which are not obviously either completely natural or completely fabricated.

Another theme, punctuated equilibrium (Gould & Eldredge, 1977), concerns the uneven pace of evolutionary change. In this view, initial speciation occurs quite rapidly, followed by long periods of stasis. This idea applies both to organisms' morphologies from the fossil record and to stone tool artifacts from the archaeological record. Notably, for several million years of hominin evolution, the evidence from fossils and artifacts runs in tandem, suggesting a correlation between biologically rooted cognitive capacity and tools' characteristics. However, it is vital to distinguish between-species variability versus within-species variability: Issues that are important for the phylogenetic emergence of the human capacity for creativity need not resemble important issues in contemporary manifestations of creativity.

A final consideration is the interaction between biology and culture. Some evolutionary adaptations, like the beaver's capacity for dam-making, exert a direct influence on their environment; Dawkins (1983) provocatively argued that beavers' dams and their effects should be considered an "extended phenotype" of the organism. With the advent of modern humans, the force of Dawkins' argument is multiplied many times over – both in the social realm of interpersonal relations and in the ecological realm, where the products of human intelligence and creativity have completely changed our living conditions and, concomitantly, the nature of the selection pressures acting on us. The interaction, co-evolution, and possible independence of biology and culture represent major ongoing research themes across many disciplines.

The Evolution of Humans and Human Creativity

What was the evolutionary path leading to modern humans? Some highlights are given in Table 6.1. Our evolutionary branch diverged from humanity's most recent common ancestor with chimpanzees, our closest extant relatives, about 7.5 million to 5.6 million years ago in eastern Africa (Dawkins, 2004). Somewhat later, *Australopithecus*, a multispecies genus of bipedal ape-like hominins that lived between about 4 million and 2 million years ago, flourished; "Lucy" is their most famous fossil representative. On average, Australopithecines stood a little over four feet tall and had a cranial capacity of about 450 cc (cubic centimeters) – within the range of chimpanzee or gorilla brains and about one-third the modern human average of almost 1,500 cc (Holloway, Yuan, & Broadfield, 2004). Subtle changes in the organization of the brain may also have occurred in this genus; notably, our Australopithecine ancestors were the first hominins to show a doubling of the human SRGAP2 gene (Dennis et al., 2012). This gene, which is found in all mammals but only in duplicated form among humans, is involved in neuronal migration and differentiation and plays a critical role in synaptic development, producing a more rapid wiring of the frontal cortex (Charrier et al., 2012; Guerrier et al., 2009).

Regardless of such incipient brain changes, archaeological evidence suggests that Australopithecines did not possess any significant creative capacity and did not use stone tools.[1]

Homo habilis: Rudimentary Creativity

The *Homo* genus evolved from Australopithecine ancestors. Its earliest representative, or possibly a transitional species, was *Homo habilis* ("handy man"). *Homo habilis* may have emerged as early as 2.8 million years ago (Villmoare et al., 2015); it was certainly present by about 2.1 million years ago. *Homo habilis* was about the size of Australopithecines but with a cranial capacity of about 610 cc. This is substantially more than that of their direct ancestors, though still less than half that of modern humans (Holloway et al., 2004). Besides increases in absolute size and in brain-to-body size ratio, it is useful to note that additional brain reorganization seems to have occurred. For instance, cranial endocasts, which reveal something of the overall brain structure of fossilized animals, show a left hemisphere impression of Broca's area, a brain region associated with speech production, in *Homo habilis* (Falk, 1983). Moreover, another doubling of the human SRGAP2 gene, some 2.4 million years ago, may also have contributed to the emergence of the species' new capacities.

Such findings do not help much in characterizing the mental lives of these creatures. However, a few intrepid scholars have attempted to speculate on this issue. For instance, Feist (2008) used the term *pre-representational*, suggesting that

[1] But see McPherron and colleagues (2010), who argued for the Australopithecine use of stone implements to scrape animal carcasses some 3.4 million years ago.

early hominins could not form mental representations that deviated from their present sensory experience. Mithen (1996) discussed a *generalized intelligence* rooted in mechanisms like Pavlovian conditioning and implicit, rather than explicit, learning (Reber, 1993), and lacking an integration of mental modules.

In any case, the advent of *Homo habilis* provides the first unequivocal evidence of creativity in the archaeological record. These so-called Oldowan artifacts were mostly single-faced stone tools used to split fruits and nuts; some specimens with sharp edges have also been found among cut-marked bones, suggesting additional possible uses (Leakey, 1971). While very simple, the appearance of Oldowan tools marks a major conceptual breakthrough: For the first time, our ancestors deliberately made something that did not previously exist.

If the mere appearance of stone tools is the most striking development associated with *Homo habilis*, a close second must be the long period of stasis that followed. Astoundingly, from our modern perspective, Oldowan stone tool technology failed to undergo any development for hundreds of thousands of years, until it was inherited – and then supplanted – by the Acheulian technology of other members of the *Homo* genus.

Homo erectus et al.: Migrations, Hand Axes, and Fire

Even before *Homo habilis* died out, some 1.4 million years ago, several other hominin species had appeared on the scene. Among these, the most prominent is *Homo erectus,* which emerged some 1.9 million years ago and may have persisted until 143,00 years ago (Indriati et al., 2011). Besides its impressive temporal endurance, *Homo erectus* is also notable for its geographical range: It was the first hominin to have migrated out of Africa, perhaps shortly after its debut, and it eventually settled most of Eurasia. That exodus coincided with the emergence of another African species, *Homo ergaster*, whose relation to *Homo erectus* remains debated.

Compared with earlier hominins, *Homo erectus* evinced further significant changes in the brain and in information-processing and creative abilities. Though similar in height to modern humans, *Homo erectus* had an average cranial capacity of about 1100 cc, a large increase over *Homo habilis*, and more than 70 percent that of modern humans (Holloway et al., 2004). Moreover, a third doubling of the human SRGAP2 gene occurred about 1 million years ago, further increasing neural density. Delineating the mental lives of such species is again highly speculative but these have been characterized as *first-order* (i.e., lacking metacognition: Gabora & Kaufman, 2010), having only *pre-syntactic protolanguage* (Dunbar, 1996), transitioning from an episodic to a *mimetic* mode of functioning (Donald, 2006), and as beginning to have a more fine-grained memory, with episodes encoded in more detail and with more potential for creative connections (Gabora, 2010).

Accompanying such anatomical changes, *Homo erectus* and related species initiated several major creative innovations, reflecting their enhanced cognitive ability to deal adaptively with the environment. Besides making intercontinental migrations, they also appear to have been the first hominins to have lived in a hunter-gatherer society and to have exploited complex stable seasonal habitats. *Homo* *erectus* went beyond simple Oldowan tools, knapping symmetrical hand axes out of stone – a feat requiring formidable coordination and executive control. African populations of *Homo ergaster* further refined the making of exquisite, sometimes task-specific hand axes, in their more sophisticated Acheulian technology.

Arguably even more impressive was the taming of fire, pioneered by *Homo erectus*, perhaps 1.6 million years ago. More effective stone tools and the use of fire for warmth and safety are key phenotype-extending adaptations. But perhaps most consequential was the use of fire for cooking *meat*, a practice for which there is direct archaeological evidence going back at least 1 million years (Berna et al., 2012). This innovation overcame a natural metabolic bottleneck in energy use by neurons and a developmental trade-off in the use of calories to enhance body size versus brain size. The increase in available calories by the consumption of cooked meat, which enabled much more efficient digestion and diverted energy to allow the growth of many more neurons, literally fueled the subsequent evolution of an even larger brain (Herculano-Houzel, 2016; Wrangham, 2009). Livio (2017) has explicitly linked this dynamic to the human capacity for curiosity and, by extension, creativity.

Homo sapiens: The Creative Explosion

The creative and intellectual capacities of modern humans derive from yet another increase in brain size between about 600,000 and 150,000 years ago, when they reached their current level (Ruff, Trinkaus, & Holliday, 1997). Phylogenetic links between *Homo erectus* and modern humans include several other species, such as *Homo antecessor*, *Homo rudolfensis*, and *Homo heidelbergensis*, whose African population 700,000 years ago seems to have been the ancestral source of all modern humans as well as our extinct cousins, the Neanderthals and Denisovans. Anatomically modern *Homo sapiens sapiens* emerged in east Africa between 200,000 and 160,000 years ago (Lewin & Foley, 2004).

However, despite *anatomical* modernity, *behavioral* modernity does not appear in the archaeological record until some 50,000–35,000 years ago, in the Upper Paleolithic in Europe and Late Stone Age in Africa (Lewin & Foley, 2004; but see McBrearty & Brooks, 2000). This modernity is evident in almost every aspect of prehistoric life: a vastly expanded repertoire of tools and hunting technology, body decoration, burials, long-distance exchange networks, musical instruments, representational art, and so on. The apparent temporal rift between anatomical and behavioral modernity is as mysterious as the long periods of technological stasis earlier, and it has been interpreted in various ways (for discussions, see Amati & Shallice, 2007; Gabora & Kaufman, 2010). The presence of occasional artifacts like ochre or beads apparently used for body decoration (164,000 and 100,000 years ago, respectively), or the Berekhat-Ram or Tan-Tan figurines (each several hundred thousand years old), complicates interpretation (see Morriss-Kay, 2010) – not to mention the likelihood of expressions of creativity leaving no archaeological traces.

Despite such scattered earlier examples, a “creative explosion” (Pfeiffer, 1982; see also Klein, 1992; Lewis-Williams, 2002) 40,000 or so years ago is emblematic of *sustained* behavioral modernity. Such developments are perhaps most striking in visual art: Masterful depictions including some so-called Venus figurines (small carved statues of ample, obviously fertile women: Conard, 2009) and the realistic cave paintings of animals at Chauvet (Clottes, 2003) date from at least 35,000 years ago (Morriss-Kay, 2010). All told, this brief period produced more creative novelty than the preceding 6 million years (Mithen, 1996). Relatedly, for the first time, there is also evidence for *cumulative* cultural change, along the lines of Tomasello's (1999) ratchet effect, whereby once a certain invention has been made, it can quickly spread throughout a whole population via sharing and imitation.

Explanations for this "creative explosion" have taken several forms. Some have emphasized changes in the organization of the brain, irrespective of size. For instance, Gabora (2003) posited a change in the use of memory, via *contextual focus* or shifting between implicit and explicit modes of thought. Amati and Shallice (2007) proposed a computational model underlying the emergence of uniquely human capacities via the evolutionarily novel quality of *abstract projectuality*. This involves humans' ability "to set objectives which do not stem directly from immediate representations of their current perceptual world and motivational systems but imply instead a representation abstracted from immediate reality" (Amati & Shallice, 2007, p. 364). In their view, this innovation resulted from a continuous increase in neural connectivity, producing something akin to a cognitive phase transition, but without qualitative changes in the brain's underlying functional architecture.

Other explanations have focused on interpersonal factors. For instance, Humphrey (1976) argued that the higher intellectual faculties of primates evolved mainly as an adaptation to the challenges and complexities of social living, rather than ecological factors. Dunbar (1998) proposed the *social brain hypothesis*, whereby the size of neocortex reflects information-processing demands resulting from larger social networks; Gamble, Gowlett, and Dunbar (2011) exploited this hypothesis to argue for the co-evolutionary development of people and materials in a social context. Mithen (1996) related the production of art to variations in economic and social organization for given environmental conditions. And, recently, Cupchik (2016) argued for the notion of *culturally mediated neural plasticity*, whereby changes in social structure and culture interact with neural processes that foster the integration of planning and imaginal activity.

Summary Points of Human Evolution

The phylogenetic origin of modern humans is a tale told in fits and starts, with many truncated collateral branches. Several periods of relatively rapid transition between species appear to run in striking parallel with the archaeological evidence, as shown in Table 6.1. Each species has its characteristic technology: We associate no significant stone tool use with Australopithecines, simple Oldowan tools with *Homo habilis*, knapped Acheulian hand axes with *Homo erectus* and *Homo ergaster*, and a vastly expanded toolkit with the emergence of *Homo sapiens*.

Given the synchrony between the fossil evidence and archaeological evidence, it is tempting to impute a simple causal relation between the two, with saltational or discontinuous brain changes producing changes in tool-making capacity. This facile conclusion is unwarranted. First, the record of hominin fossils and tools is incomplete and dating somewhat uncertain. Archaeologists and anthropologists continue to refine our understanding of relations among hominin species based on new evidence. Moreover, at best we can make only hazy inferences about the behavioral and cognitive characteristics of our hominin ancestors, let alone their social conditions. It remains unclear exactly how an emerging cognitive capacity may have reciprocally developed via hominin social dynamics or broader cultural practices, which would reinforce further brain growth, as described above.

Despite important limitations on interpretation, the basic facts and timeline of human evolution form a reasonably coherent narrative. The story, admittedly retrospective and simplified, has as its protagonist a brain that, over a few million years, tripled in size and gained enormously in neural density and subtlety of organization, supporting a soaring intellectual and creative capacity. This unique constellation of abilities demands to be understood – in terms of responsible evolutionary mechanisms and psychological theories of creativity – by the only species capable of achieving such an understanding. The next two sections pursue these themes.

Evolutionary Mechanisms

Four main categories of explanations have been offered for the phylogenetic emergence of the high-level information-processing capacities of modern humans. Besides creativity, these include symbolic reasoning, syntactic language, consciousness, theory of mind, metaphor, metacognition, cognitive fluidity, humor, and artistry, among others (see Amati & Shallice, 2007). Since the emergence of such faculties is otherwise unprecedented among organisms, it is of special interest to determine how they arose among hominins and what they imply for creativity today. Two categories of explanation – natural selection and sexual selection – reflect Darwinian principles; a third involves the co-opting of already-selected abilities to other uses; the fourth regards creativity as a distinctly cultural phenomenon, largely independent of evolution.

Natural Selection

Natural selection has been the dominant unifying idea of biology since the publication of *The Origin of Species* (Darwin, 1859) and especially since the so-called modern synthesis (Huxley, 1942) incorporated Mendelian genetics as a vehicle. Dennett (1995) has described Darwinian natural selection as a universal acid, eating through just about every traditional concept, and Dawkins (2006) argued for "universal Darwinism," characterizing natural selection as the only theory that is in principle equipped to account for life anywhere in the universe.

Natural selection is a simple idea. It is rooted in variation, selection, and heredity. In a general struggle for survival, the naturally occurring variability among different organisms means that some will be better adapted to local conditions; compared with their less well-adapted counterparts, those organisms will be more likely to survive and reproduce. The offspring of such organisms, physically and behaviorally similar to their parents, will then occupy a greater proportion of the population. The introduction of additional variability, in the form of random genetic mutations, as well as changing local conditions that impact selection pressures, keeps evolution going.

To make a compelling case for natural selection as *the* mechanism undergirding human creativity, one must show a *direct* adaptive value associated with that capacity. This is easier said than done. Plausible thought experiments promulgating the supposed benefits of such capacities are not difficult to devise, but that is very different from hard evidence. The physical evidence of early stone tools, unprecedented in earlier geological strata, may represent stronger evidence for the adaptive value of tool-making capacity, but there are complications here as well. Despite their apparent usefulness, what if these tools mainly represented a form of cultural exchange or social status, or were a vehicle for displaying creative virtuosity, rather than being purely utilitarian?

Among further complications, many adaptations are domain-specific, as in the mental toolkit approach of evolutionary psychology (Pinker, 1997). Also, determining the status of a supposed direct adaptation is challenging, though some criteria have been proposed. For instance, Justus and Hutsler (2005) argued that finding both innateness and domain-specificity in a cognitive domain would be strong evidence that it was shaped by the forces of natural selection, but this is hard to demonstrate.

Among domains, those geared toward understanding and controlling the environment (roughly, scientific and technological domains) may be the best candidates for natural selection (Feist, 2008). But cases have also been made for the direct adaptive value of artistic domains. For instance, in a review of nine hypotheses for what art does, Dissanayake (2007) discussed several possibilities that comfortably fit under the umbrella of natural selection – for instance, the use of art in perceptual learning of important objects (e.g., Ramachandran & Hirstein, 1999) and adaptive aspects of the environment (see Orians, 2014), as well as engaging in risk-free simulation of future events via storytelling (e.g., Carroll, 2004). Some additional explanations, like those involving the use of art or ritual for group bonding or commitment (e.g., Irons, 2001; see also Freeman, 2000), also invoke natural-selection principles, but at the level of the group, rather than the individual organism or gene. Group selection is a controversial and problematic theoretical position (Williams, 1966). Sometimes regarded as a kinder, gentler form of evolution, it still has winners and losers – indeed, arguably it "replaces the logic of murder with the logic of genocide" (Miller, 2000a, p. 351), since whole groups, rather than just individuals, will rise or fall within this selection dynamic.

Sexual Selection

As Darwin himself recognized, natural selection is not a complete explanation for all biological phenomena. For instance, a peacock's tail has no direct adaptive value and, indeed, seems a hindrance for its basic business of life. Resolving this dilemma, Darwin (1871) proposed an alternative mechanism, sexual selection, whereby a peacock's beautiful, metabolically costly tail would serve as an indicator of fitness and thus be sexually attractive to a peahen. Sexual selection is a theory about intraspecies competition for reproductive resources. In many species, including peafowl and people, females provide a larger minimal investment in their offspring than do males, so they must be choosier about their mates. Males engage in displays of their fitness; females choose some as mates, and their genes are more likely to be passed on to subsequent generations than those of the males who lose out in such competitions.

Miller (2000a, 2000b, 2001; Geher & Miller, 2008) is the most prominent contemporary proponent of sexual selection in the realm of human creativity. In this perspective, uniquely human cognitive abilities like fluid intelligence, creativity, humor, musicality, and artistry serve as genetic fitness indicators, in the same way that physical characteristics like facial symmetry and blemish-free skin do. Male displays of these high-level cognitive processes – like a spontaneous witty remark in conversation or musical virtuosity – should be found especially sexy by females, providing successful males with numerous mating opportunities.

Several lines of evidence support the relevance of sexual selection to human creativity. Intelligent, creative men are generally considered more attractive and have more sexual partners (Nettle & Clegg, 2006). Experimental research has also yielded some notable findings, on both the productive and the receptive sides. For instance, Griskevicius, Cialdini, and Kenrick (2006) primed male and female participants to think about mating and subsequently measured their creativity via a caption-writing task. Among other results, men wrote significantly more creative captions after being primed for both short-term and long-term romantic relationships; creativity differences were apparent among women only when primed for a long-term romance with a trustworthy, committed partner. Haselton and Miller (2006) found that, in considering short-term romantic encounters, women's selection criteria unconsciously shift over the menstruation cycle, with ovulating women preferring creativity-related traits. Kaufman and colleagues (2014) examined individual differences in patterns of attractiveness across three forms of creativity: ornamental/aesthetic, applied/technological, and everyday/domestic creativity. Overall, males and females most strongly preferred ornamental and aesthetic forms of creativity in prospective sexual partners. Individual differences appeared along the lines of assortative mating, with each form of creativity being associated with different predictors having to do with personality, interests, and creative achievement. Finally, in the realm of archaeology, Kohn and Mithen (1999) have proposed that Acheulian hand axes served as sexual-selection fitness indicators: Many axes are worked well beyond the point of utilitarian purposes, and some giant exemplars, far too unwieldy for use, may have been intended as social displays. Despite this and other evidence and ongoing research on sexual selection and "mating intelligence" (Geher & Kaufman, 2013), sexual selection as an explanation for human creativity is not universally accepted (see, e.g., Kozbelt, in press; Rothenberg, 2011).

Evolutionary By-Products

Natural and sexual selection are Darwinian mechanisms operating on the principle of adaptation, or fit to the environment. The success of these mechanisms in explaining a vast range of biological phenomena might suggest that *all* traits, behaviors, or morphological features are adaptations. Gould and Lewontin (1979) offered a strong critique of this adaptationist program, instead proposing that many biological features are *spandrels* – not themselves directly selected for but by-products of other, genuine adaptations. To cite one well-known instance, Pinker (1997) called human music *auditory cheesecake*, tickling our pleasure buttons but not in itself a direct adaptation. In contrast, he argued that music draws on a variety of mental faculties for its effect – language, auditory scene analysis, emotional calls, habitat selection, and motor control, among others – and that the phylogenetic emergence of music resulted from selection in these cognitive domains, instead of on music directly. Like the other mechanisms described here, the by-product view remains controversial (see, e.g., differing views in Dissanayake, 2007).

Culture as Independent of Biology

A fourth category of explanation de-emphasizes biological factors and regards culture as largely independent of evolution. This perspective, traditionally prevalent in the humanities and dubbed the *standard social sciences model* (Tooby & Cosmides, 1992), is emblematic of postmodernist relativism and has been strongly critiqued by scientists for its willful disregard of evolutionary and psychological principles (e.g., Pinker, 2002; Wilson, 1998). Some aspects of this view may be salvaged, however, if one treats the upper Paleolithic *creative explosion* as primarily a sociocultural phenomenon, rather than one catalyzed directly from biology. Such a view is consistent with some perspectives on creativity (e.g., Csikszentmihalyi, 1988; Sawyer, 2006), which stress that creativity invariably arises out of a sociocultural dynamic – of which, more below.

Implications

The options on this menu of evolutionary mechanisms are not mutually exclusive. Different mechanisms may have played out in different ways, contexts, timescales, domains, and populations throughout our evolutionary history. While none of the proposed explanations are obviously devoid of merit, there also appears to be no straightforward way to choose among them, or to even know what criteria would be useful for making such a decision (Rampley, 2017). This is not a fatal flaw: For a phenomenon as complex as the phylogenetic emergence of human creativity, pluralistic, nuanced support for multiple mechanisms may ultimately be more informative than conclusively falsifying a subset of those explanations. However, several integrative points about the implications of these mechanisms can be made.

One point of distinction concerns the idea that different mechanisms of selection may apply to different kinds of domains. Notably, Feist (2008) made a promising distinction between natural selection as more relevant to technical or scientific domains, versus sexual selection as more relevant to artistic or ornamental domains. A related point is the complex relation between biology and culture in engendering and furthering our creative capacity. Understanding the nature of this dynamic has implications for the relevance of evolutionary mechanisms deep in our evolutionary past versus those that are pertinent today, as well as for studies of cultural evolution.

Another issue involves the methods for assessing the present-day residue of long-standing evolutionary mechanisms. In some cases, fairly clear predictions can be theoretically derived. For instance, sexual-selection theory posits positive correlations among various cognitive fitness indicators, such as intelligence and humor production ability (Greengross & Miller, 2011); Orians' (2014) studies of people's aesthetic preference of trees and landscapes based on their adaptive features stem from natural selection. Similarly, the cross-cultural study of phenomena like putative aesthetic or creative universals – such as certain features of visual art (Ramachandran & Hirstein, 1999) or the tonal or melodic characteristics of music (Purves, 2017) – also bear on the evolutionary mechanisms described above. While the cross-cultural ubiquity of some aesthetic feature is no guarantee of a biological basis, it is at least consistent with it having had some adaptive value. In contrast, the standard social sciences model would posit fewer aesthetic or creative universals, since these are thought to emerge via culture and historical accident. The by-product view suggests the methodological strategy of studying popular works, rather than esoteric masterpieces (Pinker, 1997). To make headway on any of these issues, careful operationalization and measurement are paramount (Kozbelt & Kaufman, 2014), especially given the vagaries of creativity and aesthetic judgment.

Evolutionary Metaphors

The astonishing success of evolutionary ideas in the biological realm have made them a tempting source of theory for many domains. Indeed, evolutionary ideas have long been part of psychological theorizing about the nature of creativity, taking various forms and typically invoking evolution metaphorically – sometimes loose, sometimes more rigorous. In this section, I discuss several categories of evolution-inspired psychological theories of creativity.

Darwinian Theories

As in biology, Darwinian natural selection has had an enormous impact on psychological ideas about creativity. Arguably the most prominent and unabashedly scientific application of evolutionary ideas is the so-called Blind Variation and Selective Retention, or BVSR, model of creativity, laid out by Campbell (1960) and refined and repeatedly tested over the last half-century, primarily by Dean Keith Simonton (e.g., Simonton, 1999, 2011). The requisite blindness of the idea generation process –

especially for ideas leading to revolutionary creative achievements – is the theory's most distinctive feature, akin to the process of truly random genetic mutations driving evolution by natural selection.

The BVSR model conceptualizes the creative process as follows: Ideas are combined in some blind fashion, typically below the threshold of awareness; the most interesting combinations are then consciously elaborated into finished creative products; these in turn are judged by other people. Deductions from this model can be used to understand a variety of phenomena in the study of creativity, including how creativity unfolds over the life span, person-level and domain-level differences in creative achievement and ages at various career landmarks, the distribution of occurrences of multiple instances of the same scientific discovery, and personality and experiential variables associated with high creativity, among others. This view implies that due to the sheer complexity of the creative process, creators should have little control over guiding the progress of their works at any point in the process. Thus, mass-production is the optimal strategy for those seeking eminence; indeed, great creators are almost always very productive, besides having a large, idiosyncratic knowledge base. Overall, the BVSR model had had many successes as a theory, yielding a trove of testable predictions; many – but not all – of which have been empirically well-supported (see Simonton, 2011; cf. Kozbelt, 2008). The BVSR approach has also been critiqued on theoretical grounds. For instance, Sternberg (1998) argued that the cognitive mechanisms in human creativity are, for the most part, sighted rather than blind. Gabora (2005) objected that ideas are not discrete, independent units that exist in some dormant state, waiting to be selected out from other alternatives in a Darwinian manner; an alternative account emphasizes the context-driven actualization of potential, that is, simply a change of state in response to a context, which can propel creative thought via a non-Darwinian process. Depending on one's purposes, another arguable shortcoming is the BVSR model's fundamentally statistical treatment of the creative process and other aspects of creativity: Typically, large archival data sets are analyzed to test hypotheses about groups of creative persons – rather than dealing with or detailing individual variability.

In passing, I note that Martindale's (1990) account of creativity employs a similar Darwinian dynamic. Sharing with Simonton's work great quantitative rigor, a taste for big questions and large archival data sets, and likewise enjoying considerable empirical support, Martindale's work focused more on transhistorical-style evolution in the arts and has broad implications for cultural evolution.

Lamarckian Theories

Besides the Darwinian accounts outlined above, another venerable conception of evolution has been applied to understanding creativity: Lamarck's (1809) model of the inheritance of acquired characteristics. In this view, organisms adapt to their environments and can convey these adaptations to their offspring; a giraffe stretching its neck to reach high foliage, resulting in longer-necked progeny, is the prototypical example. With the advent of Mendelian genetics and molecular biology, Lamarckism was discredited as a viable theory of biological evolution, but it remains a useful idea for understanding both the creative process and the cultural evolution more generally.

Among psychological theorists of creativity, Johnson-Laird (1993) has made the strongest case for a neo-Lamarckian view, in which basic constraints operate much more forcefully than in Darwinian models. He posits a Lamarckian dynamic in many creative situations, including musical improvisation and other extempore performances. In such cases, certain criteria are used to generate possible products and an arbitrary choice is made from among them. This approach promotes an at least minimally satisfactory output and it minimizes demands on working memory. Notably, constraints on choices not only drive creative cognition but also form the basis underlying different creative genres as well as individual styles within those genres. Moving beyond real-time instances of creativity, multistage approaches are necessary, with revision and elaboration, as the process cannot be governed by the constraints used in the generation stage. Notably, such models are compatible with expertise- and problem-solving–centric accounts of creativity (e.g., Ericsson, 1999; Weisberg, 2006; see also Sternberg, 1998).

The distinction between ideation and elaboration echoes tenets of the BVSR model described above, as well as other models of creativity, such as the *Geneplore* model (Ward, Smith, & Finke, 1999). However, contra the BVSR view, Johnson-Laird (1993) regards a neo-Darwinian process, with a wholly arbitrary generation of ideas followed by criteria-based selection, as more likely to be used by nature than by human beings.

Evolving Systems Theories

While Darwinian and Lamarckian models of creativity have a strong quantitative, statistical flavor, alternative perspectives on creativity have been proposed, which nonetheless take their inspiration from evolution. Among the most prominent of these is the so-called *Evolving Systems Approach*, pioneered by Gruber (1981; Gruber & Wallace, 1999). This approach has mainly been applied to understanding the unique attributes of the creative person, via very detailed archival case studies, which are often motivated by a very specific question – for instance, how Darwin devised the theory of natural selection (Gruber, 1981). The Evolving Systems Approach is less analogous to reductionist evolutionary mechanisms than BVSR or neo-Lamarckian models of creativity.

The Evolving Systems Approach is holistic in focusing on how creative acts fit into the context of an individual's goals, knowledge, and reasoning, as well as broader social forces; however, it is evolutionary in attempting to understand the nature of change over the course of creative enterprises. This approach emphasizes dynamic, developmental processes that play out through various timescales, ways, and contexts. Among its foundational concepts is that great creators typically use an *ensemble of metaphors* in their thinking. Another is a *network of enterprises*, a system of goals that describes how a creator may work on seemingly disparate topics and projects, consecutively or concurrently, and continually evolve a sense of the relations between them. Such analyses put great interpretive pressure on researchers but they provide tremendous qualitative richness.

Related approaches have been proposed by Csikszentmihalyi (1993, 1996), in his notions of the *evolving self*, in which a person incorporates evolutionary principles into their own creative functioning through the pursuit of challenging activities, and *complexity* as the central defining aspect of the creative personality. These share with the Evolving Systems Approach a holistic, metaphoric sense of evolution, with an added dimension of self-actualization.

Sociocultural Theories and Cultural Evolution

Yet another category of theories, also pioneered by Csikszentmihalyi (1988), emphasizes sociocultural factors. For instance, his systems theory of creativity asserts that creativity is not an inherent property of any artifact. Rather, creativity emerges as a consensus judgment out of the dynamic interplay between three components: knowledge within a *domain* that is absorbed by up-and-coming creators; the *individual* who produces variations on that knowledge in the form of new creative products; and other experts comprising the *field*, who judge which of those variations are worth incorporating into the domain. The mutual interplay among the components in the systems model echoes interactions between organisms and environments in biological evolution, which produce meaningful novelty and change. Sawyer (2006) has further developed this sociocultural account, arguing that individualist, cognitive, biological, and computational approaches are inadequate for a full understanding of creativity, which is by nature social and collaborative.

The emphasis such theories place on sociocultural factors need not be taken as an utter disregard of evolutionary factors and a blind endorsement of the standard social sciences model. Rather, culture can take its place as one factor influencing the genome. This theme was noted earlier, in discussing explanations for the creative explosion some 40,000 years ago, but some additional theories are worth mentioning in the context of sociocultural theories and cultural evolution more generally. For example, Lumsden and Wilson (1981) provided evidence for gene-culture co-evolution, whereby cultural practices can influence the evolution of the genome, beyond the impact of the natural environment; Findlay and Lumsden (1988) conceptualized interconnections among the genotype, brain development, the cognitive phenotype (i.e., creative individual), and the sociocultural environment to represent the multiple effects and interactions of creativity. Besides the process of gene-culture evolution, more recent work (e.g., Lalande, Odling-Smee, & Miles, 2010), has additionally argued for an important role for niche construction, that is, the capacity of organisms to select and modify natural selection in their environments.

Other recent research (e.g., Fogarty, Creanza, & Feldman, 2015) has noted the heretofore under-examined role for creativity in studies of cultural evolution. In one notable study, Kolodny, Creanza, and Feldman (2015) developed a simulation model of cultural evolution relying on three modes of creativity: one in which independent large creative leaps can occur (the so-called *main-axis* tools of their model), one in which tools are created as part of a toolkit whose instances are made useful by a main-axis tool, and one in which existing tools can be combined to make new tools. Their theoretical model also takes into account the differential distribution of cultural repertoires among social groups of different sizes as well as the impact of environmental change. The model successfully accounts for several prima facie puzzling aspects of cultural evolution, including the exponential accumulation of cultural traits (like scientific knowledge or Upper Paleolithic stone tool types), punctuated equilibria in cultural history (as described above, vis-à-vis early hominin tool technology), and occasional dramatic losses of cultural diversity. Such models go a long way toward identifying the most relevant variables and the nature of their interaction in understanding key aspects of cultural evolution, in both prehistoric and historic eras. They also reciprocally inform what conception(s) of creativity are most useful for answering such complex questions – indeed, the success of their model suggests strong benefits of adopting a nuanced, pluralistic approach to creativity.

Ontogenetic Theories

The above-mentioned theories have not exhausted the possible applications of evolutionary ideas to psychological aspects of creativity. For instance, one venerable but often under-examined approach is that of evolutionary developmental biology (Hall, 1999), which compares the developmental processes of organisms to infer their ancestral relationships, as well as how developmental processes have themselves evolved. Such ideas are familiar through famous, if not fully accurate, phrases like "ontogeny recapitulates phylogeny" – the idea that a developing organism passes through a series of developmental stages reflecting its evolutionary ancestors, as in the fish-like appearance of mammalian embryos (see Gould, 1977). Evolutionary developmental principles provide a fresh perspective on the nature of the creative process (Kozbelt, 2009a).

One key principle emphasized in much biological research in this area is the importance of changes of *timing* and its capacity to generate novelty in organisms' morphologies. Consider Galápagos finches, whose highly varied beak morphologies result not from a large number of genetic differences but rather from small variability in the timing of one "switch," a segment of DNA that controls the activity of other genes (Abzhanov et al., 2004). By analogy, in the creative process leading to a painting, a novel idea per se may not be necessary for a creative outcome, if the method of elaborating a mundane idea involves manipulating the typical order and timing of operations in painting, as many visual artists throughout history appear to have done (Kozbelt, 2009a). Unfortunately, detailed studies of the emergence of creative products remain scattered (but see, e.g., Kozbelt, 2006; Weisberg, 2004), and with little application of evolutionary developmental principles to guide understanding.

The Value of an Evolutionary Approach to Human Creativity

Given the many extant approaches to creativity, what is the added value of thinking about the topic in specifically evolutionary terms? The material reviewed in this chapter has amply demonstrated that the features of extant psychological theories of creativity echo the gamut spanned by biological principles: reductionist theories of evolutionary mechanisms, statistical studies of aggregates of creators or organisms, qualitative narrative accounts of particular biological or creative episodes, consideration of ontogenetic or evolutionary developmental processes, studies on the pace of evolutionary change, and co-evolutionary aspects of nature and culture. Thus, at minimum, evolutionary biology has provided researchers with a large repertoire of concepts and metaphors that have materially advanced our understanding of creativity. Given its status as a less mature domain of inquiry, research on creativity has, alas, not reciprocally advanced biology. Indeed, in terms of considering the ongoing development of creativity as a research area, the far better-developed theoretical and empirical basis of biological and evolutionary science provides an instructive point of comparison. It is a lovely question to consider what epoch in the earlier history of biology most closely reflects the current state of creativity research – an exercise for the motivated reader.

Certainly, biological and evolutionary considerations will continue to be hugely relevant to creativity research. Biological methods will no doubt continue to inform the nature of creativity directly – as in heritability studies (e.g., Piffer & Hur, 2014), neuroimaging research (e.g., Vartanian, 2015; see also Vartanian, Chapter 8, this volume), or studies detailing a possible genetic basis of creativity (e.g., Keri, 2009; see also Barbot & Eff, Chapter 7, this volume). As noted above, developmental evolutionary principles have only recently been introduced to the study of creativity; these may ultimately prove useful for understanding the structure and dynamics of the creative process in much more detail than current models provide (Kozbelt, 2009a). Computational models of cultural evolution that incorporate a sophisticated treatment of creative innovation (e.g., Kolodny et al., 2015) likewise hold much promise for uniting disparate levels of analysis into a coherent account. Finally, evolution-inspired considerations of highly speculative issues, like what aspects of human creativity would be most readily understood by alien intelligences (and vice versa: Kozbelt, 2015), can at the very least provide additional fresh perspectives, as can the application of evolutionary ideas into domains within the humanities.

An additional research area, still in its infancy, is how our evolutionary past has constrained human creative productions themselves. Why, for instance, do human art and music show many strong cross-cultural commonalities (Purves, 2017; Ramachandran & Hirstein, 1999)? Only through great methodological care and a multidisciplinary approach combining psychological, computational, developmental, cross-cultural, neuroscience, and genetic approaches will we obtain answers to such difficult questions. Interestingly, beyond informing proposed evolutionary mechanisms for the origin of creativity, such studies would also shed light on the prospects for the future of human creativity. For instance, in the arts, to the extent that human creativity is evolutionarily grounded and biased, inexorable tensions arise between canalized aesthetic preferences and the drive for novelty among ambitious creators (Kozbelt, 2017). Along these lines, Martindale (2009) has argued that this novelty-driven dynamic leads inexorably to the death of artistic traditions. Is this really the case?

In human creativity as with biological evolution, novelty is only one, perhaps overrated, part of the story. If instead we elevate the criterion of value, that is, adaptive solutions to problems, then a different dynamic, with different implications, is evident, and it raises some interesting questions – for instance, what is the human creativity analog of long-term ecological sustainability? Along these lines, Kozbelt (2009b) explored the possibility that the creative process itself is not historically invariant, via the idea of the *evolution of evolvability* (Dawkins, 1989), whereby the evolutionary process itself becomes better at evolving over time. Discoveries about biological evolution, creativity, the mediating role of culture, and their interactions and co-evolution have begun to yield meaningful answers to basic human questions. They have also given us tools to direct our own future development to an unprecedented degree. Our creative capacities have been shaped and constrained by evolution since our inception as a species. How we use these to move forward is up to us.

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7 The Genetic Basis of Creativity

A Multivariate Approach

Baptiste Barbot and Henry Eff

Just as creativity is an ability composed of multiple resources recruited differentially across a range of domains and tasks, there is not one single "creativity gene." As a complex phenotype, creativity involves multiple traits and abilities, which themselves map onto distinct brain functions and networks. Each of these, in turn, has at least partly distinct genetic underpinnings. Although popular culture persists in associating broad human psychological characteristics such as creativity with one or the other hemisphere of the brain (e.g., left hemisphere for logical reasoning and right hemisphere for creative thinking), there is evidence that creativity involves the dynamic interactions of large-scale brain system (e.g., Beaty et al., 2016). Similarly, tracing exceptional creative "talent" solely to hereditary causes and the search for a single creativity gene are vain causes: Much like other complex phenotypes such as intelligence, the contribution of a single gene is usually infinitesimal, and it is only the combined effect of multiple genes that explains a sizable share of the phenotype. Based on a multivariate approach to creativity and its current extension as well as a growing body of Gene-Creativity research since the 2000s, this chapter suggests that a more promising direction is to uncover the common genetic bases of multiple resources involved in creativity (i.e., cognitive and noncognitive resources such as divergent thinking (DT), motivational and personality dimensions that contribute to creativity). This approach would illuminate the co-occurrence of individual resources of a different nature and, in particular, their "optimal" combination within an individual, leading to creative success in specific creative outlets.

This chapter first examines the evolutionary forces that impact the human genome and shape creativity and how, in turn, eminent creative contributions impact the genome too. A first line of genetic studies of creativity is then reviewed, focusing on "real-world" creativity (e.g., creative achievements, talents, product-based assessment of creativity), followed by a second broader line of work focusing on resources that have been determined as important for creativity (e.g., the genetic underpinning of DT, openness to experience, or cognitive flexibility). The chapter concludes by discussing future directions in the study of Gene-Creativity and its importance in uncovering a better understanding of the phenomenon and, ultimately, the realization of everyone's creative potential.

The Genetics of Creativity: From Reciprocal Culture-Gene Evolution to Individuals' Multivariate Creative Potential

In the context of greater global challenges, creativity is an aspect of the "human capital" (Walberg, 1988) increasingly recognized as a valuable asset for individuals in their daily problem-solving because it contributes to personal and societal development. This contribution to human evolution is far from new: Creativity has dynamically and reciprocally been shaped by evolutionary pressures (e.g., Dissanayake, 2007; Feist, 2007). This is particularly well illustrated with the use of creative arts outlets, which have been used for enhancing cultural cohesion throughout evolution (Boyd, 2005; Irons, 2001). Feist (2007) extrapolates that two evolutionary forces of selection have shaped human creativity over the millennia. First, natural selection pressures have probably shaped "applied" forms of creativity such as technological advances because these advances often had direct implications for solving survival problems. Second, sexual selection pressures have possibly underlined the more "ornate and aesthetic" forms of creativity (e.g., music or visual arts), as they implicitly signal an individual's genetic, physical, and mental fitness, which is attractive to the opposite sex (Feist, 2007; Miller, 2001). Reciprocally, Big-C innovations (i.e., creative breakthroughs that most people know) and creative products such as the control of fire, or the advent of electricity or telecommunication, may change the course of human evolution and ultimately impact the genome (Barbot, Tan, & Grigorenko, 2013). This reciprocal influence of cultural manifestations and genetic evolutions is elegantly operationalized by Lumsden and Wilson (1981), who outline how culture is shaped by biological constraints and how biological features are simultaneously altered by the genetic evolution brought about by cultural innovations. Accordingly, human Big-C innovations may be viewed as impacting not only the sociocultural and physical environment but also the genetic composition of following generations through natural selection and nonselective evolutionary mechanisms (i.e., Gene-Culture transmission).

In sum, as much as creativity is an essential human characteristic of adaptation and evolution that can elicit creative responses to evolving global problems, this human ability is evidently partly genetically grounded. Although shaped by popular discourse on intellectual and creative talents, Galton's (1869) *Hereditary Genius* paved the way to the empirical study of exceptionalism and its hereditability, which has fundamentally influenced the field of intelligence and creativity research. Almost 150 years later, there is a continued interest in uncovering the genetic bases of individual differences in intelligence (e.g., Deary, Johnson, & Houlihan, 2009), exceptional intelligence (Spain et al., 2016) and talents (Vinkhuyzen et al., 2009), and, more recently, the genetic underpinning of creativity (Reuter et al., 2006). From the later (thin) body of research, it is apparent that creativity is a highly complex phenotype that involves multiple genes as well as multiple environmental influences (e.g., Zabelina et al., 2016; Zhang & Zhang, 2017).

Despite this "multivariate view" of creativity's biological underpinning, genetic studies to date have overwhelmingly focused on very few of creativity's individual resources. In particular, they have largely focused on DT, often interpreted as a proxy for an individual's "global creativity." Since Guilford (1950), perhaps influenced by a Galtonian view of human phenomenon as normally distributed in the general population, DT has indeed been the primary way to operationalize creative potential. However, although DT is one of creativity's essential "ingredients," it has been established that creativity is not a monolithic entity. Rather, over the past few decades, it has been increasingly acknowledged that creativity is a multifaceted and partly domain-specific phenomenon that results from people's unique combination of resources coming into play in creative work, including aspects of cognition and personality (Sternberg & Lubart, 1995). Conceptually, one's unique combination of resources (i.e., "profile") is what constitutes his or her creative potential in a given creative work. Baer and Kaufman (2005) offer a hybrid view of the issue of domain-generality/specificity of creativity in their Amusement Park Theoretical (APT) Model, which illustrates the interplay between these various individual resources. They consider creative potential as a nested system in which some stipulations exist for entry into the whole park (e.g., a general ticket), some exist for a specific section of the park (e.g., a section-specific ticket), and some exist for individual rides (e.g., height requirements). Similarly, some requirements for creativity are domain-general (e.g., a base level of intelligence) and some are domain-specific (e.g., training in a particular medium).

Further, a person can show distinct levels of creativity in distinct outlets (e.g., fiction writing vs. musical composition), according to the "fit" between his or her unique profile of resources and the specific requirements of the creative task that people engage in. Each creative work relies on a different mixture of person-level resources. Often, the level of creativity of a person in a given creative outlet is average or low when the fit between all the individual resources needed to satisfy the task requirement is not present in that individual in an "optimal" configuration. This "optimal fit view" of creative potential (Barbot, Lubart, & Besançon, 2016) is both theoretically useful and surprisingly practical (Silvia, Christensen, & Cotter, 2016). First, it illuminates why exceptional creativity is very rare. This is because there is a low probability that one's creative potential profile perfectly fits the specific requirements of a given creative outlet. Second, because it is not likely that one's creative potential profile will optimally fit the requirement of multiple creative tasks, this view explains why creativity appears mainly domain-specific. Finally, it elucidates why scientific evidence on creativity is sometimes contradictory or lacks replication, including evidence from genetic studies of DT (Zhang & Zhang, 2017). This is because studies involve different DT tasks that vary in domain, stimuli, or instruction, and therefore rely on a different set of task-specific resources beyond "general" DT (Barbot, Besançon, & Lubart, 2016).

With this increasingly acknowledged conceptualization of creativity in mind, understanding the genetic foundations of human creativity should therefore rely on several analytical angles. First, it should seek to illuminate the genetic bases of each resource (e.g., DT, or openness to experience, but not exclusively these most commonly studied factors). Second, it should explore the interaction between resources and underlying mechanisms that explain the "optimal" co-occurrence of these resources. Finally, it should investigate the mediating role of the brain functions that underlie creativity's individual resources across domains and tasks (Barbot & Tinio, 2015). Indeed, genotype-phenotype relationships don't happen "in a vacuum." Creativity involves multiple traits and abilities, which themselves map onto distinct brain functions and networks, with (often) distinct genetic underpinnings. As outlined in the section "In Search of Common Genetic Bases of the Multiple Resources Forming Creative Potential," there are, however, creativity resources of a very different nature (such as personality traits and cognitive functions) that seem to share common genetic grounds. Another strategy to understand the genetic underpinning of "optimal" creative potential in a specific domain or task (i.e., exceptional talent) is to adopt a more holistic approach to creativity and focus on people with real-world creative achievement and talents so that their genetic characteristics can be examined.

The Genetic Bases of Domain-Specific Creative Achievements and Talents

The vast majority of genetic studies of creativity have taken a resource-based approach, focusing on components of creativity such as DT or sensation seeking in isolation. However, few studies have focused on achievements (i.e., real-world creativity). This small body of existing research falls into three categories. The first focuses on a group of individuals (or families) known for their creativity in a particular creative outlet. The second focuses on cumulative creative achievements across multiple domains. Finally, the third involves production-based tasks that are then rated for their level of creativity using the consensual assessment technique of creativity (Amabile, 1983) or related techniques.

In the first line of research (domain-specific "talents"), for example, Bachner-Melman and colleagues (2005) investigated the genetic components of creative dance performance using both case-control and family-based designs. They identified two main genes contributing to the "dancer phenotype": the *AVPR1a* (a gene already associated with affiliative and social behavior) and SCL6A4 (a gene found in this study to be *associated with* altered states of conscientiousness and spirituality that may predispose individuals to a greater ability for imagery and attention to musical stimuli).

In the second line of research (cumulative creative achievement), Zabelina and colleagues (2016) investigated dopaminergic pathways of (self-reported) real-world creative achievements among 100 healthy young adults. They found that creative achievements in the arts, but not in the sciences, were partly explained by an interaction between genetic polymorphisms related to frontal (Catechol-O-methyltransferase; COMT) and striatal (Dopamine Active Transporter; DAT) dopamine pathways, in a configuration associated with "leaky" attentional control that may help individuals create new ideas by integrating irrelevant information with relevant information. This result, according to the authors, provides good support for the domain-specific grounding of dopaminergic pathways associated with creativity. That is, this particular dopaminergic "configuration" between levels in multiple brain areas, associated with leaky attention, may be relevant to artistic domains but not scientific domains.

Finally, in the third line of research (product-based assessment), Velázquez, Segal, and Horwitz (2015) investigated applied creativity in drawing (i.e., aesthetically pleasing, well-executed, and creative drawings). This reared-apart twin study identified greater performance similarity between monozygotic twins (i.e., who share 100 percent of their genes) than dizygotic twins (i.e., who share an average of 50 percent of their genes) on the Draw-a-Person task, with about 42 percent genetic influence. However, there was no difference between the monozygotic and dizygotic twins on the Draw-a-House task. This result, according to the authors, outlines differences in task requirements with respect to the level of individual expression elicited by each task. In particular, drawing a person leads to greater variability of features, allowing for more personal expression, than drawing a house, which uniformly includes unexpressive features.

From these few examples, it appears that the genetic contribution outlined in different creative outlets is often "domain-relevant." For example, creative dance is a phenotype that involves motor coordination, musical processing, and sensory-motor coordination, among other factors. This data points out to the contribution of both genetic and nonshared environmental influences in creativity, as well as domain-relevant skills that seem difficult to disentangle from common resources of creative potential involved across domains and tasks (i.e., "domain-general" requirements such as DT or creative motivation). In other words, regardless of the approach outlined above, one possible limitation of these Gene-Creative achievement studies is that the genetic bases identified as correlates of high or exceptional creative abilities may be confounded with other domain-specific skills (knowledge, technical skills, a priori deemed independent from creativity) that lead to creative achievements in that domain. Hence, it seems critical to investigate also the genetic ground of creativity using a more "resource-based" approach that focuses on isolated components leading to successful creative outputs in various domains and tasks.

The Genetic Bases of Key Individual Resources of Creativity

Domain-Specific Skills and Knowledge

The contribution of domain-specific knowledge and skills for creativity is obvious: If one doesn't master key characteristics of the domain of interest, creative expression will likely be impeded. Even in the resolution of narrow tasks such as verbal DT tasks, the amount of domain-based knowledge influences performance (Runco, Dow, & Smith, 2006). This fact is particularly well illustrated within the musical domain. Indeed, general musical knowledge, ability, and skills are mostly independent from the ability to be musically creative among "novice" musicians or children and adolescents (Barbot & Webster, 2018; Webster, 1994). However, these skills can facilitate the formulation and expression of musical ideas that have the greatest impact. Most of these skills are acquired through formal or informal training (e.g., mastering musical notation), but many other skills seem to be highly heritable characteristics that, once again, are involved in creative production but also in noncreative activities in music. For example, perfect pitch – the ability to identify tones corresponding to notes without the aid of a reference tone – was linked to genes along the 8q24.21 band of chromosome 8 in a genome-wide linkage analysis study (Theusch, Basu, & Gitschier, 2009). On the other hand, pitch-production accuracy relied on a different genetic underpinning (polymorphism near the UGT8 gene highly expressed in the central nervous system and known to act in brain organization) evidenced by family-based linkage and association analyses, supporting the heritable nature of specific music abilities (Park et al., 2012).

In all, heritability estimates of a genetic basis for key musical abilities (such as pitch and rhythm discrimination, and the ability to recognize patterns in sound sequences) was about 40–50 percent across several family-based linkage and association studies (Pulli et al., 2008; Tan et al., 2014). Most of these studies outline the influence of genes located in chromosome 4. Recently, Oikkonen, Onkamo, and colleagues (2016) used a convergent evidence method of 105 published studies to extract candidate genes related to general music aptitudes (including recognition and production of sounds). They identified twelve genes (mainly located on chromosome 4 in a region coined "the genomic region for music abilities in humans") underlying these musical aptitudes, which, interestingly, also underline biological functions involved in learning and memory. In another study (Oikkonen, Kuusi, et al., 2016), the authors also identified evidence for the involvement of genes located on the genomic region for music abilities (on chromosome 4) to be involved in specific creative activities in music (e.g., composing).

Of course, the genomic region associated with musical abilities is distinct from those involved in other domain-specific skills. For example, a recent combined meta-analysis of three cohorts identified four single nucleotide polymorphisms (i.e., a type of genetic variation) (SNPs rs1012694, rs11743006, rs17778739, and rs17777541) of SPOCK1 gene (a gene on chromosome 5), showing association with mathematical ability (Chen et al., 2017).

Cognitive Skills: A Focus on Divergent Thinking

A plethora of studies on the genetic bases of DT has emerged in the past decade (e.g., Kéri, 2009; Mayseless et al., 2013; Runco et al., 2011; Takeuchi et al., 2012; Zabelina et al., 2015; Zhang & Zhang, 2017). Once again, most of these studies use DT as a proxy for a "general" creative aptitude and they often turn a blind eye to the specific parameters and requirements of each task used. As a result, studies greatly vary along the domain and nature of the DT task used (e.g., whether the task is graphic or verbal, Alternate Uses Task [AUT], or story-completion task), the indicator of divergent production considered (e.g., ideational fluency or originality), the time allotted to complete the task (e.g., 2 minutes or 10 minutes), and the method to derive divergent production scores (e.g., top three original ideas or frequency-based originality scoring), which can account for inconsistencies in genetic studies' results (e.g., Zhang & Zhang, 2017). Additionally, there are variations across studies with respect to focal genes, genotyping methods, and variations in sample size, gender, age, and race, which too can account for some contradicting results in genetic studies (Laucht, Becker, & Schmidt, 2006).

The issue of variations in the DT task used in genetic studies is not trivial. As outlined above, specific creative task requirements engage distinct resources that are relevant to distinct creative outlets. This observation also applies to distinct DT tasks, which generally reflect limited contribution of a “general” DT ability (Barbot, Besançon, & Lubart, 2016), illustrated by low to moderate inter-task correlation estimates (usually on the 0.20–0.30 range across domains and 0.30–0.50 within domains). In other words, each DT task involves a great portion of individual resources that are not DT per se. DT itself would in fact represent only about up to 25 percent of the total performance variability in DT production tasks (Barbot, Besançon, & Lubart, 2016). The contribution of other resources important for DT production (such as knowledge, personality, and motivational components) may somewhat obscure the isolation of the genetic underpinning of “general” DT, viewed as core cognitive function of creativity across tasks and domains. As such, it is warranted for future research to conduct a thorough meta-analysis of this growing body of studies, while factoring in the specific characteristics of each task requirement used in these studies. This is not the purpose here; however, the identification of similar results in this literature (despite variations of tasks used) allows us to make some initial inferences about the likely biological grounding of DT.

Reuter and colleagues (2006) initiated a line of work on the genetic bases of DT, essentially showing the involvement of the DRD2 gene (dopamine receptor) and the TPH gene (serotonin synthesizer), which, in their pilot study, explained 9 percent of the variance on a composite index of ideational fluency of DT production across six tasks and three domains (verbal, figural, numeric). They also elicited domain-specific DT differences in performance, with, for example, the A1+ allele of DRD2 shown to be related to higher ideational fluency in verbal tasks as compared to the A1− allele. In contrast, carriers of the A allele of TPH1 showed significantly higher ideational fluency scores in figural and numeric DT production tasks. This pilot work was further refined in several studies (e.g., Runco et al., 2011), showing that Reuter and colleagues’ initial conclusions of candidate genes for DT were somewhat consistent with respect to ideational fluency but not to the other indices. Specifically, DRD4 (another dopamine receptor) was involved in both fluency and originality in verbal and figural tasks, whereas COMT (which breaks down dopamine’s messengers) was involved in fluency only, across domains. In this study, no genes were related to indicators of ideational flexibility. However, this study and similar studies building on Reuter and colleagues’ work (e.g., Murphy et al., 2013) suffered from small sample sizes and did not explore genetic variants other than those initially proposed by Reuter and colleagues (Zhang & Zhang, 2017). Zhang and colleagues’ (2014) exploratory study confirmed and précised the association between SNP rs1800497 (polymorphism of the dopamine D2 receptor DRD2 gene) and creative potential.

Mayseless and colleagues (2013) examined DT using classic Torrance Tests of Creative Thinking and AUT (e.g., Guilford et al., 1978). They showed that the presence of a repeat polymorphism of the DRD4 gene (7 R allele) was associated with lower flexibility of DT productions, which was consistent with other studies showing the association between 7 R and impaired cognitive flexibility. They also showed that 7 R was associated with lower ideational fluency in an AUT-type task but not in a figural task (possibly due to an underpowered analysis).

Other genes unrelated to dopaminergic pathways were identified in the literature. Kéri (2009) identified the polymorphism (rs6994992) to be associated with DT in individuals with high intellectual and academic performance. This polymorphism was also widely confirmed to be associated with risk for psychosis and altered/ inefficient patterns of prefrontal activation (Jagannath et al., 2018). Volf and colleagues (2009) investigated Verbal and Figural DT with a focus on 5-HTTLPR polymorphism, an important neurotransmitter involved with regulating psychological traits, physical functions, and behaviors (Goldman et al., 2010). Using the Torrance TTCT, they found that people with S/S (short-short) or L/S (long-short) genotypes of the 5-HTTLPR polymorphism demonstrated higher ideational fluency in verbal tasks than those with the L/L genotype. People with S/S also showed higher ideational fluency in figural tasks than those with L/S or L/L.

The interactions between genetic polymorphisms related to frontal (COMT; underlying executive functioning) and striatal (DAT; dopamine transportation, associated with reward seeking and distractibility) were also implicated in the originality of DT production (Murphy et al., 2013; Zabelina et al., 2016), whereas three newly discovered TPH2 SNPs (rs6582071, rs4570625, and rs11178999) were found to be associated with originality of figural DT production (Zhang & Zhang, 2017). Additionally, because the TPH2 rs4570625 was associated with originality, Zhang and Zhang (2017) speculated that this genetic variant, also involved in traits and disorders related to emotional dysregulation (e.g., Gutknecht et al., 2007), could be an underlying shared genetic vulnerability factor that links creativity to psychiatric disorders.

In all, this body of Gene-DT studies illuminates the implication of multiple genes (of rather small effect sizes) underlying an “additive” genetic influence on DT through their corresponding brain functions. This genetic combination has been increasingly established in the neuroscience of creativity literature (e.g., relationship between ideational fluency and D2 density in the thalamus; De Manzano et al., 2010).

Other Cognitive Functions

The biological grounding of other cognitive skills involved in creativity has been explored in other studies, especially investigating general intelligence (e.g., Benedek et al., 2014). Although the relationship between general intelligence and creativity is still the subject of passionate debates, it is generally acknowledged that general cognitive abilities contribute to some extent to creativity (see Benedek & Jauk, Chapter 10, this volume). A detailed review of the Gene-

Intelligence relationship is beyond the scope of this chapter, but a brief overview of this literature suggests that about 50 percent of the variance in intelligence is explained by genetic contributions (with great variations according to age, SES, and other contextual factors). This is demonstrated by numerous twin and adoption studies (e.g., Deary, Spinath, & Bates, 2006; Plomin & Spinath, 2004), which also emphasize an additive genetic influence resulting from many genes with small effects (Davies et al., 2011), in particular rare variants found in some genes (Hill et al., 2018). Relatedly, cognitive flexibility has been associated with both the presence of the 9 R allele (Garcia-Garcia et al., 2010) and the absence of the 7 R allele (Mayseless et al., 2013) of the DAT dopamine transporter gene. Other evidence has also supported the contribution of cortical dopamine and its underlying genetic basis in cognitive flexibility (Logue & Gould, 2014). Barnett and colleagues' (2007) meta-analysis referenced multiple studies showing the association of a classic SNP in the COMT gene (rs4680) with cognitive flexibility in both healthy individuals and schizophrenia patients. Other recent studies have shown that individuals carrying A allele of this SNP (rs4680) or T allele of rs4633 (another variant on the COMT gene) also scored significantly higher on insight problem-solving tasks (Jiang, Shang, & Su, 2015). Insight problem-solving, the ability to resolve a problem or come up with an idea on the spot, is also a cognitive ability often related to creativity and the realization of important discoveries (e.g., Simonton, 2003).

Conative, Personality, and Motivational Pathways

The biological grounding of conative (natural preferences and tendencies), personality, and motivational traits involved in creativity has also been explored, often targeting phenotypes other than creativity (e.g., personality traits associated with drug abuse, or motivational dimensions involved in academic success). However, this literature remains relevant to the understanding of the genetic bases of creativity given that some of these factors and traits have been shown to be important "ingredients" of creative potential.

One of the key personality factors associated with creativity across domains is Openness to experience. Using a large sample of European adults, Power and Pluess (2015) analyzed the heritability of the Big Five personality traits through genomic-relatedness-matrix residual maximum likelihood analysis (GREML) of over half a million SNPs across the genome. They showed that Openness was the most heritable trait (with 21 percent of its variance accounted for by heritability), followed by Neuroticism (15 percent heritable). The other three Big Five traits had null heritability estimates. Similar to results from the creative cognition literature reviewed in the section "Cognitive Skills: A Focus on Divergent Thinking," results from genetic studies suggest that DRD4 and COMT (and, in general, dopamine-related genes) are genes that predict Openness/Intellect in both children and adults (DeYoung et al., 2011). However, it is worth mentioning that the result with the children sample showed main effects of both genes, whereas results with the adult sample showed that only an interaction between the two genes predicted Openness (DeYoung et al., 2011). The authors argued that such interactions in adults but not in children are somewhat expected given that genetic interactions are more likely to influence phenotypic traits as development progresses.

Surprisingly, novelty seeking, a narrower personality trait related to Openness and creativity, has been far more studied from a genetic standpoint. This trait, which is not only associated with high Openness/Intellect but also with low Conscientiousness and high Extraversion (e.g., Markon, Krueger, & Watson, 2005), has been found to be related to common polymorphisms (7-Repeat allele) in the D4DR dopamine receptor gene (Ebstein et al., 1996), and DRD2-A2 (other dopamine receptor) labeled the "novelty seeking genes" (e.g., Schweizer, 2006). Heck and colleagues (2009) also show the contribution of the HTR2A gene (involved in encoding one of the receptors for serotonin) to novelty seeking in specific SNPs also associated with bipolar and other personality disorders. Together, the clear involvement of the DA system in novelty seeking is consistent with other studies that have shown the importance of DA genes for Openness (e.g., DeYoung et al., 2011) or sensation seeking (Derringer et al., 2010).

In Search of Common Genetic Bases of the Multiple Resources Forming Creative Potential

Because creativity is a complex phenotype that involves multiple individual factors, there is a need for comprehensive, multivariate studies accounting for the contribution of multiple key resources coming into play in creative work. These studies would help us illuminate the genetic underpinning of each of the resources taken in isolation (such as DT or openness) and their interactions. In other words, future work on the biological genesis of creativity should focus on uncovering the common genetic grounds of multiple resources of creative potential (both cognitive and noncognitive). This would illuminate the co-occurrence of resources of different natures and their optimal combination within an individual that can result in outstanding creative performance in a specific creative outlet.

Although no genetic study to date has considered creative potential through such a multivariate approach, it is possible to hypothesize common genetic bases from the genetic investigations of isolated components reviewed above. Indeed, throughout our brief review of the literature, it has become apparent that many of the resources of different natures involved in creativity seem to be underlined by common biological bases, in particular both frontal and striatal dopaminergic pathways, as well as serotonin pathways. In fact, genes involved in dopamine and serotonin expression are at the center of the most complex behaviors, including creativity.

Specifically, the genes most commonly outlined in our review above include the COMT, which breaks down dopamine's messengers (DeYoung et al., 2011) and is related to the prefrontal dopaminergic pathway, showing relationships with convergent operations (Chermahini & Hommel, 2010), ideational fluency (Murphy et al., 2013; Zhang et al., 2014), and Openness/Intellect (DeYoung et al., 2011). Dopamine receptors DRD2 and DRD4, related to the striatal pathway are associated with cognitive control, novelty seeking (Zald et al., 2008), flexibility (Durstewitz, 2009), and ideational fluency (Murphy et al., 2013; Reuter et al., 2006). With respect to serotonin pathways, we have pointed out the contribution of the HTR2A gene for novelty seeking (Heck et al., 2009), the 5-HT gene for executive control and working memory (Zhang & Zhang, 2017), and the TPH gene for ideational fluency (Reuter et al., 2006). Overall, the co-occurrence of "clusters" of specific resources of creative potential make great conceptual sense. For example, it is understandable that both novelty seeking and motivational dimensions important for creativity share common underlying biological markers, as novelty-seekers are rewarded via the dopamine system by their intrinsic motivation (Schweizer, 2006), which in turn increases their creativity.

However, as pointed out throughout this chapter, these inferences are based on the synthesis of numerous studies that focused on very specific components of the creative potential taken in isolation. Therefore, there are several important directions for future genetic studies of creativity. First, future studies should assess creative potential comprehensively using a "resources-based" approach. Such an approach would focus on cognitive and noncognitive dimensions among large samples of subjects, including cases with specific creative talents in various domains. Second, future studies should identify homogeneous profiles (i.e., combinations of cognitive and noncognitive resources) that are associated with specific talents in a given creative task. This would serve to identify the "optimal" profile of individual resources coming into play in each creative task, while refining a domain- or task-specific phenotype. Third, future studies should identify "SNP profiles" (i.e., haplotypes) associated with these well-defined phenotypes. Such investigations must account for the possible moderating roles of participants' gender, age, and race (Laucht et al., 2006), especially given the importance of dopaminergic pathways in the phenotype of interest (Wang et al., 2004). Finally, integrating neuroimaging insights to pinpoint brain networks as mediators of Gene-Creative behavior seems to be an obvious but so far unexplored endeavor.

Conclusion

Every human has the genetic background that makes creativity possible and that made humanity evolve throughout time. Based on an overview of recent Gene-Creativity research, this chapter has outlined the multidimensionality of both the creativity phenomenon and its genetic bases. The implication is that multiple genes of small effect sizes combine in an "additive" genetic influence of greater effect size. Specifically, the convergence of distinct lines of work led to the conclusion that each individual's genetic profile (especially in targeted gene regions involved in dopamine and serotonin pathways) maps onto one's unique profile of creative potential. This potential, in turn, leads to individual differences in creativity in distinct areas of creative pursuit. These individual differences are likely explained equally by biological influences and the specific requirements of each creative work, as well as gene × environment interactions. Therefore, whether one's profile or resources optimally fits the requirements of a given creative task and whether one's creative potential will actually be turned into real-life achievement are questions that are probably beyond what the genetics of creativity can address. However, advances in this scientific endeavor may not only provide a better fundamental knowledge of this human ability but also pave the way for bringing one's potential to realization by identifying biological predispositions for particular creative expressions that would otherwise remain latent.

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8 Neuroscience of Creativity

Oshin Vartanian

Interest in the biological bases of creativity has had a long history in academic thought. For example, in what is considered to be the first investigation to attempt to study highly creative individuals *directly* (Simonton, 2001), Sir Francis Galton surveyed elected Fellows of the Royal Society using a questionnaire he had devised himself. The aim of the questionnaire was to measure the relative contributions of nature vs. nurture to eminence in science and addressed a wide host of developmental issues, including the distribution of ability in the family, birth order, and educational experience, among others. The results of this investigation were published in 1874 in the monograph entitled *English men of science: Their nature and nurture* (Galton, 1874) and represent an early intellectual contribution to resolving the extent to which individual differences in creativity (as well as other traits and abilities) are a function of genetic endowment or environmental influences in eminent people.

Of course, interest in the biological bases of creativity can focus on individual differences that operate at various levels of analysis, ranging from genetic influences to contributions that variations in brain structure and function make to creative behavior. Indeed, in most theoretical models that link genetic variation to creative behavior, brain characteristics (e.g., structure and function) are viewed as downstream manifestations of the effects of gene-environment interactions, which in turn influence personality traits and cognitive processes associated with creativity (Eysenck, 1993, 1995; Feist 1998, 1999, 2010; see also Barbot & Eff, Chapter 7, this volume). Interestingly, prior to the advent of modern neuroimaging techniques, relatively little was known about the contributions of brain structure and function to creative cognition (see also Ward & Kolomyts, Chapter 9, this volume) in healthy humans. For example, as recently as 1999, when Colin Martindale reviewed the empirical evidence in support of the biological bases of creativity for the *Handbook of creativity* (Sternberg, 1999), not a single brain scanning study involving a modern neuroimaging approach had been published that focused on creativity. This gap in knowledge was filled shortly thereafter as independent investigators in Russia (Bekhtereva et al., 2000) and Sweden (Carlsson, Wendt, & Risberg, 2000) obtained measurements of regional cerebral blood flow (rCBF) using positron emission tomography (PET) to demonstrate the involvement of the frontal lobes in creative cognition, and thus began an intense period of research activity on the neural bases of creativity that has now spanned nearly two decades.

My primary aim in this chapter is to conduct a selective review of the key empirical findings from brain imaging studies to our understanding of the psychology of creativity – focusing primarily on brain function but also partly on brain structure. The relatively greater focus on brain function rather than structure in this chapter in no way reflects that the former is more important for understanding the neural bases of creativity than the latter. Rather, it betrays my own greater familiarity with functional studies of creativity, as well as the fact that excellent recent summaries of the structural bases of creativity are available elsewhere (e.g., Jung et al., 2013; Takeuchi & Kawashima, 2018). In conjunction with this main thread I will also discuss important parallel findings from experimental psychology that have contributed greatly to the value of the neuroimaging evidence by contextualizing it within a richer theoretical framework. Owing to space limitations, I will leave out discussion of the following three areas of inquiry that have also contributed greatly to our understanding of the neurobiological foundations of creativity: (1) historically earlier studies that used the methods of electroencephalography (EEG) and event-related potentials (ERP) to study electrical activity generated by the brain (either spontaneously or in response to a stimulus) in relation to creative cognition (for reviews, see Kaufman et al., 2010; Martindale, 1999); (2) studies focusing on the relative contribution of genetic vs. environmental factors to the emergence and exhibition of creativity (see Barbot & Eff, Chapter 7, this volume); and (3) studies on the relationship between creativity and psychopathology (see Carson, 2018; see also Carson, Chapter 14, this volume; Kyaga, 2018). Fortunately, the reader can locate extended recent reviews of those three areas in the aforementioned publications and elsewhere in the literature (Jung & Vartanian, 2018; Vartanian, Bristol, & Kaufman, 2013).

The Big Aims of the Neuroscience of Creativity

At the outset it would be useful to consider what the big aims are in the program of research that comprises the cognitive neuroscience of creativity, as well as why pursuing those aims is important for the advancement of knowledge regarding the psychology of creativity. I will argue that three major aims have remained relatively consistent and important throughout the short history of this domain. The first aim has to do with understanding what *causes* creativity. According to the classic Aristotelian model (see Killeen, 2001; see also Vartanian & Mandel, 2012), a complete explanation of a phenomenon requires an understanding of four different types of causes that lead to its instantiation: (1) *efficient causes* represent the triggers that are sufficient to generate or prevent an effect against its causal background; (2) *final causes* are the functional explanations that address purposive questions (e.g., "what is it supposed to do?"); (3) *formal causes* are models that specify the transition from efficient causes to final causes; and (4) *material causes* are explanations of the substrates that comprise a phenomenon or give rise to it, an exclusive focus on which is known as *reductionism*. In this sense, it can be argued that by elucidating its brain correlates, research in the neuroscience of creativity can contribute to a more complete explanation of the phenomenon of creativity by revealing its material bases. Of course, in isolation, neuroimaging data are correlational in nature and unable to reveal the causes of the behaviors under consideration. However, in combination with complementary approaches that can be used to test causal hypotheses (e.g., patient studies involving loss of function due to focal brain damage), neuroimaging data can reveal structures that are both necessary and sufficient for the realization of specific cognitive functions (Abraham, 2019; Abraham et al., 2012; Chan Barrett & Limb, 2019; Ovando-Tellez et al., 2019). In addition, novel analytic approaches such as Dynamic Causal Modeling (DCM) can be used to test causal hypotheses regarding brain function – where in accordance with control theory a "cause" is understood to mean activity in one region controlling activity in another region (Stephan et al., 2010). Indeed, DCM has recently been used to test specific hypotheses about causal pathways in the brain during divergent thinking (Vartanian et al., 2018).

The second overarching aim that has motivated the search for the neural correlates of creativity revolves around the extent to which brain data can be used to falsify central ideas and theories in the psychology of creativity. For example, brain data can be used to determine whether neural structures that are involved in creativity exhibit domain generality versus domain specificity. This question is important because it can shed light on this central and historically important question in the psychology of creativity in new ways (Baer, 1998; Kaufman & Baer, 2005). Simply put, if it were the case that at the level of the brain two variants of creativity exhibit domain specificity (i.e., the neural correlates of creativity in domains A and B do not exhibit structural and functional overlap), then this would represent inconsistent evidence with the idea that the psychological processes that underlie those two types of creativity exhibit domain generality. As such, alongside behavioral data, brain data offer an additional type of data that can be used for the falsification of ideas and theories – a critical process for improving the quality of the science of creativity.

Third, an overarching theme of research in the cognitive neuroscience of creativity is to offer better mechanistic explanations of some of the core constructs that drive research in the psychology of creativity. Simonton (2018) has identified two major candidates for this endeavor, including (1) what is a creative idea and (2) what are the processes that lead to the emergence of a creative idea. In terms of the latter, there is mounting evidence to suggest that creative ideas emerge from the interaction of multiple large-scale brain networks that underlie spontaneous and controlled thought processes. Perhaps even more remarkably, the same large-scale networks appear to be at play across a wide range of tasks, ranging from divergent thinking to musical improvisation and creative drawing. There is now also a sense that, as a field, we are finally gaining some traction on the time course of the emergence of creative ideas in the brain and gaining insights into what each of the large-scale brain networks contributes to various phases of this process. In contrast, we have made relatively less progress in gaining a better understanding of the neural representation of creative ideas (i.e., what are the functional and structural correlates of a creative idea?). Part of this shortcoming might be related to the limitations of the types of tasks and samples that have been studied in neuroimaging studies of creativity. Specifically, truly creative ideas and the people that exhibit them might be too singular for the types of designs and analytic approaches that typify neuroimaging studies. As noted by Simonton (2018), "Those measures that emphasize personal creativity will come closest to the creative process going on in a creator's head, whereas those that emphasize consensual creativity are contaminated with sundry social, cultural, economic, political, and historical factors that may have nothing to do with either psychology or neuroscience" (p. 15; see also Simonton, 2010). Nevertheless, at least in principle, there is no reason to assume that methodological approaches cannot be developed that can eventually identify the neural representation of creative ideas emerging in truly creative people in different contexts, and this remains one of the main long-term goals of this research program. Indeed, at least one recent has already examined the neural correlates of divergent and convergent thinking in a sample of Big-C creative achievers who included internationally acclaimed creative achievers in multiple disciplines spanning the visual arts (e.g., painting, drawing, sculpture, photography, graphic design, and animation) and the sciences (e.g., biology, neuroscience, chemistry, and mathematics) (Japardi et al., 2018). Clearly, the field needs more studies of this type to elucidate the neural correlates of creative cognition in truly creative individuals.

The Early Years of Neuroimaging Creativity: Focus on Spatial Localization

The early neuroimaging studies of creativity were primarily motivated by a search to localize regions or structures in the brain where brain activation was correlated with creativity. Perhaps not surprisingly, given the nascent and largely exploratory stage of the domain, early studies used a heterogeneous set of tasks and imaging methodologies for isolating the neural correlates of creativity. The typical types of tasks included in early studies involved creative story generation, open-ended problem-solving (e.g., divergent thinking), drawing, finding pragmatic links between incoherent sentences, and solving anagrams and insight tasks, among others. In terms of neuroimaging methods, the studies utilized PET, functional magnetic resonance imaging (fMRI), EEG, ERP, near infrared spectroscopy (NIRS), diffusion tensor imaging (DTI), and single-photon emission computed tomography (SPECT). PET is a functional imaging technique that uses radioactive tracers to detect metabolic changes in the brain. It can be used to isolate brain regions that use a specific metabolite (e.g., glucose) more during a specific task. In turn, fMRI measures neural activity indirectly based on relative changes in blood flow and oxygenation in the brain. When (groups of) neurons are active, they increase their consumption of oxygen, and the local response to such increased consumption of oxygen is increased blood flow to the region, accompanied by changes in local blood volume and flow. This neural signal can be used to isolate brain regions that are consuming more oxygen during a specific task. EEG represents recordings of the electrical activity measured along the scalp (produced by the synchronous firing of groups of neurons within the brain), whereas ERPs are calculated based on EEG and represent changes in electrical activity in relation to specific stimuli. In turn, NIRS computes ratios of oxygenated and deoxygenated hemoglobin at the scalp and thereby provides a measure of brain activity based on its hemodynamics (i.e., dynamics of blood flow). Like PET, SPECT also uses a radioactive tracer but is used to show how blood flows through arteries and veins. Finally, DTI is an MRI-based imaging method that enables one to study brain network connectivity by mapping white matter tracts. Needless to say, all of these methods have intricate analytic workflows, variable signal-to-noise ratios, and exhibit vast differences in temporal and spatial resolution. As such, any result obtained in neuroimaging studies of creativity must be interpreted with great care in relation to the specific imaging method and protocol used for data collection.

Dietrich and Kanso (2010) and Arden and colleagues (2010) conducted two large-scale descriptive reviews of this large literature, including both early and contemporary studies, with slightly different approaches. Dietrich and Kanso (2010) categorized the available literature into (1) studies that used some variant of the divergent thinking paradigm, (2) studies focusing on art and music cognition (i.e., artistic performance), and (3) studies involving the phenomenon of insight. Focusing on divergent thinking, Dietrich and Kanso (2010) noted that the only consistency across studies was the observation of diffuse prefrontal activation. In addition, this diffuse prefrontal activation in the case of divergent thinking was accompanied further by the engagement of motor and temporoparietal regions in studies of artistic performance and activation in the anterior cingulate cortex in studies of insight. They concluded their review by calling into question the very usefulness of many of the theoretical constructs motivating the search for the neural bases of creativity, particularly divergent thinking.

In contrast to Dietrich and Kanso (2010), Arden and colleagues' (2010) approach for their review was based on a methodological categorization of the available literature into three bins: (1) EEG studies, (2) fMRI studies, and (3) PET and SPECT studies. Nevertheless, they too noted large variability and inconsistency across studies, prompting them to argue that "creativity research would benefit from psychometrically informed revision, and the addition of neuroimaging methods designed to provide greater spatial localization of function. Without such revision in the behavioral measures and study designs, it is hard to see the benefit of imaging" (p. 143). In a nutshell, both reviews concluded that the available neuroimaging and electrophysiological literature at that point in time had not advanced our understanding of the psychology of creativity.

In response, Vartanian (2012) argued that it is not surprising to find inconsistency across studies of creativity, given that the results had been based on a heterogeneous set of tasks known to engage different cognitive processes, and using a wide array of imaging modalities known to exhibit vastly different temporal and spatial resolutions. Rather than expecting to see consistency in results across *all* neuroimaging and electrophysiological studies of creativity, what we should expect to observe instead are (1) consistent and theoretically derived set of brain activations for a *specific* task (and its cognitive components) across studies using the *same* imaging modality (Hypothesis 1) and (2) dissociable sets of brain activations for closely related tasks that rely on different cognitive subprocesses (to demonstrate discriminant validity) (Hypothesis 2).

In order to address these hypotheses (henceforth H1 and H2), Vartanian (2012) used the Activation Likelihood Estimation (ALE) method to conduct a quantitative meta-analysis of the fMRI literature, focusing only on analogy and metaphor. Unlike meta-analyses in the behavioral sciences, using which one can derive an average effect size for a particular manipulation across studies, ALE calculates the extent to which the same brain regions are activated consistently by the same manipulation across studies. Vartanian opted to focus on analogy and metaphor for a number of reasons. First, both analogy and metaphor have been linked historically, theoretically, and empirically with creativity (Dunbar, 1997; Gentner et al., 2001; Green et al., 2012) and were included in the reviews of studies by both Dietrich and Kanso (2010) and Arden and colleagues (2010). The link between analogy and creativity becomes obvious when we consider its definition: Analogical reasoning occurs whenever we aim to understand novel situations by drawing parallels to earlier situations (Sternberg, 1977). This type of reasoning has played an important role in creative scientific discovery; perhaps the most important example was Bohr's conceptualization of the motion of the electron around the nucleus of the hydrogen atom (target domain) by drawing a parallel with the motion of planets around the sun in the solar system (source domain). Although several different models of analogical reasoning exist (e.g., Gentner, 1998), there is broad agreement that two of its necessary cognitive subcomponents include (1) retrieval of relevant content from long-term memory based on current content in working memory (WM) and (2) mapping (i.e., aligning) the representational content of cases in WM and projecting inferences from one case to another. There is now substantial evidence to suggest that the core maintenance and manipulation functions of WM are represented within the frontoparietal system in the brain (Baddeley, 2003). In addition, converging neuropsychological (Waltz et al., 1999), neuroimaging (Christoff et al., 2001), and developmental (Crone et al., 2009) evidence has pointed to the role of the rostrolateral prefrontal cortex in structural alignment across relations – termed *relational integration* (Bunge, Helskog, & Wendelken, 2009). As such, Vartanian (2012) predicted that across analogy studies, one would expect to observe activations in regions within the frontoparietal WM system and the rostrolateral prefrontal cortex.

How about metaphor? Because metaphors can serve as vehicles for contemplating concepts at higher levels of abstraction, they make category membership more flexible, which in turn can contribute to a defining feature of creative cognition that involves the flexible manipulation of concepts (Vartanian, 2009; Vartanian & Goel, 2005). For example, how does one understand an utterance such as "lawyers are sharks?" According to classic standard pragmatic models of metaphor comprehension, people extract metaphoric meaning only after failure to extract a literal meaning (Grice, 1975). Given that the literal meaning (i.e., lawyers are marine creatures) is nonsensical, the metaphoric meaning (i.e., lawyers are predatory animals) follows. According to this account, one should expect to observe greater demands on WM and text comprehension resources for metaphorical than literal meaning. More contemporary models have de-emphasized processing differences between literal and metaphoric meaning, while maintaining the existence of qualitative differences involving categorization and abstraction between the two types of processes (Glucksberg, 2003). Nevertheless, one would predict the engagement of the frontoparietal WM and temporal lobe structures involved in linguistic comprehension in relation to processing of metaphor (see Mashal et al. (2007)).

Vartanian's (2012) meta-analysis of the analogy and metaphor literatures – based on ten fMRI studies within each category – supported H1 and H2. Specifically, as predicted, analogy was associated with reliable activation in left rostrolateral prefrontal cortex and dorsolateral prefrontal cortex across studies. In contrast, metaphor was associated with reliable activation in left dorsolateral prefrontal cortex and the temporal pole – a well-established hub for text comprehension (Ferstl et al., 2008). In addition, and contrary to expectation, activation was also observed in the cingulate gyrus for metaphor. This structure is known to be an important part of the brain's frontal attentional control system (Carter et al., 1997) and its activation is consistent with the idea that metaphor requires more attention than the corresponding control conditions across studies. Overall, the results of Vartanian (2012) demonstrated that when the cognitive task and imaging modality are kept consistent, reliable patterns of neural activation emerge across studies of processes related to creativity.

A largely similar conclusion was reached by Gonen-Yaacovi and colleagues (2013), who also used ALE to conduct a comprehensive meta-analysis of the available neuroimaging literature related to creativity. Not surprisingly, they demonstrated that across all studies, large sections of the brain appear to be engaged in creativity, including a largely left-lateralized set of regions including caudal lateral prefrontal cortex, the medial and lateral rostral prefrontal cortex, and the inferior parietal and posterior temporal cortices. More interestingly for the present purposes, however, they further analyzed their data by dividing their studies according to the (1) stimuli or (2) task under consideration. Under stimuli, they distinguished between verbal and nonverbal tasks, thereby comparing the neural correlates of creativity in two distinct domains of cognition. When analyzed separately, there were overlapping but distinct patterns of neural activation associated with verbal and nonverbal tasks. Next, the authors compared them directly, demonstrating certain regions to be more consistently associated with verbal tasks, including the left and right lateral prefrontal cortex, left anterior cingulate cortex, left posterior superior temporal gyrus, right lingual gyrus, and the left thalamus. In turn, regions more consistently associated with nonverbal tasks included the right and left premotor regions, the left middle frontal gyrus, and the left occipital cortex. Indeed, regions in the left prefrontal cortex and temporal cortex that were activated more in verbal tasks are known to play important roles in linguistic processing in terms of the generation and comprehension of language, and their stronger involvement in relation to verbal tasks is consistent with the idea that psychological processes (and by extension their neural correlates) vary as a function of the domain in which creativity is exercised (Baer, 1998; Kaufman & Baer, 2005).

Next, Gonen-Yaacovi and colleagues (2013) distinguished between creativity tasks that necessitate combinatorial processes for correct solution versus tasks that necessitate generation of novel and/or unusual products for successful performance. This distinction reflected two historically distinct theoretical approaches in the creativity literature regarding the core cognitive processes that underlie creative cognition, one based on accessing and combining remote associations in semantic memory (Mednick, 1962) and the other based on producing original or unusual responses to a given stimulus or situation (Guilford, 1967). Their results demonstrated that generation and combinations tasks activated distinct but overlapping set of brain regions across studies.

Of particular interest here is the involvement of left rostrolateral prefrontal cortex in combination tasks, given its role in relational integration. Specifically, rostrolateral prefrontal cortex could contribute to problem-solving in a wide array of combination tasks by enabling assessments of relational similarity. However, rostrolateral prefrontal cortex has also been shown to be involved in other functions, all of which could be relevant to various types of combination tasks, including analogical reasoning, similarity judgment, abstract thinking, and coordinating goals and subgoals. In contrast to combination tasks that more consistently activated lateral aspects of the frontal lobes, generation tasks more consistently activated its medial regions, including left middle frontal gyrus. This region is engaged by counterfactual thinking, prospective memory, future thinking, mentalizing, and daydreaming. Its role in idea generation – which encompasses the core feature shared by this list of thought processes – is likely the generation and simulation of new ideas. Further, the observation in the right inferior gyrus was notable, given the large evidence base from lesion and neuroimaging studies in support of this region's involvement in cognitive and behavioral inhibition (Aron et al., 2003; Aron, Robbins, & Poldrack, 2004). Its involvement here signals a possible role for this region in relation to the inhibition of inappropriate responses in generation tasks (i.e., responses that do not meet certain criteria) or perhaps a modulation of cognitive inhibition to enable the entrance of unusual ideas into consciousness (Vartanian, 2011, 2012; Vartanian & Goel, 2005).

In summary, one can draw a few conclusions based on the data collected in this "first wave" of neuroimaging and electrophysiological studies of creativity. First, across all tasks, a distributed cortical network is engaged in creativity (Arden et al., 2010; Dietrich & Kanso, 2010). In other words, no hemisphere or single brain region plays a leading role in creativity. Second, the neural bases of creativity vary as a function of the requirements of the task (i.e., generation vs. combination) as well as its modality (i.e., verbal vs. nonverbal) (Gonen-Yaacovi et al., 2013; see also Boccia et al., 2015; Wu et al., 2015). This finding is important because it demonstrates that, much like other higher cognitive functions such as reasoning, various brain regions can be reconfigured dynamically for performance as a function of task demands (see Goel, 2007). Third, it is possible to isolate areas of the brain that demonstrate reliable *process-specific* activation across studies (Vartanian et al., 2012). This is consistent with a componential view of creativity specifically (Amabile, 2013) and of problem-solving ability more generally (Sternberg, 1980). In other words, given that as a higher-order cognitive ability creativity is likely decomposable into specific subprocesses (e.g., semantic memory, attention), regions of the brain that exhibit a degree of functional specificity in relation to those subprocesses appear to contribute to the types of creativity that draw on those functions. However, perhaps the most important contribution of this early set of studies was that they highlighted a set of brain regions that are engaged by tests representing different aspects of creativity (e.g., Alternate Uses Task, Remote Associates Test). In turn, they set the stage for more hypothesis-driven approaches to uncovering the cognitive components of creativity in the studies that followed. I will next discuss the shift away from spatial localization and toward network dynamics underlying creativity in the "second wave" of neuroimaging studies of creativity.

Neuroimaging of Creativity: The Later Years of Network Dynamics

Resting-state connectivity is a technique using which one can identify brain regions that exhibit similar patterns of fMRI activity fluctuations at rest and can therefore be grouped into large-scale brain systems called "networks." One of the major technological advances in neuroimaging research has involved the use of this technique to study the interactions (i.e., dynamics) of these large-scale brain networks in the service of various types of thinking, including creative cognition (see Zabelina & Andrews-Hanna, 2016).

Two such networks that appear to play a particularly important role in creative cognition involve the default-mode network and the executive control network (Beaty, Benedek et al., 2016). Activity in the default-mode network is associated with spontaneous and self-generated thought, and is typically observed when the person is not instructed to engage in a task. In contrast, activity in the executive control network is associated with tasks that necessitate externally directed attention (i.e., cognitive control). Beaty, Benedek, and colleagues (2015) used whole-brain functional connectivity analysis to highlight a network of brain regions associated with divergent thinking, which included several regions within the default-mode network and the executive control network, all well as structures within the salience network such as the insula, shown to be involved in high-level cognitive control and attentional processes (Menon & Uddin, 2010). The brain's salience network has an important role to play in many types of higher-order cognition because it is involved in the detection and allocation of neural resources to behaviorally relevant stimuli (Bressler & Menon, 2010; Uddin, 2015). As such, it can trigger the engagement of other networks based on the relevance (i.e., salience) of the task at hand. Beaty and colleagues' analyses revealed direct functional connections between these three networks in the service of divergent thinking. Specifically, the posterior cingulate cortex – a region that lies within the default-mode network – exhibited increased functional coupling with regions of the executive control network, including the dorsolateral prefrontal cortex, as well as regions within the salience network such as the bilateral insula. Finally, using dynamic functional connectivity analysis conducted in the course of engagement with the Alternate Uses Task, Beaty and colleagues were able to show that the time course of the coupling between the posterior cingulate cortex and regions within the salience and executive control networks varies as a function of the phase of the task. Specifically, the posterior cingulate cortex showed early coupling with the insula and later coupling with the right dorsolateral prefrontal cortex among other regions. There is evidence to show that one of the roles of the salience network is to facilitate switches between the default-mode network and the executive control network (Cocchi et al., 2013). As such, its early involvement in the Alternate Uses Task could be to facilitate later coupling between the default-mode network and the executive control network.

Data from several recent fMRI studies on musical improvisation (Pinho et al., 2016) and poetry composition (Liu et al., 2015) have shown that engagement across numerous creativity tasks is associated with dynamic coupling between the default-mode network and the executive control network (reviewed in Beaty, Benedek et al., 2016). In this context, default-mode network activity is perceived to reflect the spontaneous generation of ideas or information derived from long-term memory, whereas activity in the executive control network is understood to reflect evaluative processes that constrain thinking to meet specific task goals. Not only does this dynamic interplay between generative and evaluative processes have a long history in creativity research (Campbell, 1960; Martindale, 2007; Simonton, 2010) but numerous classical models of cognition emphasized the ability of creative people to navigate back and forth in the service of novel idea generation (see Kris, 1952). In this sense, the interplay between the default-mode network and the executive control network can be perceived as the interplay between controlled and spontaneous thought processes in the service of novel and useful idea generation.

The dynamic interplay between the default-mode network and the executive control network is also apparent when one focuses on resting-state rather than task-related data. For example, Beaty and colleagues (2014) reported that, compared with less creative people, more creative people exhibit increased coupling of default-mode network regions with the left inferior frontal gyrus – a region within the executive control network whose involvement in divergent thinking tasks is frequently attributed to its role in cognitive control. The close coupling of these two networks at rest suggests that there might be stable functional differences involving the coupling of the DMN and the executive control network that distinguish more from less creative people.

Whereas the studies discussed thus far in this section have demonstrated that the default-mode network and the executive control network interact in the course of creative cognition, the precise nature of this interaction had not been made particularly clear. One can imagine at least a couple of possibilities in terms of how these two networks might exert control over each other in the service of creativity. According to one model, kernel ideas emerge in nodes within the posterior brain regions, including the temporal and parietal lobes, whereas nodes within the frontal lobes exert control over those regions to ensure that the originated ideas meet the relevant tasks demands. Thus, according to this *unidirectional* model, the frontal lobes exert control over the temporal and parietal lobes during creative cognition. Another possibility, however, could be that the posterior and frontal lobes exert control over each other in the form of feedback loops in the course of creative cognition. According to this *bidirectional* model, the temporal and parietal lobes exert reciprocal control over brain activity in the frontal lobes in the course of successive generation-evaluation cycles. Vartanian and colleagues (2018) used

DCM to test these two possibilities head-to-head using fMRI data collected in the course of the Alternate Uses Task. As noted before, DCM is an analytic tool that enables one to test whether certain regions in the brain exert control over the activity of other regions in the brain during engagement in any task. The results from the study offered stronger support for the unidirectional rather than the bidirectional model, by demonstrating that the inferior frontal gyrus exerts control over the middle temporal gyrus and the inferior parietal lobule during engagement in the Alternate Uses Task. As such, we now have a better mechanistic understanding of the specific nature of the interaction between frontal and posterior lobes during creative cognition.

Interestingly, a very similar picture that suggests the involvement of multiple brain systems has also emerged when one shifts focus to evidence relating variation in brain *structure* (rather than function) to creativity. Jung and colleagues (2013) have conducted the most comprehensive review of structural studies of creativity to date, focusing on data from numerous sources (i.e., morphometry, spectroscopy, DTI, and lesion studies) that speak to this issue. They found that in terms of brain structure, creativity was related to the involvement of regions within both the default-mode network (i.e., precuneus, inferior parietal lobes, and medial/orbital frontal cortices) and the cognitive control (e.g., dorsolateral prefrontal cortex) networks, which they related to their contributions to blind variation and selective retention, respectively (Campbell, 1960). Note that this is similar to the idea proposed by Beaty, Benedek and colleagues (2016) regarding the likely contributions of these two networks to creative cognition (based on functional data), although the latter did not refer to the output of DMN as "blind."

What Jung and colleagues (2013) also noted was that, unlike studies focusing on intelligence where greater ability is typically associated with increased cortical thickness and/or volume (e.g., Draganski et al., 2004; Haier et al., 2005), creativity has been found to be associated with not only increases but also decreases in cortical thickness and/or volume across a broad network of brain regions, including the lingual gyrus, cuneus, angular gyrus, inferior parietal gyrus, fusiform gyrus, the orbitofrontal cortex, and the splenium of the corpus callosum. What they concluded was that the brains of more creative individuals might be more disinhibited in their organization, as measured in terms of lower cortical volume and lower white matter fidelity (Jung, Grazioplene et al., 2010; Jung, Segall et al., 2010), and anterior cingulate biochemistry that tends to gate frontal information flow (Jung et al., 2009). Thus, according to this view, lower cortical thickness associated in relation to creativity in certain regions of the brain is not a marker of decreased cognitive function but rather a function of cognitive disinhibition characteristic of creative cognition, in particular novelty generation.

In summary, early research in the neuroscience of creativity was primarily concerned with localizing the brain structures that contributed to various aspects of this multifaceted phenomenon. The typical approach involved decomposing the particular type of creativity under consideration into various cognitive subcomponents and localizing the neural correlate of each component across the brain. This type of work has been useful for generating a static picture of the neural architecture responsible for the emergence of creativity but it did not provide a functional account of how this phenomenon emerges in the brain. More recently, the field has embraced systems approaches to study how the dynamic interactions between various networks – specifically the default-mode network, the executive control network, and the salience network – lead to creative idea generation. In this sense, our knowledge about the neural bases of creativity has evolved from straightforward mapping of function in different regions to an improved understanding of how different systems that underlie different types of cognition cooperate to bring about creative ideation. When the focus is on functional data, the "cooperation" can be studied using analytic approaches such as network analysis (Beaty et al., 2018) and DCM (Vartanian et al., 2018), whereas when the focus is on brain structure it can be studied based on analytic approaches such as DTI that can reveal white matter tracts that form anatomical connections between different structures (Jung et al., 2013).

Recent Advances

Personality. Historically, personality – defined as "the unique and relatively enduring set of behaviors, feelings, thoughts, and motives that characterize an individual" (Feist, 2010, p. 114; see also Feist, Chapter 17, this volume) – has had a major influence in studies of creativity. Essentially, researchers have sought to isolate the contribution of relatively stable individual differences in personality to creative cognition. However, *how* does personality contribute to the emergence of creative thought and behavior? In his influential model, Feist (1998, 1999, 2010) proposed that personality influences creativity by lowering the behavioral thresholds that make creativity more likely. According to this model, genetic and epigenetic factors are perceived to influence brain characteristics (e.g., structure and function), which in turn influence the four clusters of personality traits most consistently associated with creativity – namely cognitive, social, motivational-affective, and clinical – which in turn influence creative thoughts or behaviors. In this sense, personality mediates the link between brain characteristics and creative thoughts and behaviors. In support of this model, Feist (1998) conducted a large-scale meta-analysis to demonstrate empirically that personality can be used to distinguish scientists from nonscientists, more creative scientists from less creative scientists, and artists from nonartists.

Advances in neuroimaging have now made it possible to test predictions derived from Feist's model by studying the relationship between creativity and brain structure and function. This work has been conducted under the broad umbrella of *personality neuroscience* – an area of research motivated by the premise that "the whole person cannot be understood without understanding the brain" (DeYoung, 2010, p. 1165). Personality neuroscience aims at testing and refining neurobiological theories of personality (DeYoung et al., 2010) to arrive at better representations of the brain's contributions to the emergence of personality structure. Naturally, among the Big Five's broad domains, creativity researchers are particularly interested in *openness to experience* – defined as "the breadth, depth, originality, and complexity of an individual's experiential life" (John, Naumann, & Soto, 2008, p. 120).

Openness to experience has been the factor most consistently associated with creativity across a broad spectrum of tasks, outcome measures, and ages (see Feist, 1998, 1999, 2010, and Chapter 17, this volume). Cognitive neuroscientists have now begun to study the ways in which openness to experience is related to variations in creative cognition (see Vartanian, 2018).

Beaty, Kaufman, and colleagues (2016) collected resting-state fMRI to determine whether openness to experience is related to the global function of the default-mode network. Analytically, the authors used a graph theoretic method to derive a measure of (global) network efficiency, considered to reflect the efficiency of information processing within a system. Their results demonstrated that as openness to experience scores increased, the default-mode network exhibited more efficient information processing (i.e., network efficiency). The results of this study suggest that individual differences in openness to experience affect the functional organization of the default-mode network – a large-scale brain network. In addition, the authors suggested that the functional role of the observed association between openness to experience and greater network efficiency in the default-mode network might be because people with higher scores on this factor are better at engaging the psychological processes associated with the default-mode network – many of which are related to creativity (e.g., mind wandering, spontaneous thinking).

Beaty, Kaufman, and colleagues (2016) demonstrated that the Openness aspect of the Big Five (DeYoung, Quilty, & Peterson, 2007) underlies efficiency of information processing within the default-mode network. Specifically, they were able to demonstrate that even after controlling for intelligence, age, gender, and other personality variables, Openness explained 18 percent of the variance in default-mode network functioning. This led the authors to state that their findings "point to a biological basis of Openness to Experience, and suggest that normally distributed personality traits affect the intrinsic architecture of large-scale brain systems" (p. 773). This finding is important because activity in the default-mode network is related to creative cognition (see Beaty, Benedek et al., 2016), and the ability of Openness scores to predict network efficiency within the default-mode network lends support to Feist's (1998, 1999, 2010) functional model linking variations in personality to brain characteristics.

Attention. Historically, the construct of attention has been useful in cognitive approaches to understanding creativity (Mendelsohn, 1976). Whereas early research associated creativity with a state of defocused attention, more recent evidence suggests that creativity is related to flexible cognitive control (Zabelina & Robinson, 2010) and/or flexible variation of the focus of attention in relation to task demands (Dorfman et al., 2008; Vartanian, 2009; Vartanian, Martindale, & Kwiatkowski, 2007). These empirical findings are consistent with theoretical views that have emphasized the flexibility of cognitive control for optimal regulation of cognition (Chrysikou, Weber, & Thompson-Schill, 2014). In a recent series of studies, Darya Zabelina and her colleagues have shown that there are distinct patterns of attention related to different measures (i.e., types) of creativity. Specifically, Zabelina, Saporta, and Beeman (2015) distinguished between two different conceptualizations of attention that have been related to creativity in the literature: leaky vs. flexible attention. Whereas leaky attention allows irrelevant information to enter consciousness, flexible attention allows adjustment of its focus. Having made this distinction, the researchers were able to show that whereas participants with higher divergent thinking scores (as measured by the Abbreviated Torrance Test for Adults [Goff & Torrance, 2002]) exhibit more *flexible* attention, participants with higher scores in real-world creativity (as measured by the Creative Achievement Questionnaire [Carson, Peterson, & Higgins, 2005]) exhibit more *leaky* attention. In other words, different types of creativity may be associated with different types of attention (for more information on leaky vs. flexible attention, see Carson, Chapter 14, this volume). In a related study, Zabelina and colleagues (2015) examined the relation between individual differences in the Abbreviated Torrance Test for Adults and Creative Achievement Questionnaire scores and sensory gating as measured by the P50. The P50 is a form of neurophysiological response (i.e., evoked potential) that occurs 50 milliseconds after stimulus onset. It is considered to be a very early and automatic form of sensory gating, influencing which stimuli receive attention. The results of Zabelina and colleagues revealed that, whereas divergent thinking was associated with selective sensory gating, real-world creativity was associated with leaky sensory gating. They concluded that "leaky sensory gating may help people integrate ideas that are outside of focus of attention, leading to creativity in the real world; whereas divergent thinking, measured by divergent thinking tests which emphasize numerous responses within a limited time, may require selective sensory processing more than previously thought" (p. 77). This body of work suggests that the relationship between creativity and attention varies as a function of the type of creativity and type of attention taken into consideration, and that the same neurophysiological measure (as a proxy for attention capture) can exhibit opposite relationships with creativity based on the measure under consideration.

Memory. Perhaps even more so than attention, the construct of memory has played a major role in directing research in creative cognition (Mednick, 1962). Historically, the focus had been on semantic memory and centered around how individual differences in creativity are related to differences in associational hierarchies: Creative people are characterized by a "flat" associative hierarchy (i.e., they can access more and broader associations to a given stimulus) whereas noncreative people are characterized by a "steep" associative hierarchy (i.e., they can access fewer and closely linked associations to a given stimulus). However, until recently, there was no direct empirical demonstration that the structure of semantic memory differs in creative vs. noncreative people. Kenett, Anaki, and Faust (2014) addressed this shortcoming by applying a modern computational approach from network science to the study of semantic networks based on the analysis of free associations. Their results demonstrated that the semantic memory networks of participants with low creative ability are more rigid compared with the semantic memory networks of participants with high creative ability – where rigidity is defined as a function of the extent to which the network spreads out and breaks apart into more subparts. As such, Kenett and colleagues' results were supportive of Mednick's (1962) idea that the structure of semantic memory varies as a function of a person's creativity, and subsequent work by Kenett and colleagues has shown that creative people exhibit greater flexibility in the structure of their semantic memory compared with noncreative people (Kenett et al., 2018). Complementary research by Benedek and Neubauer (2013) has offered evidence to demonstrate that creative people are also better at accessing the contents of their semantic memory. In other words, creative people might be distinguished by both the structure of their semantic memory and how well they can access its contents.

A relatively more recent addition to our understanding of mnemonic contributions to creativity has involved demonstration of a positive link between divergent thinking ability and episodic memory (Madore, Addis, & Schacter, 2015; Madore, Jing, & Schacter, 2016). Specifically, the researchers have shown that episodic specificity induction, defined as a brief training in recollecting details of a recent event, boosts divergent thinking performance. How could this be? Madore and colleagues (2015) suggested that this might be due to *episodic retrieval orientation* – a flexible, goal-directed strategy invoked when presented with a retrieval cue. In other words, the provision of a retrieval cue that orients one's focus to the episodic details may impact subsequent memory, imagination, and divergent thinking "because these tasks all involve creating mental scenarios that contain details like those emphasized during the specificity induction" (p. 1467). This work on episodic memory is very promising because it links research on creativity to work on imagination and simulation – where much like creativity, imagining and/or simulating events in the future has also been shown to be related to an interplay between the default-mode network and the executive control network (Addis, Wong, & Schacter, 2007; Addis et al., 2009; Szpunar, Watson, & McDermott, 2007). It may very well turn out that the neural engines that underlie creativity, imagination, and simulation – all of which likely share common cognitive components – may be underpinned by a shared core set of regions that are in part related to episodic and semantic memory. This may also include a focus on the process of forgetting, given the role that it has been shown to play in retrieval from long-term memory during creative cognition (see Storm, Angello, & Bjork, 2011).

Fluid intelligence and executive functions. Kim (2005) conducted a large-scale meta-analysis of the literature to investigate the relationship between intelligence and creativity, including classic studies of creativity up to that date. Her analysis based on this corpus of studies demonstrated that the mean correlation coefficient between intelligence and creativity was small (r = 0.174) and that therefore the relationship between the two constructs could be deemed "negligible." As noted by Silvia (2008), this picture may have emerged because of the reliance of earlier studies on intelligence measures that overemphasize achievement and aptitude at the expense of fluid intelligence and reasoning abilities (see Kane et al., 2004). Under such conditions, the correlation between intelligence and creativity is likely to be attenuated. Accordingly, when the focus is shifted to *fluid intelligence* – defined as the ability to solve novel problems (Horn & Cattell, 1966) – rather than *crystallized intelligence* – which is understood to emerge from learning and is reflected in tests of knowledge, general information, and acquired skills (Horn & Cattell, 1967) – one arrives at a different picture of the relationship between intelligence and creativity. Indeed, numerous recent studies that have focused on measures of fluid intelligence and also utilized novel methods that more directly score the creativity of generated responses in divergent thinking tests (i.e., subjective scoring methods) have consistently reported positive correlations between fluid intelligence and divergent thinking ability (e.g., Benedek et al., 2012; Jauk et al., 2013; Nusbaum & Silvia 2011). Similarly, executive functions have been shown to contribute to both creativity and fluid intelligence. Benedek and colleagues (2014) conducted perhaps the most extensive examination of this topic, demonstrating that fluid intelligence was predicted by updating but not by shifting or inhibition. This finding is consistent with a large body of empirical data that has demonstrated a strong connection between WM and fluid intelligence (e.g., Chuderski, 2013). Essentially, it has been argued that the ability to maintain and manipulate information in the span of attention (i.e., WM) is a strong contributor to one's ability to solve novel problems (i.e., fluid intelligence). Second, it was found that updating and inhibition but not shifting were predictors of divergent thinking performance. Inhibition's primary function in creativity could be related to its role in suppressing interference caused by dominant response tendencies. Not only has this body of work demonstrated that when measured properly, creativity, fluid intelligence, and executive functions are positively correlated (Gilhooly et al., 2007) but it has been crucial for making sense of the involvement of the executive control network during creative cognition. The executive control network is heavily implicated in individual differences in intelligence and executive functions in the brain, and its involvement in creative cognition can be understood in terms of the contribution of these two abilities to cognitive control necessary for the generation of novel and useful products (i.e., goal-directed behavior).

Limitations

External validity. As with any methodology, cognitive neuroscience approaches to understanding creativity have their limitations. First, it could be argued that studying creativity in the scanner lacks external validity because it does not mimic the breadth of conditions in which people act creatively in the real world (Sawyer, 2011; see also Boden, 2013). Although this criticism is legitimate and true of most studies of creativity, some strides have been made to study creativity in different domains, including drawing (Ellamil et al., 2012), poetry writing (Shah et al., 2013), and jazz improvisation (Limb & Braun, 2008) in ecologically valid ways. Specifically, using MRI-compatible devices, it is now possible to instruct participants to engage in writing of poetry and fiction in ways that were not possible before (reviewed in Vartanian, 2015). It is likely that similar methodological innovations will continue to improve the ecological validity of cognitive neuroscience approaches to studying creativity in the future.

Significant samples. It has been argued that to truly understand the workings of the mind in highly creative people, it is necessary to study highly creative people (see Simonton, 2014, 2018). This need is related to the well-known distinction in the creativity literature concerning the dichotomy between little-c ("everyday") and Big-C ("eminent") creativity (but see Kaufman & Beghetto, 2009). Essentially, to what extent are findings about the neural bases of creativity obtained from largely student populations generalizable to our conceptions of the neural bases of creativity in eminent people? Admittedly, only a single scanning study to date has focused on a "significant sample" of the eminent variety (Japardi et al., 2018) and this, too, represents a limitation of the current body of work. Clearly, more studies focusing on Big-C creativity are needed to determine whether there are differences in the neural basis of creativity in high-achieving creative people.

Furthermore, as noted by Simonton (1999), studies using eminent samples can be differentiated along seven distinct dimensions: qualitative vs. quantitative, single vs. multiple cases, nomothetic vs. idiographic, confirmatory vs. exploratory, cross-sectional vs. longitudinal, micro vs. macro analytic units, and direct vs. indirect assessments. In this sense, if a program of research into the neural bases of eminent creativity were to emerge, serious consideration would have to be given to the dimensions that are more relevant and methodologically feasible for implementation. Studies that have begun to study the neural bases of creativity in experts are very promising (see De Pisapia et al., 2016; Lotze et al., 2014) and could shed light on which of the aforementioned dimensions are more relevant than others.

Social psychology of creativity. It is well known that creativity is influenced by contextual factors (Amabile, 1983, 1996). Whereas cognitive neuroscience approaches to studying creativity have proven useful for elucidating the cognitive and neural components of persons working individually to solve problems that require creative solutions, the data collection settings are typically purposefully decontextualized. As such, we have little knowledge about how social factors known to influence creativity affect its neural correlates. However, promisingly, work on this important topic has begun to emerge (see Fink et al., 2012) and it is hoped that methodological approaches from areas such as judgment and decision-making research (i.e., two-person interaction games) can be used to study the creative brain at work in group contexts.

Summary and Future Directions

Whereas the early focus in neuroscientific approaches to creativity involved functional localization of creative thought, current evidence suggests that creativity is an emergent property of the dynamic interplay between spontaneous and controlled processes in the brain (see Abraham, 2014). In addition, given some of the limitations of the cognitive neuroscience approach to creativity, there is a need for a holistic research program for a more complete understanding of this phenomenon. This aim can be achieved by continuing to build on the deep links that already exist between cognitive neuroscience approaches and theoretical and methodological advances in allied disciplines.

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Cognitive Underpinnings of Creativity

9 Creative Cognition

Thomas B. Ward and Yuliya Kolomyts

Creativity is one of a small set of cognitive capacities that clearly differentiate humans from other species. The validity of this statement hinges on how one defines creativity, so we will be clear that we are referring to creativity as the mental capacity and tendency to generate new ideas and products that have some purpose, utility, or worth. There is no question that other species exhibit innovative behaviors that fit that definition (see, e.g., contributions to A. Kaufman & J. Kaufman, 2015), but the cumulative production of ever more complex concepts and artifacts is unique to humans. For example, many species use and modify found objects as tools to accomplish particular goals, but only humans have extensively refined those types of initial innovations, developed new ones, systematically changed the materials from which such tools are made, and so on.

One way to account for the advantage humans have in cumulative creative accomplishment is that we have a greater capacity to faithfully transmit innovations from innovators to observers and across generations. Tennie, Call, and Tomasello (2009) attribute that capacity to four factors: our social learning focus on the intentions and actions of others, our propensity toward direct teaching, our socially motivated desire "to be like others," and normative pressures for conformity. Although it may seem counterintuitive to associate conformity with creativity, in this cultural view, that tendency makes it more likely that any given innovation will be copied by others and accurately preserved in a culture long enough that it can later be modified by another innovator. In the absence of such supportive tendencies, any innovations generated by individual members of other species tend to be transient and ephemeral, reducing the possibility of cumulative creativity.

Notice that this cultural transmission view places more emphasis on the human capacity for preserving innovations than on the tendency to produce the innovations to begin with. We endorse this view, but at a different level of analysis we advocate a cognitive psychological perspective concerned with how the operating characteristics of *individual minds* allow us to build on previous innovations by storing, retrieving, modifying, and exploiting *existing knowledge*. From this perspective, what's old about new ideas is at least as important as what's new about them (e.g., Ward, 1995).

The Creative Cognition Approach

This chapter examines the literature on cognitive psychological contributions to understanding human creativity through the lens of *creative cognition* (Finke, Ward, & Smith, 1992). The creative cognition approach is concerned primarily with understanding how human minds produce creative ideas. It examines how basic mental processes are applied to existing knowledge to generate ideas that have some degree of novelty and worth (Finke et al., 1992; Smith, Ward, & Finke, 1995). In that sense, it represents what Sternberg and Lubart (1996) referred to as a unidisciplinary approach. It is intended to complement other unidisciplinary approaches, such as personality (Feist, 1998; McCrae, 1987; Silvia et al., 2011), social (Amabile, 1983, 1996) and cultural (Chua, Yannig, & Lemoine, 2014; Glaveanu, 2010; Lubart, 2010), and to provide details about how individuals use knowledge, which may be relevant to aspects of some confluence models (e.g., Amabile, 1983; Csikszentmihalyi, 1999; Lubart & Sternberg, 1995). The creative cognition approach is consonant with the broadly agreed on notion that existing knowledge plays a role in creativity (Cropley, 1999; Cropley & Cropley, 2010; Feldhusen, 1995, 2002; Frensch & Sternberg, 1989; Mumford & Gustafson, 1988; Sternberg & Lubart, 1995). It examines how that knowledge may be either helpful or harmful to creative functioning.

Levels of Creativity and a Convergence Approach

Cognitive psychology is an experimental science, relying primarily on data from precisely controlled laboratory studies, often using convenience samples of participants, such as undergraduate students. Creative cognition, because it is deeply rooted in that parent discipline, has tended to follow suit, hoping to provide generalizable knowledge about creative processes based on data from rigorous laboratory studies. Complicating that goal is the fact that not all manifestations of creativity are equal. Some creative achievements represent fundamental changes to the most basic assumptions of a domain (Big-C), whereas others are relatively minor tweaks to ideas that have come before (little-c). Between those extremes there is an identifiable Pro-c level (Kaufman & Beghetto, 2009), whereby individuals adopt a particular creative endeavor as a profession, going beyond the dabblings of little-c contributors in similar domains, without necessarily achieving the eminence implied by Big-C.

Distinctions among levels of creativity raise an important question about the creative cognition approach, namely whether or not the types of processes that can be examined readily in laboratory studies are the same as those that operate to produce other levels of creative accomplishment (see, e.g., Perkins, 1997; Simonton, 1997, Ward, 2018). As a means of answering that question, creative cognition researchers have used a *convergence* strategy, considering the extent to which patterns observed in the laboratory are consistent with observations from other modes of inquiry, such as anecdotal and historical accounts of real-world creativity (e.g., Ward, 1995, 2001; Ward, Finke, & Smith, 1995; Weisberg, 1995, 2006).

Additional approaches include testing Pro-c participants (e.g., design engineers, elite actors) using surveys or controlled experimental situations (e.g., Cardoso & Badke-Schaub, 2011; Goodman & Kaufman, 2014; Janson & Smith, 1991; Purcell & Gero, 1996; Youmans, 2011), documenting Pro-c activities in vivo as people perform real-world creative tasks (e.g., Christensen & Schunn, 2007; Dunbar, 1997) and performing content analyses on large-scale collections of real-world creative products (e.g., Chan & Schunn, 2015b). Synthesizing the types of information available from laboratory studies and other modes of inquiry provides a more complete picture of creativity and the factors that can inhibit or facilitate it than can be obtained by relying exclusively on just one approach or another.

Retrieval and Use of Specific vs. General Information

A topic of particular interest in creative cognition has been the role of existing conceptual structures in guiding and constraining creative activities. A wealth of research in mainstream cognitive psychology has identified key organizing attributes of such knowledge structures. That body of work makes it possible to move beyond the obvious point that people retrieve existing knowledge when they attempt to create new ideas toward a more precise characterization of how specific properties of knowledge shape new ideas. In the sections that follow, we examine some of those properties.

Laboratory Studies. In an early study on the influence of conceptual structure, Ward (1994) had students in psychology classes imagine life on other planets different from Earth. They were instructed to draw and describe a member of one species of animals that might live on the planet and then to draw and describe both another member of the same species and a member of a different species. The vast majority of students developed creatures that had eyes and legs and that were bilaterally symmetric. In addition, the second member of the same species tended to be the same shape as the first but differ in size or sex, whereas the member of the other species differed from them in shape.

The ubiquitous presence of eyes and legs is readily predictable based on the properties people list as being characteristic of animals (Ashcraft, 1978; Hampton, 1979; Rosch et al., 1976; Tversky & Hemenway, 1984). In addition, symmetry is predictable from the idea that people's knowledge contains the understanding that observable characteristic properties (such as eyes and legs) are not scattered about and disembodied but rather configured into coherent whole entities (Tversky & Hemenway, 1984). Similarly, the preservation of shape (but not size) within species is consistent with a well-established *shape bias*, by which even young children expect that members of the same category are shaped the same but can differ in size (Becker & Ward, 1991; Landau, Smith, & Jones, 1988). Finally, the preservation of shape within species suggests that the students were operating at the basic level of abstraction, since members of categories at that level of abstraction in a conceptual hierarchy tend to share the same shape (see, e.g., Rosch et al., 1976). This last point is particularly important because the basic level has been shown to powerfully influence noncreative cognition, including how readily people name, verify, and identify presented items. For example, when people are shown photographs of objects (e.g., a kitchen table), they are faster to correctly confirm them as members of their basic level category (e.g., table) than either their superordinate (e.g., furniture) or subordinate (e.g., kitchen table) categories. Such results indicate a primacy of the basic level in which information at that level is more readily accessible than at other levels. That compelling aspect of conceptual structure also appears to strongly influence creative cognition.

This tendency of newly generated ideas to closely mirror the properties of the domains from which they are generated has been called *structured imagination* (Ward, 1994). It is a robust tendency, occurring even when instructions encourage participants to deviate from existing ideas (Ward & Sifonis, 1997). It also occurs across multiple conceptual domains (Bredart, Ward, & Marczewski, 1998; De Cruz, 2013; Rubin & Kontis, 1983; Ward, 2008; Ward et al., 2002), different cultures (Niu & Sternberg, 2001; Yi et al., 2013), and different age and ability groups (Cacciari, Levorato, & Cicogna, 1997; Karmiloff-Smith, 1990; Ward, Saunders, & Dodds, 1999). It is also observed in virtual environments where real-world constraints need not apply (Ward, 2015; Ward & Sonneborn, 2009) and with other modes of production, such as having participants perform the creature generation task using *Spore*, a video game that allows players to develop novel species for later interaction with other species (Cockbain, Vertolli, & Davies, 2014).

The Ward (1994) findings and the results of subsequent studies led to the development of the Path of Least Resistance Model (Ward, 1994, 1995; Ward et al., 2000; Ward et al., 2002). The model states that when people develop new ideas for a particular domain, the predominant tendency is to access fairly specific, basic level exemplars from that domain as starting points, and to project many of the stored properties of those exemplars onto the novel ideas being developed. For example, in imagining new types of animals, the predominant tendency would be for people to retrieve specific basic level animals, such as dogs and elephants, and to pattern their novel creatures after those instances. In addition, retrieval of those basic level instances is predicted to be determined by their relative accessibility or representativeness in the domain. Category instances that come to mind most readily should be the ones most often used as starting points in creative tasks.

The most direct test of the predictions of the Path of Least Resistance Model is the set of studies by Ward and colleagues (2002). For each of the three distinct conceptual domains of animals, fruit, and tools, they had separate groups of college students perform a noncreative task of listing as many examples of the domain as they could, and a creative task of imagining novel examples of those categories that might exist on another planet. Data from the listing task were used to derive a measure of representativeness, namely Output Dominance, or the number of participants who listed any given exemplar. Exemplars listed by more people can reasonably be interpreted as more accessible and be taken as more representative of the domain. In the creative imagination task, after producing their novel products, participants described the kinds of things they used as the basis for their ideas. References to specific domain exemplars (e.g., dogs, hammers, oranges) were tabulated to derive a measure of Imagination Frequency for each exemplar.

Consistent with the predictions of the Path of Least Resistance Model, Ward and colleagues (2002) found that approximately two-thirds of the participants reported relying on basic level instances in generating their own ideas, and Output Dominance and Imagination Frequency were positively correlated. That is, most people relied on specific known instances and those instances were the ones that were most accessible within the categories.

An additional finding of note across studies of structured imagination is that participants who rely on specific category instances develop ideas that are rated by coders as less novel or original than those generated by participants who adopt more abstract approaches, such as considering the attributes a creature might need to survive in a particular environment (Ward, 1994; Ward et al., 2002). This is likely due to the fact that specific information is more constraining than abstract information. For example, when people project properties of retrieved information onto their new products, a creature based on a cat would seem more likely to have eyes, and therefore be deemed less novel, than one based on the abstract principle of "needing sensory information," which could be implemented in a multitude of ways other than standard eyes.

Research has also focused on the question of whether the tendency to access information at specific levels and to develop less original products is a fixed individual difference or malleable with task instructions. In other words, can people be induced to adopt more abstract approaches in creative generation tasks, and do they develop more original creations as a result? The answer appears to be "yes." For example, Ward, Patterson, and Sifonis (2004) had participants imagine life on other planets under different instructional conditions. Some were asked to consider abstract attributes of living things (e.g., need for nutrition to support biological processes), whereas others were asked to keep in mind specific Earth animals or were given no special instructions. Those instructed to access their knowledge at more abstract levels produced creatures that were rated as more original, thus establishing a causal link between that type of approach and more creative outcomes. Similarly, procedures that preclude reliance on the most readily accessible specific solutions by imposing constraints have been shown to increase originality (Moreau & Dahl, 2005).

Although accessing abstract information is linked to greater originality, research suggests that it may be detrimental to appropriateness or practicality. In particular, when participants were asked to devise new sports, those who reported relying on specific known sports developed ideas that were rated as more playable than those developed by individuals who reported other, more abstract approaches (Ward, 2008). More generally, originality and playability were significantly negatively correlated. It should be noted that originality and practicality are not always negatively correlated (e.g., Dahl & Moreau, 2002). Nevertheless, both properties need to be considered in assessing the relative merits of reliance on specific instances versus more abstract levels of knowledge.

Evidence from Pro-c Instances. One concern about the research findings discussed in the previous section is that the participants were college students, not selected for special skills, high levels of creativity, or motivation to achieve in the domains under investigation (e.g., imagining life forms on other planets). They also had limited time, typically developing ideas in single sessions lasting less than an hour. In contrast, higher level real-world creativity can involve more complex problems, with an extended period of effort performed by professionals with a high level of motivation to succeed in their domains, operating at what Kaufman and Beghetto (2009) describe as the Pro-c level of creativity. With those types of concerns in mind, Ward (1994) examined creatures envisioned by professional science-fiction writers for the same types of properties as those included by college students in laboratory studies. Specifically, he examined paintings shown in the book *Barlowe's Guide to Extraterrestrials* (Barlowe & Summers, 1979). Barlowe, a painter, had chosen to depict creatures from the science-fiction literature that "challenged the imagination" (p. 9). Coding revealed that roughly three-fourths of them possessed the eyes, legs, and symmetry that so dominated the college students' creatures. Thus, structured imagination is not limited to college students performing contrived tasks within limited amounts of time.

There is also evidence that abstraction can sometimes be beneficial in Pro-c activities from a laboratory study with graduate and undergraduate students in engineering who were familiar with the use of search engines (e.g., Google). Zeng, Proctor, and Salvendy (2011) had the students "design a creative main page of a web search engine ... that is novel and useful to promote users' adoption and use" (p. 260). Students who were given instructions that encouraged abstraction (i.e., thinking of essential features of search engines in general) developed ideas that were rated as more creative than those who received no special instructions. The results are consistent with those of Ward and colleagues (2004), who found greater originality in imaginary extraterrestrials developed by psychology students instructed to think about abstract properties needed for survival, and they extend the findings to a population that is arguably operating at a higher level of creative expertise than unselected students.

In addition, there are interesting anecdotal/historical accounts that reveal negative influences from reliance on specific known instances. For example, in the 1830s, when passenger rail travel was just getting started in the United States, designers seem to have patterned the first railway passenger cars directly on horse-drawn stagecoaches of the day, including the fact that conductors had to sit on the outside of the car (White, 1978). This approach was efficient in the sense that railway passenger cars became available quickly, but because the conductors were seated on the outside, several of them fell off and were killed.

In the railway passenger car case, accessing and relying on a specific exemplar of earlier knowledge got in the way of innovation. However, history is replete with examples of major advances occurring through a slow incremental process of patterning new ideas after very specific earlier ones (see, e.g., Basalla, 1988; Ward et al. 1995; Weisberg, 1995, 2006). An example noted by Basalla is the close connection between Eli Whitney's Cotton Gin, designed to separate the seeds from the cotton fiber, and a previously existing device, the charka, that performed a similar function. Another example is that Edison's light bulb was a close variant on preexisting designs of which Edison was cognizant (Friedel & Israel, 1986). As shown in laboratory studies (e.g., Ward, 2008), the approach of relying heavily on specific existing products in developing new ones may favor practicality over extreme, but potentially impractical, originality.

Importantly, the historical cases described in this section highlight a distinction between cognitive processes of introducing incremental advances on specific previous ideas and the potential far-reaching, Big-C impacts of those modifications. As eloquently stated by Weisberg (2006), "one must keep separate the importance of a product, which may be extraordinary, and thought processes that brought it about, which may be very ordinary" (p. 31).

To summarize, research using the creative cognition convergence approach does reveal commonalties between the findings from laboratory studies employing convenience samples in artificial tasks and those from content analyses and anecdotal accounts of higher-level creativity. There is a general tendency among people approaching creative tasks to rely on specific domain instances in developing new products, and that tendency is associated with less originality but greater utility of the resulting products.

Situational Variations in Knowledge Accessibility

Much of the work reviewed in the preceding sections reveals the impact of chronically accessible information on creative activities. That is, some aspects of knowledge are, in general, retrieved more readily than others and they play a large role in shaping creative ideas. Information at the basic level is easier to get to than information at other levels, and typical category members (e.g., dogs) come to mind before less typical ones (e.g., aardvarks). Both properties have been shown to influence creative idea generation. However, accessibility is malleable rather than fixed. For example, exposure to category exemplars early in an experimental session has been shown to increase their likelihood of being listed in a subsequent category exemplar listing task (e.g., Graf, Shimamura, & Squire, 1985).

Modifying the Accessibility of Category Instances. The fact that the accessibility of exemplars can be manipulated has been used to establish a more direct causal link between that property and performance in creative tasks. Ward and Wickes (2009), for example, had students rate the pleasantness of particular fruit and tools prior to generating imaginary instances from those domains. The basic finding was that people were more likely to base their imagined creations on exemplars that had been presented in the rating task than on exemplars that had not been presented in that task. Those presented items had become more accessible and played a greater role in creative generation.

The accessibility of particular types of category instances can also be manipulated by exploiting other aspects of conceptual structure, such as correlated attributes. Traditional studies on categorization have shown that certain groups of features tend to occur together in natural, real-world categories (e.g., Rosch et al., 1976). For instance, in animal categories, the feature "wings" tends to occur more often with "feathers" than with "fur." To determine whether feature correlations would influence creative exemplar generation, Ward (1994) had student participants imagine and draw extraterrestrial animals, and told different groups that the creature had either feathers, scales, or fur. The participants in the "feather" condition were significantly more likely to include wings and beaks as additional features, whereas those in the "scales" condition were significantly more likely to include fins and gills, relative to those in the "fur" condition. More importantly, self-reports collected after subjects created their animals indicated that they tended to base them on particular instances of known birds, fish, or mammals, in the feather, scales, and fur conditions, respectively. Thus, the different instructions led to the retrieval of different instances of Earth animals, whose properties were then mapped onto the novel entities.

Conformity Effects. A related line of research has also examined how knowledge can be made more accessible by exposure to examples. As a starting point, Smith, Ward and Schumacher (1993) had undergraduate students from psychology classes develop ideas for alien life-forms and novel toys. Prior to performing the task, participants in the experimental condition were shown three examples each of novel aliens and toys, whereas those in a control condition were not shown examples. Across three experiments, participants who saw examples were significantly more likely to include properties of the examples in their own designs, even when asked to develop ideas as different as possible from the examples. The tendency to copy the properties of the examples was dubbed the *conformity effect*, and it has been replicated across multiple studies that include different knowledge domains, task instructions, and task variations (Chrysikou & Weisberg, 2005; Landau & Lehr, 2004; Landau & Leynes, 2004; Marsh, Landau, & Hicks, 1996; Marsh, Ward, & Landau, 1999).

Studies have also advanced understanding of the sources of the conformity effect by noting situations that increase or decrease it. Marsh and colleagues (1996), for example, found that participants showed a stronger conformity effect as the number of examples presented increased from one to nine. This effect could indicate that exposure to multiple examples helps participants to form a kind of category or schema from them, much as people form and use schemas of analogical problem solutions from exposure to multiple instances of the same type (Gick & Holyoak, 1983).

Importantly, the term *conformity effect* should be taken as a description of the tendency to imitate observed examples and not necessarily as an indicator of reduced creativity. A particularly important finding in this regard is that George and colleagues (2017) replicated the Smith and colleagues (1993) conformity effect for toys but also found that toys generated by participants who were exposed to examples were *higher* in rated novelty than those generated by participants in the control condition.

They also found that the number of example features used was positively correlated with the rated novelty of the participants' creations. These findings suggest that instead of constraining creativity, conformity to some types of examples can instead facilitate it.

Several recent studies also have shown that examples that violate constraints or are otherwise creative can increase the unusualness or creativity of participants' creations. Yi, Plucker, and Guo (2015), for instance, had participants develop alien creatures and collages either with or without exposure to examples, but, in contrast to previous studies, the examples chosen had previously been rated as highly creative. The results showed that those viewing these examples generated products that were rated more creative. In addition, Okada and Ishibashi (2016) showed that Japanese students who were instructed to copy abstract drawings later produced drawings of their own that were rated as more creative than ones produced by students who did not copy the abstract examples. The authors contended that the abstract drawings violated a default cultural constraint that drawings should be "realistic," and copying them led to a relaxation of that constraint, a mechanism also thought to underlie insight in problem-solving (e.g., Knoblich et al., 1999).

Design Fixation in Pro-c Individuals. Research on the conformity effect has relied on nonspecialist samples of undergraduate students, typically recruited from psychology classes. However, a parallel line of research has examined similar phenomena in individuals with advanced training or work experience in engineering domains, who can be regarded as operating at the Pro-c level. In a seminal study, Jansson and Smith (1991) had practicing mechanical engineers and advanced mechanical engineering students perform a variety of creative generation tasks, such as developing ideas for novel car-mounted bicycle racks, spill-proof coffee cups, and devices to assist blind individuals in measuring quantities for cooking. Prior to completing their own designs, some of the participants were shown examples of previous attempted designs. A crucial aspect of the examples is that they had design flaws built into them. For instance, the spill-proof coffee cup had a straw that would leak if the cup were tipped over and would make the coffee too hot to drink by not allowing the passage of air across the liquid. Although the participants were alerted to the flaws and were instructed not to copy them, many of them nevertheless incorporated them into their own designs. In addition, those shown the examples generated a narrower range of designs than participants who were not shown examples, tending instead to generate ideas of the same basic type as the examples.

Jansson and Smith referred to copying the examples' properties as *design fixation*, and the work sparked efforts to replicate the findings and identify the factors underlying such effects. As a case in point, Purcell and Gero (1996) noted that, in contrast to Jansson and Smith's robust findings with mechanical engineers, fixation effects for students in architecture and industrial design are slight and limited to designs with which they are already most familiar. Mechanical engineering students, in contrast, show fixation for examples with which they are unfamiliar, as long as the designs use typical mechanical engineering design principles. Taken together, the findings suggest that the examples activate existing knowledge, which then is incorporated into the participants' designs. Without the domain-specific mechanical engineering knowledge about the principles operating in the examples, industrial design students are influenced by general, surface-level knowledge about objects they have encountered before, whereas the mechanical engineers are influenced by the domain-specific principles of their discipline embodied in those objects. In either case, the effect of the examples is due to knowledge activation.

Several recent studies have also identified factors that can decrease design fixation and the findings are consistent with the value of abstraction and of avoiding the path of least resistance. Cardoso and Badke-Schaub (2011), for example, had industrial design students develop ideas for a device to pick up a book from a shelf that was out of reach. Some participants were shown depictions of existing devices either as photographs or as line drawings. Those who viewed line drawings performed similarly to participants in a control condition, but those who viewed photographs developed ideas rated as less original. Those in the photograph condition may have been affected negatively by the concrete, detailed representation of the objects, whereas those in the line drawing condition may have been less constrained due to the abstractness of those representations.

In addition, Cheng, Mugge, and Schoormans (2014) had graduate students in industrial design develop ideas for redesigning the appearance of products, such as mixers and hairdryers. Prior to the task, they viewed either ordinary photographs depicting whole examples from those categories or partial photographs separately depicting recognizable parts of the objects. Expert judges rated designs produced in the full-photograph condition as less original than those from the partial photograph condition. The authors noted that the direct representation of whole objects in the full photograph condition allowed participants an easy opportunity to use them as starting points to be modified, thereby resulting in lower originality of their ideas. In contrast, the information provided by partial photographs is incomplete, requiring participants to engage in more processing to fill in the gaps and disrupting easy movement down a path of least resistance to a specific category instance to be modified.

Consistent with findings from studies of nonspecialized populations (e.g., Yi et al., 2015), research with students preparing for Pro-c careers related to product development also reveals that particular types of examples can boost rather than inhibit novelty. Chan and colleagues (2011), for example, gave advanced students in engineering and other product-design disciplines the task of generating ideas for a device to collect energy from human motion. Some of the students were shown examples of actual patented devices selected by the experimenters to be from either conceptually near (e.g., recovery of geothermal energy) or far (escapement mechanism for pendulum clocks) domains, and to be either familiar (waterwheel generating assembly) or unfamiliar (apparatus for producing electrical energy from ocean waves) to the students. Exposure to distant domain examples and unfamiliar examples resulted in greater rated novelty of the students' designs relative to near domain and familiar examples respectively. In addition, exposure to examples that were both distant and unfamiliar resulted in greater novelty than a control condition in which no examples were shown.

Overcoming Fixation via Incubation. The fact that people can be fixated on chronically accessible ideas or on ideas made more accessible by way of examples raises the question of how such fixation might be overcome to yield better creative performance. One possibility is incubation, a temporary withdrawal from ordinary attempts at solving a problem, initially suggested by Wallas (1926) nearly a century ago. An oft-cited anecdotal account of incubation is Archimedes' "Eureka" realization while bathing that the principle of displacement could be used to measure the volume of Hiero's crown, which could be combined with its weight to determine if it was pure gold.

Attempts to demonstrate incubation effects in laboratory studies are not universally successful but a growing body of work has documented that improvements in problem-solving can occur following periods of temporary withdrawal from a problem, particularly when the interval is filled with a distracting activity (e.g., Christensen & Schunn, 2005; Dodds, Smith, & Ward, 2002; Dodds, Ward, & Smith, 2003; Kohn & Smith, 2009; Smith, 1995a, 1995b; Smith & Blankenship, 1989, 1991; Smith, Gerkens, & Angello, 2017). More importantly, the studies have provided evidence about the cognitive mechanisms responsible for incubation effects.

One prominent view of incubation effects is Smith's Forgetting Fixation Theory, which states that activities that temporarily distract a problem solver can lead to forgetting of interfering information, which then leads to a greater likelihood of retrieving new, relevant information (Smith, 1995a, 1995b; Smith & Blankenship, 1989, 1991). In a more recent test of this view, Kohn and Smith (2009) had participants attempt to solve Remote Associates Test (RAT) problems in which they had to determine one word that would form a compound word or two-word phrase with each of three presented words (e.g., *walk* for the triad *cat, board, and sleep*, forming *catwalk, boardwalk, and sleepwalk*). Prior to performing the RAT, an attempt was made to fixate some participants on an incorrect solution by having them form two-word phrases from a related set of three words. For example, the set *cat, board*, and *black* might be expected to lead to *black cat* and *blackboard*, thereby fixating participants on the misleading word *black*. Other participants performed the initial two-word phrase task with words unrelated to the RAT problem, which would not lead to fixation on a misleading word. Participants worked on each RAT problem for 15 seconds, followed by either 40 seconds of a digit monitoring task (incubation) or a 1-second pause (no-incubation) and then an additional 7 seconds of work on the RAT problem. Of most interest were resolution rates of problems solved in the final 7 seconds that had not been solved in the first 15 seconds. Participants showed a significantly higher resolution rate in the incubation condition than the no-incubation condition only when fixation was induced by the related version of the prior two-word phrase generation task. The results imply that incubation effects are largely due to people forgetting interfering information and are less likely to occur when people are not initially fixated.

It should be noted that other investigators have found incubation effects even without fixation (e.g., Morrison, McCarthy, & Molony, 2017), leading to questions about the generality of the forgetting fixation account. In addition, there are other possible explanations of incubation effects, including conscious work periodically throughout the incubation interval (e.g., Browne & Cruse, 1988) and opportunistic assimilation, whereby chance encounters with relevant clues during incubation can trigger insightful problem solutions (Seifert & Patalano, 2001; Seifert et al., 1994). Nevertheless, work on incubation continues to hold promise as one possible means of overcoming the influence of information that has become active due to recent exposure. One important challenge that remains is to determine whether the activation and forgetting of knowledge that operates over short time spans in laboratory studies can be applied to real-world cases involving longer term periods of effort and incubation.

Conceptual Combination

Another process that has been of considerable interest in explicating creativity is conceptual combination, whereby previously separate ideas, concepts, or other forms are mentally merged. The elements to be combined can be words, concepts, visual forms, and other simple elements or, at a more abstract level, they can be hypothetical scientific constructs, musical styles, artistic genres, and so on. Whether in science, technology, art, music, literature, or other creative realms, combinations are seen as stimulants to creativity and have been mentioned frequently in historical accounts of creative accomplishments (e.g., Rothenberg, 1979, Thagard, 1984, Ward, 2001; Ward et al., 1995). Rothenberg in particular has argued that simultaneously entertaining or integrating two opposing ideas, a process termed *Janusian thinking*, underlies creative acts as diverse as the paintings of da Vinci, the symphonies of Mozart, and the scientific reasoning of Einstein. In addition, combining concepts is a crucial component in several process models of creative functioning (e.g., Mumford et al., 1991; Sternberg, 1988).

Combination is directly relevant as a process underlying creativity because combinations are not mere summations of the elements being merged. Instead, they can yield *emergent features*. That is, combinations can produce or highlight properties that are either absent from or very low in salience for the representations of either of their component elements. Even a simple combination such as “pet bird” might include an emergent property, namely “talks,” which would not typically be thought of as an attribute of “pets” or “birds” in general.

A more intriguing example of the power of combining simple concepts from the realm of literature is the case of noted fantasy writer Stephen Donaldson. He attributed the inspiration for his series on *Thomas Covenant, The Unbeliever* to the combined concepts of *unbelief* and *leprosy*. Unbelief is an unwillingness to accept the possibility of alternatives to our observed physical reality. The double trilogy tells the tale of Thomas Covenant, who has leprosy in the real world but finds himself in a fantasy world where he is not only cured but also welcomed as a legendary hero.

He steadfastly refuses to believe in that realm. Donaldson had wanted to write a story about unbelief but was stymied until he combined that concept with the disease of leprosy, at which point his "brain took fire" (Donaldson, 1992, p. 223). The reason it was so powerful a combination for Donaldson is that his knowledge of leprosy told him that a person with the disease would be extremely vigilant to detect un-sensed but potentially life-threatening injuries and therefore loath to accept the reality of a fantasy world, even one in which he had a hero's status and apparent relief from the disease. The dynamic tension between Covenant's need for continued self-vigilance and the attraction of the fantasy world sets the stage for a powerful series of books.

Several laboratory studies using nonexpert samples also converge on the power of combinations, particularly unusual ones, to produce emergent ideas. Combinations of personal traits that are stereotypically less common (e.g., Harvard-educated carpenter, and Republican social worker), as well as nonsensical conjunctions (e.g., furniture that is also fruit), lead to emergent properties not characteristic of the separate elements of the combination (Hampton, 1997; Hastie, Schroeder, & Weber, 1990; Kunda, Miller, & Claire, 1990). One interpretation of the findings is that participants have to generate explanations or otherwise reconcile the discrepancies of the component concepts, which leads them to postulate novel properties. Although these studies did not require participants to develop stories, much like Donaldson's "unbelieving leper," the more discrepant combinations seem to suggest more creative possibilities than more stereotypic combinations (e.g., Harvard-educated lawyer).

Estes and Ward (2002) provided evidence directly consistent with Rothenberg's suggestion about Janusian thinking. They had a sample of college students interpret various types of adjective–noun combinations. Of most interest, when the adjectives and nouns were opposing in meaning (e.g., healthy illness) the participants' interpretations contained more emergent properties, ones not salient for either concept considered separately, than when the terms represented more typical pairings (e.g., harmful illness). A healthy illness, for example, might be one that temporarily incapacitates its victim, thereby preventing the person from engaging in some activity that could have resulted in more harm (e.g., taking a fateful trip). A harmful illness, by contrast, is just one that causes some harm to the body – not a particularly novel construct.

Additional laboratory research also reveals that concepts need not be specifically opposite or contradictory in meaning to provoke emergence. Instead, more generally, the dissimilarity of the components of a combination determines the extent to which they will yield emergent properties (Wilkenfeld & Ward, 2001). In the Wilkenfeld and Ward study, participants interpreted similar and dissimilar noun–noun combinations (e.g., guitar harp versus airplane puddle). Consistent with the expectations regarding the role of constituent similarity, they found that dissimilar combinations resulted in more emergent properties than similar combinations. Thus, the laboratory results support and extend the anecdotal accounts.

Combination processes include more than just interpreting noun–noun or adjective–noun combinations. For example, sometimes combination involves figuring out how to integrate sets of objects that ordinarily are not grouped together into a single coherent concept. Mobley, Doares, and Mumford (1992) used a paradigm to approximate that type of combination process, in which participants were given four exemplars from each of three categories (e.g., furniture: chair, couch, table, stool) and had to develop concepts to explain the grouping of all of them together. When the component objects were more dissimilar, people generated more original concepts (an effect since replicated by Kohn, Paulus, & Korde, 2011) but the outcomes were also judged to be of lower quality. Apparently, as with the results of studies already described, the need to integrate more discrepant pieces of information provided a boost to originality, though not necessarily to overall quality. As with studies discussed in the section on "Retrieval and Use of Specific vs. General Information," the findings point to the need for product ratings along multiple dimensions, including the key creativity ingredients of originality and appropriateness.

Consistent with the notion of greater creative potential of unusual combinations, Howard-Jones and colleagues (2005) showed that participants generated stories that were rated as more creative when they did so on the basis of triads of unrelated words (e.g., flea, sing, sword) than triads of thematically related words (e.g., magician, trick, rabbit). In addition, Zeng and colleagues (2011) had students in technical areas, including Computer Graphics Technology and Industrial Technology, create ideas for web service "mash-ups" combining other currently existing ones in domains such as *location* (e.g., Google maps) and information (e.g., Wikipedia). When they combined across types of services, they produced more creative ideas than when they combined services of the same type. Thus it appears that similar benefits of conceptual combination processes are seen in nonspecialist samples performing very general tasks (Howard-Jones et al., 2005) and in individuals preparing for a Pro-c creative career performing more specialized creative tasks (Zeng et al., 2011).

It is important to note, however, that initial interpretations of conceptual combinations should not be expected to necessarily yield creative outcomes directly. Chan and Schunn (2015b), for example, analyzed a large data set of crowdsourced contributions to OpenIDEO, a platform for developing solutions to pressing real-world problems, such as managing electronic waste and increasing the number of bone marrow donors. They measured the conceptual distance between sources of inspiration in people's suggested solutions and differentiated between direct and indirect influences (using a concept that itself was inspired by that source). There was no direct effect of conceptual distance between the sources on the creativity of the solutions but there was a positive indirect effect. Chan and Schunn interpreted their results in terms of creativity involving iterative steps and using both divergent and convergent processes. High-quality ideas possessing novelty and utility should not be expected to spring immediately from combining widely discrepant concepts but instead from continued convergent refinement of the divergent ideas suggested by those combinations. This position is wholly consistent with the Geneplore model of creative cognition and its emphasis on cycles of generation and exploration of ideas (Finke et al., 1992).

Research also shows that a combination does not have to involve verbal units at all to be a stimulus for creativity. Merging visually presented abstract forms, for example, can also lead to emergent new ideas. Rothenberg and Sobel (1980) showed that participants who viewed two images superimposed on one another created metaphors that were rated as more creative than those produced by participants who saw the same images next to one another. Finke (1990) also showed that people who mentally combined randomly selected visual forms were able to develop ideas for inventions and discoveries for a variety of domains under a wide range of procedures (see also Roskos-Ewoldsen et al., 1993). Although superimposed or merged images do not always lead to more creative outcomes (e.g., Sobel & Rothenberg, 1980), the results are suggestive that combined images can, at least under some circumstances, be a stimulus to originality.

Analogy

Another generative process with a special link to creativity that has undergone careful experimental examination is analogical reasoning, the application of *structured knowledge* from a familiar domain, called the *source domain*, to a novel or less familiar one, called the *target domain* (see, e.g., Gentner, Holyoak, & Kokinov, 2001; Holyoak & Thagard, 1995). The emphasis on *structured* knowledge is important because it allows a formal description of the domains and the processes involved in connecting them. As an example, within Gentner's (1983) structure-mapping model, domains can be described in terms of the *objects, relations*, and *higher-order relations* that comprise them, and analogy is the process whereby corresponding entities are aligned and matched. Consider, for example, Robbins, Laurents, Bernstein, and Sondheim's adaptation of Shakespeare's *Romeo and Juliet* to the context of a 1950s New York City gang conflict in *West Side Story.* The analogy can be described in terms of aligning the two domains to find corresponding objects (e.g., Romeo and Tony, Juliet and Maria), relations (e.g., Romeo loves Juliet and Tony loves Maria), and higher-order relation (e.g., a clash between love for each other and hate between the groups they are affiliated with).

The goal in analogical thought is to find a mapping that maximizes systematicity using the principles of one-to-one mapping (e.g., Juliet maps to Maria and no other characters) and parallel connectivity (e.g., if the relation Romeo loves Juliet maps to Tony loves Maria, the component objects of those relations must map to each other; Romeo to Tony and Juliet to Maria). Systematicity is a general principle that has also been shown to influence other forms of cross-domain mappings, such as generating and interpreting novel metaphors (Tourangeau & Sternberg, 1981, 1982). That is, the aptness of a metaphor is strongly determined by the extent to which the tenor and vehicle in a metaphor "occupy similar 'relative positions' within their respective domains" (Tourangeau & Sternberg, 1982, p. 225).

Commonly cited real-world examples of analogy in creative endeavors abound, such as Rutherford's use of a solar system as a model for how the hydrogen atom was structured, Kepler's reasoning about planetary motion (Gentner et al., 1997), Edison's development of an electric light distribution system (Basalla, 1988; Friedel, Israel, & Finn, 1986), and the Wright brothers' efforts to craft a workable flying machine (Crouch, 1992). Not surprisingly, then, analogy has been a key ingredient in proposals for enhancing creativity (e.g., Gordon, 1961) and has been listed as a component process in cognitive process models of creativity (e.g., Finke et al., 1992).

The transformational power of analogies derives, at least in part, from the fact that good analogies connect the familiar and novel domains at very deep levels (e.g., Gentner, 1983, 1989; Gentner & Toupin, 1986). Consider the solar system/atom analogy. It means that just as planets orbit around a more massive central body, the sun, electrons may orbit around a more massive central body, the nucleus. But the nucleus and electrons do not resemble the sun and planets in any superficial way. What matters is that there are corresponding objects that bear particular relations to one another.

Laboratory studies on analogical thinking show that college and high school students can use analogies to help them solve open-ended problems but they tend not to do so spontaneously (Gick & Holyoak, 1980, 1983). For example, in some of the Gick and Holyoak studies, students were asked to try to solve the *tumor problem*, in which a physician can destroy a malignant tumor with a sufficiently strong ray but a ray of that intensity will also destroy healthy tissue along the way. One solution is to direct multiple rays of lower intensity along different paths, reaching a focal point at the tumor, which will destroy it but leave healthy tissue unharmed. The students were unlikely to achieve this type of convergence solution on their own but were more likely to do so if they first read an analogous problem and its solution. Specifically, they read a problem about a general who desires to overtake a fortress but who faces the limitation that he cannot send all of his troops down a single path due to the likelihood that such a force would set off landmines. When the students also read that the general's solution was to divide his troops and send smaller numbers of them along separate paths to converge on the fortress, roughly 30 percent of them developed the analogous convergence solution for the tumor problem. But the majority did not do so until also given the hint to use information from the general story. The studies reveal both the potential and the limitations in people's use of analogy.

One important challenge for analogy theorists is to go beyond laboratory studies with relatively simple problems and convenience samples to explain the role of analogy in the higher-level creativity that occurs in more complex real-world settings (see e.g., Perkins, 1997). Researchers and theorists have attempted to bridge the gap by way of detailed case studies of analogical thought (e.g., De Cruz & De Smedt, 2010; Gentner et al., 1997), experimental studies with Pro-c creators (e.g., Dahl & Moreau, 2002), and in vivo observations of high level creators at work (e.g., Chan & Schunn, 2015a; Christensen & Schunn, 2007; Dunbar, 1997).

Gentner and colleagues (1997), for example, meticulously analyzed Johannes Kepler's analogical reasoning, particularly his use of light as a source domain for understanding the forces that control planetary motion. He identified the sun as the locus of the motive power that propels the planets, just as it is the source of light that illuminates them. He also reasoned that the motive force would spread out and thus diminish with distance just as is true for light. He used this decrease with distance to explain the slower movement of the more distant planets. The case study is especially valuable because Kepler's writings, both published and in the form of notebooks, contain an extraordinary amount of detail about his thought processes. Gentner and colleagues showed not only how alignment and mapping were operative but also how other psychological processes such as highlighting of commonalities across the domains influenced Kepler's success. Each domain separately contains a potentially overwhelming wealth of knowledge, but, by aligning the corresponding elements of the domains, crucial pieces of information to be considered can become more salient.

Even fine-grained case studies such as Gentner and colleagues' analysis of Kepler's reasoning have the limitation that they cannot establish causal connections between analogy and creative discovery nor establish how commonly such advancements occur. It is possible that the analogies are not the source of the advancements but rather a means to communicate new ideas to others, though De Cruz and De Smedt's (2010) analysis of historical cases does point to some instances of a more causal role.

One way to provide definitive information is to carefully document the activities of highly creative workers, in vivo, as they go about their ordinary tasks. Dunbar's (1997) observations of the reasoning of intact molecular biology lab groups is a case in point. His extensive observations with those groups led him to conclude that analogies between distant domains (e.g., solar system/atom) are rare and that many creative advances are instead the result of analogies between close conceptual domains (e.g., between two different viruses). Furthermore, distant analogies were not used to develop an understanding of something but instead served a more communicative goal of explaining something.

Research using such in vivo methods also makes it clear that the picture is not as simple as one might think. In particular, Christensen and Schunn (2007) examined the functioning of design engineers working on a project within a firm noted for its creative accomplishments. In contrast to Dunbar's results, Christensen and Schunn found distant analogies occurred as commonly as near analogies. In addition, some distant analogies were used for problem-solving, a function directly linked to the creative process itself and not just after-the-fact communication about it. In a related in vivo study of a professional design group, Chan and Schunn (2015a) found that new concepts were more likely to be generated following far analogies than following comparable baseline observations not preceded by such analogies. However, the new concepts were *less distant* rather than more distant from preceding ideas in comparison to the baseline observation. The ideas immediately preceding far analogies were also conceptually closer, suggesting that, rather than provoking conceptual leaps (Holyoak & Thagard, 1995; Ward, 2008), far analogies are part of an ongoing stream of deep reasoning about the domain and incremental progress toward solutions. Thus, the use of the in vivo method has helped to draw attention to the idea that the use of various analogical processes depends on the type of creative task involved. It has also shown that the functional role of far analogies may be different than implied by the commonly held view that far analogies provoke rapid conceptual leaps in understanding a problem.

Dahl and Moreau (2002) also used a more controlled testing situation to observe the causal role of analogies in the activities of Pro-c creators. In one study, they had teams of professional designers with an average of seventeen years' design experience develop solutions for a "product that will meet the needs/solve the problems of the commuting diner" (Dahl & Moreau, 2002, p. 48). They found that the number of analogies used in developing a solution was positively linked to the rated originality of the teams' ideas. In subsequent studies with engineering students, they also found that instructions to use many analogies led to more originality than instructions to use just one but that the effect was negated when the students were also shown example solutions prior to working on the problem. The effect appears to be due to a constraining effect of the examples on the ways the students analogized; the examples reduced the use of far analogies, which were the ones most likely to boost originality. Taken together, the studies provide experimental support for the creative benefits of far analogies.

Other Processes and a Path to Progress

A host of other processes that have been investigated by cognitive psychologists also have the potential to serve creative purposes. These include problem-finding (see e.g., Basadur, 1994; Csikszentmihalyi & Getzels, 1971; Getzels & Csikszentmihalyi, 1976; Mumford et al., 1991; Runco & Chand, 1994, 1995; Sternberg, 1988; Treffinger, Isaksen, & Dorval, 1994), the reorganization of existing category knowledge to form ad hoc or goal-derived categories to meet a particular need (e.g., Barsalou, 1983, 1991; Mumford, Reiter-Palmon, & Redmond, 1994; Smith et al., 2017), metaphoric interpretation, which can yield emergent properties (e.g., Tourangeau & Rips, 1991), and reasoning from unexpected observations (Dunbar, 1997). In addition, recent approaches that examine interplay of default and executive control brain networks and their link to generative and exploratory evaluative processes hold great promise (e.g., Beaty et al., 2016). Despite the progress made in understanding these processes and the ones considered in more detail in the present chapter, much remains to be done to understand the cognition of creativity. Applying a convergence approach and bringing together the ecological validity of real-world examples with the experimental rigor of behavioral cognitive science research and detailed observations of corresponding brain activity can provide the path to continued progress on this important goal.

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10 Creativity and Cognitive Control

Mathias Benedek and Emanuel Jauk

Creative people differ substantially in how they approach their creative process. Thomas Mann followed a highly rigid working schedule each day and shielded himself from all environmental influences, including his children, during his precisely timed working hours. In contrast, Jean-Paul Sartre harnessed the creative power of leisure time via socializing and consumption of mind-altering drugs. Yet both writers were able to produce eminently creative work. This raises the question: Is creativity the result of deliberate effort, spontaneous insight, or both? Will cognitive control support this complex cognition, or could cognitive control come in the way of the spontaneity and flexibility needed to be creative?

This chapter starts by presenting empirical research exploring the relationship between creativity and cognitive control. Many different lines of investigation have contributed relevant evidence, including individual differences research examining the correlation between creativity and executive abilities or intelligence, research on incubation and mind-wandering, experimental manipulations of cognitive control, and neuroscientific investigations of creativity. Notably, most of this research has studied creativity in terms of creative cognitive ability as measured by divergent thinking (DT) or insight problem-solving, whereas only a few studies have explored relationships with more naturalistic creative activities and actual creative achievements. In the second part of the chapter, we attempt to consolidate the available evidence and propose some general mechanisms and conditions that explain how high or low cognitive control may contribute to creativity. To this end, we first highlight the role of cognitive control in short-term creative tasks and subsequently move on to discuss the complex interplay between controlled and spontaneous cognition in naturalistic long-term creative behavior.

Empirical Evidence

Executive Functions

Executive functions are general-purpose mechanisms that coordinate thought processes toward the attainment of goals and thus underlie the control of thought and action. They include specific functions such as updating, shifting, and inhibition and were shown to be relevant to a wide range of basic as well as complex cognitive tasks (Miyake et al., 2000). The role of executive functions for creativity has been mainly studied from an individual-differences perspective. It follows the rationale that if individual differences in the effectiveness of cognitive functions are relevant for creativity in terms of directly facilitating or limiting performance, then these traits will exhibit correlations with creativity. Consequently, correlations of low-level cognitive abilities (e.g., working-memory capacity) with high-level cognitive abilities (e.g., creative ability) can be used to infer that the low-level process is crucially involved in the high-level process.

Updating ability and working memory. Updating refers to the monitoring of incoming information and the revision of working-memory content by replacing obsolete information with new and relevant information (Jonides & Smith, 1997). It is closely related to working-memory processing, which additionally involves the manipulation of available information. High working-memory capacity (WMC) is particularly needed in complex tasks that require handling much information at a time. Although the relationship between working memory and intelligence has been seriously studied in the past (e.g., Conway et al., 2010), there is little research on its role in creativity. Several studies have reported positive relationships between updating ability/WMC and DT ability (Benedek, Jauk et al., 2014; de Dreu et al., 2012; Oberauer et al., 2008) as well as with the performance at solving insight problems (de Dreu et al., 2012; Gilhooly & Fioratou, 2009; Lee & Therriault, 2013). Two other studies, however, found no significant relationship between WMC and DT ability (Lee & Therriault, 2013; Smeekens & Kane, 2016). Taken together, there is mixed evidence but the majority of findings suggests that executive control in terms of updating and WMC facilitates creative thought.

Shifting. Shifting refers to the cognitive process of switching between different tasks and mindsets (Monsell, 2003). Shifting ability can be assessed with tasks that require one to variably apply different rules depending on external cues. In a typical task, pairs of characters, containing a letter and a digit, are continuously presented at different locations of the screen. When the stimulus is presented in the upper half of the screen, participants have to decide whether the letter is a consonant or vowel; when the stimulus is presented in the lower half of the screen, they have to decide whether the digit is odd or even. Higher shifting ability was found to predict higher DT fluency and DT flexibility but was not associated with DT creativity (i.e., the rated creativity of ideas generated in DT tasks; Benedek, Schickel et al., 2014; Pan & Yu, 2018). Moreover, frequent switches between categories during creative idea generation predicts higher DT performance (Benedek et al., 2012; Nijstad et al., 2010; Nusbaum & Silvia, 2011). Shifting ability hence may represent a form of cognitive flexibility that is helpful when we need to abandon strategies after they are no longer fruitful and to switch swiftly to new promising ways to explore unseen parts of the solution space.

Cognitive inhibition. Cognitive inhibition can take various forms (e.g., inhibition of proactive interference, distractor inhibition) but commonly refers to prepotent response inhibition, which reflects the suppression of dominant but irrelevant response tendencies (Friedman, & Miyake, 2004). On the one hand, cognitive inhibition could be deemed useful to withhold common, unoriginal thoughts, but, on the other hand, creative people are often characterized by fluency of thought and even disinhibition (Eysenck, 1995; Martindale, 1999). Cognitive inhibition as measured with the Stroop task or random motor-generation tasks has consistently predicted higher DT ability but also teacher ratings of creativity and self-reports of creative achievement (Benedek et al., 2012; Benedek, Jauk et al., 2014; Cheng et al., 2016; Edl et al., 2014; Golden, 1975; Groborz & Necka, 2003; Zabelina et al., 2012). Similarly, cognitive inhibition in a dichotic listening task was found to be positively related to DT ability (Rominger et al., 2017). Other studies reported that creative people show a more adaptive or flexible engagement of inhibition (Dorfman et al., 2008; Kwiatkowski, Vartanian, & Martindale, 1999; Vartanian, Martindale, & Kwiatkowski, 2007; Vartanian, 2009; Zabelina & Robinson, 2010). For example, higher creativity predicted a more effective trial-to-trial modulation of cognitive control within the Stroop task (Zabelina & Robinson, 2010). Together, these findings indicate that cognitive inhibition supports creative thought by effectively suppressing salient but irrelevant associations, which helps to avoid perseveration on uncreative thoughts.

Sensory gating. A more nuanced picture emerges when we look at less deliberately controlled attentional processes such as sensory gating. It has long been hypothesized that creativity goes along with states of defocused attention (Mendelsohn, 1976; see also Martindale, 1999) and an inability to screen out irrelevant information (Galang, 2010). Empirical evidence shows that real-life creative achievement is indeed associated with reduced sensory gating (Zabelina, O’Leary et al., 2015) and reduced latent inhibition (Carson, Peterson, & Higgins, 2003), which refer to the ability to implicitly learn to disregard irrelevant information (Lubow, 1997). For real-life accomplishments, decreased latent inhibition may be particularly fruitful in combination with high intelligence (Carson et al., 2003; see also, Carson, Chapter 14, this volume). In contrast, in DT research, higher creativity is usually associated with *increased* sensory gating and attentional control (Zabelina, O’Leary et al., 2015; Zabelina, Saporta, & Beeman, 2015) as well as increased latent inhibition (Burch et al., 2006), although some studies also report null results (e.g., Green & Williams, 1999). Together these findings suggest that effective sensory gating supports creative thinking, whereas reduced sensory gating may provide benefits in the context of long-term creative achievements.

Intelligence

As fluid intelligence is strongly related to working-memory capacity (Ackerman, Beier, & Boyle, 2005; Kane, Hambrick, & Conway, 2005), it is commonly viewed as an index of the ability to apply cognitive control in complex cognitive tasks. So, how does intelligence relate to creativity (for an extended treatment of the creativity–intelligence relationship, see also Sternberg, Kaufman, & Roberts, Chapter 16, this volume)? An abundance of studies have examined the relationship between different facets of intelligence and creativity. This research revealed a robust positive association between intelligence and creativity (Silvia, 2015; Batey & Furnham, 2006). It is consistently observed for different facets of intelligence, including fluid intelligence

(Gf; e.g., Cho et al., 2010; Jauk et al., 2013), and broad retrieval ability (Gr; e.g., Avitia & Kaufman, 2014; Benedek et al., 2017; Silvia, Beaty, & Nusbaum, 2013). Moreover, it generalizes to different measures of creative potential, including DT (e.g., Jauk, Benedek, & Neubauer, 2014; Nusbaum & Silvia, 2011), generation of creative metaphors (Beaty, & Silvia, 2013; Silvia & Beaty, 2012), production of humor (Kellner & Benedek, 2017; Nusbaum, Silvia, & Beaty, 2017), and insight problem-solving (Beaty, Nusbaum, & Silvia, 2014; Lee, Huggins, & Therriault, 2014), and even predicts real-life creative achievements (Kim, 2008; Plucker, 1999).

An early meta-analysis estimated the average relationship between intelligence and creative potential to be of modest magnitude (Kim, 2005). More recent research, however, suggests that this relationship is much more pronounced when considering latent relationships (Jauk et al., 2014; Silvia, 2008), when creativity is measured by DT creativity rather than mere fluency (Benedek et al., 2012; Jauk et al., 2013), and when employing DT tasks that explicitly instruct participants to be creative rather than to produce many different ideas (Forthmann, Gerwig et al., 2016; Nusbaum, Silvia, & Beaty, 2014). Finally, above-average intelligence has been viewed as a necessary condition for high creativity (Guilford, 1967). This notion is supported by increased intelligence-creativity correlations in the lower range of the intelligence spectrum (Cho et al., 2010; Jauk et al., 2013; Karwowski et al., 2016, 2017).

These correlational findings show the general relevance of intelligence for creativity at an individual-differences level. Further research has begun to shed light on the functional role of intelligence for creative thought. Interestingly, intelligence predicts creativity more strongly when people are instructed to focus on producing creative ideas rather than on generating many ideas (Nusbaum, Silvia, & Beaty, 2014; O'Hara & Sternberg, 2001). Moreover, after providing a useful idea-generation strategy in the Alternate Uses Task (AUT; i.e., to consider the disassembly of objects), intelligence predicted whether people profited from the strategy (Nusbaum & Silvia, 2011). Another study showed that higher intelligence predicts higher creativity of ideas, especially at the beginning of idea generation, suggesting that intelligence contributes to an effective suppression of initial common ideas right from the start (Beaty & Silvia, 2012). These studies suggest that intelligence facilitates the effective implementation of top-down strategies during creative idea generation. In sum, research on intelligence and creativity provides broad and consistent support of the relevance of cognitive control for creativity.

Incubation and Mind-Wandering

Other lines of research seem to emphasize the relevance of reduced control in creativity. A major argument for the involvement of spontaneous processes in creative thought is the observation that we sometimes have unexpected insights relevant to unsolved problems while we are actually busy with something else. These observations prompted researchers to study how times of disengagement from creative problems, that is, intermittent *incubation* periods, affect subsequent creative problem-solving. For example, working on an undemanding distractor task was found to facilitate AUT performance more strongly compared with no break or engaging in a demanding task (Baird et al., 2012). Meta-analytic findings suggest that incubation periods have robust positive effects on DT as well as insight problem-solving (Sio & Ormerod, 2009). Incubation gains are especially pronounced when individuals are confronted with distraction tasks that are cognitively undemanding and involve a different stimulus modality (i.e., verbal vs. figural; e.g., Gilhooly, Georgiou, & Devery, 2013). Notably, incubation gains are observed not only after short breaks but also after extended incubation periods such as following a nap (Cai et al., 2009) or a night's sleep (Wagner et al., 2004).

Different cognitive mechanisms have been proposed to underlie the positive effect of incubation. Breaks are thought to reduce the saliency of inappropriate task sets, such as self-imposed irrelevant constraints that can cause blocks to task performance (Smith & Blankenship, 1991). Putting the task away will help to "refresh" one's mindset and mitigate fixation effects that were established during deliberate task engagement. Breaks to conscious task performance are also assumed to give more room to unconscious processing (Ritter & Dijksterhuis, 2014). The latter view is supported by the finding that incubation periods benefit more strongly from a disengagement of task-relevant cognitive systems (using a numerical distractor task between verbal creative problem-solving; Ellwood et al., 2009; Gilhooly et al., 2013). Moreover, incubation gains were found to be stronger when participants were aware of the posttest following the incubation period (Gallate et al., 2012), suggesting that the awareness of the uncompleted task triggers additional processes that cannot be easily explained by passive mechanisms (Zeigarnik, 1927).

A related form of task-disengagement is mind-wandering or daydreaming. Mind-wandering refers to task-unrelated thoughts that occur when our attention is unintentionally drawn away from a task (Smallwood & Schooler, 2015). While mind-wandering has traditionally been viewed as a dysfunctional lapse of attention, today, the adaptive sides of mind-wandering related to self-reflection and future-oriented planning are increasingly acknowledged (McMillan, Kaufman, & Singer, 2013). It has even been proposed that mind-wandering in the incubation period (i.e., thoughts unrelated to the distractor task but also unrelated to the interrupted creative task) may be responsible for incubation effects (Baird et al., 2012). However, this notion was not replicated by later research, as the amount of task-unrelated thought did not predict subsequent creative performance across three studies (Smeekens & Kane, 2016). Mind-wandering during actual creative task performance is even detrimental to creativity (Hao et al., 2015), as it is in most areas of cognitive performance (Kane et al., 2007).

Mind-wandering can also take the form of thoughts that spontaneously return to an unsolved problem and eventually reveal a new solution, while we have been engaged with something else (e.g., taking a bath, or riding a bus). Many famous "eureka" moments, such as those attributed to Archimedes, Kekulé, or Poincaré, originated from problem-related mind-wandering. But they also appear common in more mundane contexts in terms of good ideas off the job (Kounios & Beeman, 2014). Spontaneous ideas were found to arise about every other day in artists during a two-week project (Benedek, Jauk et al., 2017). Mind-wandering thus may be particularly relevant for time-extensive creative work, where problems have to be abandoned but can be spontaneously revisited. Time spent apart from voluntary, goal-directed engagement in creative problem-solving thus can be fruitful when it helps to mitigate fixation effects, when it gives room or attention to unconscious processing, and when it reflects spontaneous, yet conscious task engagement as in task-related mind-wandering.

Experimental Attenuation of Cognitive Control

A particularly exciting empirical approach in this field is the experimental manipulation of cognitive control, as it allows causal inference on the role of cognitive control on creativity. For example, several studies have investigated the effects of moderate alcohol consumption (i.e., inducing a blood alcohol concentration < 0.08) on creative cognition. One study reported that the fluency of idea generation was reduced in both an alcohol group and a placebo group compared with the control group (Gustafson, 1991). Another investigation found that intoxicated writers and nonwriters showed reduced idea flexibility but an increased number of nonobvious, original ideas (Norlander & Gustafson, 1998). In yet another study, participants evaluated their performance as more creative when they thought that they had received alcohol, although no notable effects of alcohol on DT performance were observed (Lang, Verret, & Watt, 1984). A more recent study demonstrated that moderate alcohol intoxication impaired working-memory processing and, at the same time, the intoxicated group showed higher performance in the Remote Associates Test (RAT) compared with a control group not receiving any drinks (Jarosz, Colflesh, & Wiley, 2012). These findings were replicated by a placebo-controlled study comparing effects of alcoholic versus nonalcoholic beer (Benedek, Panzierer et al., 2017). Alcohol impaired updating and facilitated RAT performance but did not affect DT performance. Taken together, these findings suggest that moderate alcohol intoxication involves expectancy effects (i.e., feeling more creative) but also pharmacological effects that can support certain forms of creative cognition related to associative flexibility as measured by the RAT. These effects are likely restricted to very moderate forms of alcohol consumption as more excessive forms have been associated with reduced creative output (e.g., Grim, 2008; Ludwig, 1990).

As another experimental approach, cognitive control has been manipulated by means of sleep deprivation. Sleep loss of one night was shown to impair cognitive inhibition and led to reduced word fluency and response novelty (Harrison & Horne, 1998). Similarly, sleep deprivation reduced DT performance (Horne, 1998; Wimmer et al., 1992) and impaired flexible thinking in a simulation game (Harrison & Horne, 1999). Even a minor sleep restriction to five hours' sleep in a preadolescent sample resulted in reduced verbal but not figural DT performance (Randazzo et al. 1998). These sleep deprivation studies provide consistent evidence that reduced cognitive control may impair DT ability. Another interesting study specifically exhausted inhibition abilities by engaging participants in prolonged inhibition tasks (Radel et al., 2015). They observed that decreased inhibition led to increased DT fluency but had no effects on DT flexibility, DT originality, or RAT performance. Together, the findings from experimental attenuations of cognitive control are mixed, suggesting that reduced cognitive control can either impair or foster different aspects of creativity. Effects may depend on the level of induced cognitive impairment and the type of creative performance. Positive effects are likely restricted to mild attenuation of cognitive control and to measures of associative flexibility or idea fluency but have not yet been demonstrated for measures reflecting the quality of ideation (i.e., DT creativity).

Neuroscientific Evidence

Neuroscience research has also contributed valuable insights into the role of cognitive control for creativity. Here, we briefly cover relevant findings obtained using common neuroscientific approaches such as EEG, MRI, and brain stimulation, as well as brain lesion studies. For a general overview of the neuroscience of creativity, see Vartanian, Chapter 8, this volume.

EEG. EEG research early revealed that creativity is associated with increased alpha activity (i.e., brain oscillations in the range of 8–12 Hz) (e.g., Martindale & Hasenfus, 1978; Martindale & Hines, 1975). As EEG alpha activity has traditionally been viewed as an index of cortical idling or deactivation, alpha increases during creative thought were presumed to reflect states of "hypofrontality" and thus reduced control or diffuse attention (Dietrich, 2003; Martindale, 1999). However, more recent interpretations of EEG alpha activity rather consider it as an index of internally directed attention (Cooper et al., 2003; Klimesch, 2012; Palva & Palva, 2007; Ray & Cole, 1985). This active functional interpretation has been ascertained in the context of creativity by showing that frontal EEG alpha activity during DT actually corresponds to increased frontal brain activation (Fink et al., 2009). Moreover, EEG alpha is higher when creative tasks are independent of sensory information or after relevant sensory information was removed, again linking EEG alpha to an internal focus of attention (Benedek et al., 2011; Benedek, Schickel et al., 2014; for reviews, see Fink & Benedek, 2013, 2014).

Creative thinking is a prime example of internally directed cognition (Dixon, Fox, & Christoff, 2014). It relies on imagination and mental simulations (Schacter et al., 2012), which requires sustained internally focused attention in order to shield the ongoing internal stream of thought from irrelevant, potentially distracting external stimulation (Benedek, 2018a; Smallwood & Schooler, 2015). The shutting out of visual input during creative thinking has also been observed at the level of eye behavior: A study by Salvi and colleagues (2015) found that moments of insight to RAT problems are preceded by longer blinks and gazing away from the problem (Salvi et al., 2015). Moreover, during creative idea generation, people tend to blink more frequently, show less visual updating (as assessed by microsaccade activity; Martinez-Conde, Otero-Millan, & Macknik, 2013), and sometimes look through the screen rather than focusing on the problem presented in front of them (Benedek, Stoiser et al., 2017; Walcher, Körner, & Benedek, 2017). Cognitive control thus seems to play an important attentional role for creative thought by supporting sustained attention on internal, self-generated representations.

MRI. Creativity has also been extensively studied by means of MRI. Pertinent research revealed that creative thinking is characterized by brain activation in left-lateralized networks, including the ventrolateral and dorsolateral prefrontal cortex, inferior parietal cortex, and posterior cingulate cortex, which can be attributed to two large-scale brain networks, the cognitive control network (CCN) and the default mode network (DMN; Abraham, 2016; Gonen-Yaacovi et al., 2013; Jung et al., 2013). The CCN is typically involved in cognitive tasks requiring sustained top-down, executive control, whereas the DMN is mainly implicated in self-generated thought, which can be spontaneous as in mind-wandering or goal-directed as in mental navigation (Andrews-Hannah, Smallwood, & Spreng, 2014; K. C. R. Fox et al., 2015; Spreng, Mar, & Kim, 2009). While these two networks often show an anti-correlated activation pattern (M. D. Fox et al., 2005), functional connectivity analyses revealed that they actually exhibit increased functional connectivity during many forms of creative cognition including DT (Beaty et al., 2015), poetry composition (Liu et al., 2015), and piano improvisation (Pinho et al., 2015). Since the CCN is associated with controlled, evaluative processes and the DMN is associated with generative, constructive thinking, this connectivity pattern suggests that generative and evaluative processes cooperate during creative thought (Beaty et al., 2016; Jung et al., 2013; Zabelina & Andrews-Hannah, 2016).

Brain stimulation. Some studies aimed to explore the functional role of cognitive control for creative thought by means of brain stimulation of the prefrontal cortex (PFC). Most of these studies have used the technique of transcranial direct current stimulation (tDCS), which allows researchers to either excite or inhibit brain activation at specific stimulation sites (Santarnecchi et al., 2015). Excitatory tDCS of the left dorsolateral PFC stimulation was found to increase RAT performance in two studies (Cerruti, & Schlaug, 2009; Zmigrod, Colzato, & Hommel, 2015). In contrast, inhibitory tDCS of the left ventrolateral PFC resulted in faster generation of uncommon ideas in the AUT in one study (Chrysikou et al., 2013). Another study found that AUT performance increased with left prefrontal inhibitory tDCS but only if it was combined with right excitatory stimulation (Mayseless & Shamay-Tsoory, 2015). Moreover, focused excitatory tDCS of the left frontopolar PFC was shown to increase semantic distance in verb and analogy generation (Green et al., 2017). These findings suggest that modulation of brain activation in prefrontal regions, which are associated with cognitive control, can affect creativity, but effects seem to depend strongly on tasks and the specific stimulation location (Weinberger, Green, & Chrysikou, 2017).

Brain lesion. Brain lesion studies represent yet another way to study effects of altered brain function in control-related brain regions of the PFC on creativity. Some intriguing single-case studies reported increased creativity after brain lesion (e.g., Seeley et al., 2008). One study found that patients with dorsolateral prefrontal lesions outperformed healthy controls in solving difficult matchstick insight problems (Reverberi et al., 2005). A review of various lesion-induced neurological impairments, however, comes to the conclusion that frontal lobe deficits typically decrease idea generation, although impairments can still be associated with increased creative drive (Flaherty, 2011). Another systematic review of literature concerning artistic creativity and dementia revealed that creativity increased in some patients but only when right prefrontal regions remain intact (Palmiero et al., 2012). Similarly, patients with right-hemispheric lesions involving the medial PFC showed lower DT ability, whereas patients with left-hemispheric lesions including the inferior frontal gyrus showed higher DT ability (Shamay-Tsoory et al., 2011). Finally, Abraham and colleagues (2012) found that frontolateral lesions are associated generally with reduced DT performance and reduced practicality of creative imagery; however, patients with focal frontopolar lesions showed higher ability to overcome salient constraints in idea generation. In sum, brain-lesion studies indicate that compromised function of the frontal cortex is commonly associated with reduced DT ability, although certain focal lesions (e.g., left prefrontal and frontopolar cortex) may also enhance specific aspects of creative cognition.

Summary of Empirical Evidence

The pertinent empirical research provides evidence that cognitive control commonly supports creativity, although creativity may sometimes also benefit from reduced cognitive control. Evidence for the beneficial role of cognitive control comes from individual-differences research showing that intelligence and most executive abilities are consistently related to higher performance in creative thinking tasks. Moreover, DT ability suffers from reduced control after sleep deprivation. In line with these findings, neuroscience research has demonstrated the relevance of the control-related brain network for creative thought. On the other hand, incubation research indicates that creativity increases after breaks, which points to fixation effects caused by controlled task engagement and suggests the relevance of unconscious work. Moreover, mild attenuations of cognitive control as induced by alcohol can increase insight performance. Finally, brain stimulation studies sometimes find that inhibition of control-related brain areas may actually increase certain aspects of creative performance. While these findings appear partially conflicting at first glance, considering them together may help to better understand the mechanisms and conditions underlying the relationship between creativity and cognitive control.

How Does Cognitive Control Affect Creative Cognition?

In order to better understand how cognitive control affects creativity, we first need to consider the role of cognitive control for cognition in general. The function of cognitive control can be described from a dual-process perspective. Dual-process models of cognition assume that cognition relies on two types of thinking processes, which are named Type 1 and Type 2 processes (e.g., Evans, 2008): Type 1 processes are described as automatic, rapid, effortless, nonconscious, and associative in nature, whereas Type 2 processes are controlled, analytic, slow, conscious, and effortful, and are related to working-memory processing (Kahneman, 2011). Since Type 1 processes are automatic, they are always involved, while Type 2

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processes can be additionally recruited to complement or deliberately overrule Type 1 processes (e.g., when we want to inhibit a dominant response). According to the dual-process framework, states of low cognitive control thus are predominantly characterized by Type 1 processes, whereas states of high cognitive control are characterized by the additional presence of Type 2 processes.

Type 1 processes are highly effective for quickly producing associative responses but they run largely undirected. In contrast, Type 2 processes support the effective implementation of conscious goals (Evans & Stanovich, 2013). In states of high control, cognitive resources are fully directed on relevant steps toward goal attainment while potentially interfering processes are inhibited (Barrett, Tugade, & Engle, 2004). This focus of attentional resources on task-relevant processes is beneficial for most cognitive tasks, but not necessarily for all. According to the *matched filter hypothesis* (Chrysikou, Weber, & Thompson-Schill, 2014),

> the optimal level of cognitive control is task-dependent, with high levels of cognitive control best suited to tasks that are explicit, rule-based, verbal or abstract, and can be accomplished given the capacity limits of working memory and with low levels of cognitive control best suited to tasks that are implicit, reward-based, non-verbal or intuitive, and which can be accomplished irrespective of working memory limitations. (p. 341)

In the context of dual-process accounts, this means that the role of cognitive control for specific tasks may depend on the optimal balance between Type 1 and Type 2 processes. How does this relate specifically to creative thinking? We propose that the specific role of cognitive control for creativity crucially depends on the goal-directedness and the complexity of the specific creative activity.

The Role of Goal-Directedness

Creative problems are often considered to be ill-defined. Many creative problems are open-ended and do not have a single solution (e.g., DT tasks). Other creative problems (e.g., insight tasks) have single correct answers but their initial problem representation is misleading and needs to be restructured in order to get to the solution (Gilhooly & Murphy, 2005). Hence, unlike many other cognitive tasks, creative-thinking tasks are not characterized by an obvious analytical strategy. Think-aloud studies have begun to shed light on the various ad hoc strategies involved in creative problem-solving. In DT tasks, like the AUT, people engage in the recall of uses from memory, or generate uses based on specific object properties, or disassemble objects and consider uses for object parts (Gilhooly et al., 2007). Once a certain strategy has been selected, it activates immediate goals on how to proceed. For example, if people engage in the disassembly use strategy, they will scan the object for relevant parts, which may then inspire relevant uses. Think-aloud studies have also revealed certain strategies involved in insight tasks and the RAT (Fleck & Weisberg, 2013; Smith, Huber, & Vul, 2013). This shows that even ill-defined problems can generally be approached in a strategic, goal-directed way after devising a useful cognitive strategy.

Although it may be possible to find useful strategies for most creative tasks, different tasks may still vary in their level of goal-directedness. Let us illustrate this point by considering differences in the cognitive processes involved in the RAT compared with DT tasks. The RAT requires finding a compound associate to three semantically unrelated stimulus words (Mednick, 1962). These tasks are sometimes solved soon after just reading the three cues, and these solutions are often accompanied by subjective experiences of spontaneous insight (Kounios & Beeman, 2014). This is likely the effect of primarily Type 1 processes, where automatic spreading activation related to the three cues reveals an overlap in semantic space (Jung-Beeman, 2005), before Type 2 processes can even come into play. In DT tasks, however, simple Type 1-based solution attempts may not be effective to generate creative ideas. Undirected associative processes will likely result in typical and thus uncreative ideas (e.g., generating typical object uses in the AUT). If the RAT is approached analytically, a common strategy is to make guesses based on one cue and check if it works for the other cues as well – a largely undirected strategy based on trial and error (Smith et al., 2013). Since later guesses are based on initial guesses, inappropriate starting points get people easily stuck in wrong parts of the semantic space, resulting in mental fixation. In contrast, DT tasks can be tackled well with different cognitive strategies, some of which are particularly useful to produce original ideas (Gilhooly et al., 2007). These differences between RAT and DT illustrate that creative thinking tasks may differ considerably in the cognitive demands and specially the role of Type 1 and Type 2 processes.

We conclude that certain creative tasks like the RAT can be viewed as less goal-directed compared with DT tasks, as the former can generally be solved in an associative way based on primarily Type 1 processes and is less amenable to analytical strategies. This might also explain why alcohol studies found that a mild attenuation of cognitive control benefits RAT performance but typically not DT performance (Benedek et al., 2017; Gustafson, 1991; Jarosz et al., 2012) because the attenuation of Type 2 processes leads to a bias toward Type 1 processing, which benefits free associative thinking particularly needed in the RAT. To sum up, all creative tasks are generally assumed to rely on both controlled and spontaneous processes (Beaty et al., 2014) but they may still differ in the level of goal-directedness and thus the optimal level of cognitive control (see Chrysikou et al., 2014). Cognitive control (Type 2 processing) is particularly helpful for implementing explicit goals, while Type 1-based processing is particularly advantageous for fast, parallel associative processing.

In this context, it is interesting to remember that cognitive abilities show a robust positive relationship with virtually all creative thinking tasks. A closer look at the correlation patterns suggests that executive functions show more consistent correlations with quantitative scores of creative potential such as DT fluency and DT flexibility (e.g., Benedek et al., 2012; Pan & Yu, 2018), whereas intelligence appears more strongly related to qualitative aspects reflected in DT originality/creativity (e.g., Jauk et al., 2013). Executive functions such as inhibition and shifting may help to suppress proactive interference and switch to novel domains after exploiting certain parts of the solution space, thereby supporting fluent idea generation over time but not necessarily directly affecting idea quality. In contrast, intelligence may be particularly relevant for selecting and implementing effective task strategies (Beaty & Silvia, 2012; Forthmann, Wilken et al., 2016; Gilhooly et al., 2007; Nusbaum & Silvia, 2011) and for the skilled evaluation of ideas (Benedek et al., 2016; Cropley, 2006), which primarily contributes to idea quality rather than idea quantity. This is consistent with the finding that intelligence predicted idea fluency only up to an IQ of 86, whereas it predicted average idea creativity up to an IQ of 120 (Jauk et al., 2014).

Importantly, studies have never yielded significant negative correlations of creative potential with measures of cognitive control, indicating that executive capacities represent an important cognitive resource for any goal-directed aspects involved in creative thought. The more goal-directed processes are involved in a creative task, the more it should benefit from high cognitive ability; and the more cognitively demanding these processes, the more they may benefit from intelligence. Notably, high cognitive ability does not necessarily imply that higher control is permanently employed, but rather that more effective cognitive control is available when explicit goals need to be implemented. The habitual employment of Type-2 processes is rather indicated by measures of cognitive reflection (Toplak, West, & Stanovich, 2011) or the mode-shift index (Pringle & Sowden, 2017a). First evidence suggests that a moderate (rather than a low or very high) level of cognitive reflection predicts higher DT fluency but is unrelated to rated creativity in DT tasks (Corgnet, Espín, & Hernán-González, 2016).

The Role of Task Complexity and Time

The presented literature suggests that the relevance of cognitive control for creativity may also depend on task complexity. Many creative tasks cannot easily be solved within a minute of conscious effort and thus imply more extended task engagement. Incubation research shows that creative problem-solving can suffer from extended deliberate task engagement (Sio & Ormerod, 2009). One common explanation of this incubation effect is that inappropriate or no longer relevant solution approaches become increasingly salient over time and interfere with subsequent performance (Smith & Blankenship, 1991). While executive functions should generally be helpful to overcome proactive interference and switch to new tasks sets (Miyake et al., 2000), they may become gradually depleted with extended engagement (Radel et al., 2015). This suggests that cognitive control may become increasingly ineffective in the course of extended task performance. At this point, abandoning the task, and thus relieving cognitive control, will help to refresh the mindset and mitigate fixation effects. Breaks in task performance can also give more room to unconscious, Type 1-related work (Ritter & Dijksterhuis, 2014). After we decide to stop active task engagement, we no longer expend Type 2 processes on the task but automatic Type 1 processes can still go on, shifting the overall balance to a Type 1 focus. This may be particularly helpful when we are at a stage in the task that is more effectively solved by Type 1 processes – for example, because it benefits from parallel associative processing or because the relevant information exceeds the narrow limits of working-memory capacity (Chrysikou et al., 2014).

We also need to consider that creative tasks are not fully homogeneous but actually consist of different stages and subtasks that may differ in their optimal level of cognitive control. This point has long been acknowledged in stage models of the creative process, which often involve seemingly more controlled stages such as preparation or verification and less controlled stages such as incubation (Wallas, 1926). More recent process models aim to replace broad stages with increasingly more specified cognitive processes such as strategy selection, retrieval, integration, or evaluation (Benedek, 2018b; Lubart, 2001; Mumford et al., 1991). These specific cognitive models allow one to narrow down the effective operation area of cognitive control. For example, cognitive ability is known to support the selection of effective strategies (Beaty & Silvia, 2012; Gilhooly et al., 2007). We further know that effective cued retrieval is tied to the intelligence facet of broad retrieval ability and cognitive inhibition (Benedek et al., 2012; Silvia et al., 2013, Zabelina et al., 2012; see also McGrew, 2009). It is less clear how cognitive control contributes to the integration process in creative idea generation. Conceptual integration can be viewed as a central associative mechanism (Fauconnier & Turner, 1998), which suggests that integration processes strongly rely on associative Type 1 processes. Finally, the evaluation of creative ideas is viewed as a convergent process that may be associated with intelligence (Benedek et al., 2016; Cropley, 2006).

So far, we have mainly focused on a short-term perspective on creative cognition, as evident in creative thinking tasks such as RAT and DT, but it appears particularly interesting to consider the role of task complexity and time in the context of long-term creative projects. While creative problem-solving tasks used in experimental research typically take a couple of minutes, extended creative work (e.g., writing a piece of music or a book, or developing a scientific theory) can take days, months, or years. In this case, it is even more obvious that the creative work involves many different stages and subtasks, which could be seen as series of small interdependent creative problems, requiring many recurrent stages of generative and evaluative processes (for an illustrative example, see Stevens et al., 2003). Extended creative work is a highly complex task and therefore takes time and likely leads to impasses along the way. This is the kind of creativity that has been associated with the intriguing anecdotes of spontaneous insights in the arts and sciences that inspired incubation research. Spontaneous ideas are very common in artists when working on a creative project (Benedek et al., 2017), but we also know this phenomenon well from personal experience: Our mind wanders to an unsolved problem while we are actually concerned with something else, and we might only become aware of it when we suddenly notice that thoughts have brought us to an unexpected idea. As these thoughts occur unbidden, they reflect a state of low cognitive control, yet they can be highly relevant to creative work. It is exciting to speculate that in the absence of controlled, Type 2 thought, we might be able to witness parts of ongoing Type 1 processes that can only enter conscious attention when it is not occupied with other goal-directed activities (Benedek & Jauk, 2018; Wiggins & Bhattacharya, 2014).

Can we count on spontaneous task-related thoughts? Mind-wandering is often concerned with personally significant events (Singer, 1966). Unsolved problems, on which we have devoted much time and effort without any success, will easily become very significant to us and attract attention (Smallwood, 2013). Moreover, unsolved problems are more accessible for recall than solved problems (Yanif & Meyer, 1987; Zeigarnik, 1927). This implies that effective spontaneous work requires a preceding phase of deliberate work to preactivate relevant concepts and enhance its subjective significance. Since spontaneous thoughts are undirected, they may often reflect irrelevant or inappropriate solutions with respect to a given problem. However, if they happen to be appropriate, they may likely involve more radical novelties than ideas from previous goal-directed deliberations. Once we become aware of potentially relevant ideas, controlled processes may take over to check and elaborate them.

We conclude that the consideration of task complexity and time is important for different reasons: First, cognitive control may become ineffective with time as it establishes and acts within a task set that is increasingly difficult to overcome. Moreover, ongoing engagement of executive control is cognitively demanding and cognitive capacities will deplete with time. Second, extended creative work involves many different steps and tasks, some of which may be more effectively carried out either with high or low cognitive control. Importantly, different stages in the creative process can inform each other and thus particularly benefit from an iterative interplay of controlled and spontaneous processes over time. The significance of this interplay between controlled and spontaneous processes has been long acknowledged by dual-process models of creativity such as the *Geneplore* model (Finke, Ward, & Smith, 1992) or the *Blind Variation Selective Retention* model (Campbell, 1960; Simonton, 2011; for an excellent overview, see Sowden, Pringle, & Gabora, 2014). Future research in this field is challenged to become more precise on what specific executive functions support or hinder certain aspects of creative thought and thus be able to predict the optimal interplay between controlled versus spontaneous processes for different forms of creativity.

Final Conclusions

The available evidence suggests that creative thinking may variably benefit from high versus reduced cognitive control depending on the goal-directedness and complexity of creative tasks. As a rough approximation, we may conclude that working on short, well-defined creative problems (e.g., DT tasks) typically profits from high cognitive control, whereas the benefits of reduced control may unfold in tasks that are hard to approach analytically as well as in extended creative work. From a dual-process perspective, this can be explained with the different strengths of Type 1 versus Type 2 processes. Type 1 processes are fast and not limited by working-memory capacity and thus suited to handle complex information in an associative way. As Type 1 processes occur unsupervised, they will produce many irrelevant results, but the sheer processing power comes with the promise of eventually creating relevant novel associations. Deliberate Type 2 processing is effortful and limited by working-memory capacity but efforts are directed on relevant goals. The consideration of conscious goals will limit the search space in a meaningful way, which comes at the risk however of missing unexpectedly relevant parts (Dietrich &

Haider, 2016). Cognitive control thus will be particularly effective in creative tasks where goals are explicit or can be established reasonably well via ad hoc task strategies. Reduced control can be beneficial for certain cognitive processes and stages (cf. Chrysikou et al., 2014), although it clearly seems inappropriate to claim that creativity generally benefits from reduced cognitive control (see Amer, Campbell, & Hasher, 2016). Some tasks can be well achieved by Type 1 processes (e.g., producing multiple associations) but many can only be achieved by Type 2 processes (e.g., evaluation of ideas with respect to task goals). Since creative tasks are characterized by generative and evaluative stages, they will benefit from both but with a different focus at different stages.

For extended creative work, it may be specifically relevant to adaptively switch between controlled and spontaneous modes of thought and thus employ cognitive control flexibly (Pringle & Sowden, 2017b). Controlled work will activate all relevant information and assign the problem with personal significance. This is the precondition that the problem gets in the focus of spontaneous thought. Spontaneous ideas then can be evaluated and implemented or discarded by subsequent controlled thought. Both modes of thought, thus, are relevant to different phases of the creative process. Creative people seem well aware of the productive power of this temporal dynamic when they organize their daily habits (Currey, 2013) so as to harness the interplay between controlled and spontaneous modes of thought.

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11 Divergent Thinking

Mark A. Runco and Selcuk Acar

Introduction

The scientific study of creativity was sporadic early in the 1900s (Patrick, 1935, 1937, 1941; for a review, see Runco & Jaeger, 2012). Guilford (1950, 1968) gave the field a huge push forward with his ideas about creativity as a natural resource and distinguishing between divergent and convergent thinking (CT). This distinction was one part of Guilford's (1968) *Structure of Intellect* (SOI) model, which contained 180 different kinds of cognition. What really caught on was the definition of divergent thinking (DT), or what Guilford called *divergent production*. This was an enormously attractive idea because it clarified what was (or could be) unique about creative cognition. In addition, Guilford designed reliable tests that could be used for empirical research on the topic. His own statistical methods were justifiably criticized and, as a result, his SOI never drew wide attention. Yet the idea of DT and many of Guilford's tests are still used and cited with regularity today. A fifty-year analysis of Guilford's theory and tests was published in a special issue of the *Creativity Research Journal* (Plucker, 2001).

The theory of DT and the methods used to assess it have changed dramatically over the years. Most notable is the idea that DT is meaningful but not involved in all creative behavior. In short, DT is not synonymous with creativity. This view represents a kind of synthesis. The initial response to Guilford's idea about DT represented a kind of thesis but it went too far and equated DT with creativity. An antithesis emerged when empirical work showed only limited relationships between DT and various indicators of creativity. The synthesis holds that DT is involved in many creative efforts but it really is just an estimate of the potential for creative problem-finding and problem-solving. It is best viewed as an estimate because, like all tests, DT tests sample behavior. They are not comprehensive and they are given under artificial conditions, namely the testing environment. All test settings differ from the natural environment and, as such, generalization is a concern with all tests. As we will see in this chapter, there are ways to ensure generalization from test scores but we will also see that the only reasonable view of DT is that it is sometimes involved in actual creative performances, but not always. Rewording slightly, some kinds of creativity rely, in part, on DT. This chapter supports those claims by reviewing a large portion of the empirical work on DT. This includes research on the predictive, convergent, discriminant, and construct validity of DT. This chapter reviews examples of exactly how DT methods and interpretations have evolved and what limitations and gaps still exist.

Divergent and Convergent Thinking

The earliest debate about DT concerned its relationship with general intelligence. One view was that DT, and all creative thinking, was just a particular kind of general intelligence. An implication of this view is that creativity need not be given any special treatment in schools, in organizations, in the home, or in research. After all, if creativity is just one kind of intelligence, then all anyone needs to do is support intelligence and then creativity will follow along. Guilford's theory provided a method for testing this position. That is because DT is an estimate of the potential for creative thinking and CT is involved in many expressions of general intelligence. Guilford had precise definitions of DT and CT and he developed tests for both. DT, from this perspective, is thinking that explores various directions of thought, whereas CT refers to processes that move toward a single option, or very few. CT is useful when conventional ideas or a particular and correct solution are required. This is typical in the schools and in certain problems faced in the natural environment. If a student is asked what year Neil Armstrong first walked on the moon, there is only one correct answer: 1969. CT is, in this case, useful and adequate.

DT and CT are not mutually exclusive. CT is certainly frequently involved in creative thinking (Cropley, 2006) and newer models of creative process refer to both DT and CT. Eysenck (2003) had them as polarities on one continuum but most often they are thought to occur sequentially (Isaksen & Treffinger, 1985; Parnes, 1992; Puccio, Mance, & Murdock, 2011; Runco & Chand, 1995). This reasoning underlies the method of brainstorming and various efforts to systematically enhance idea quality (Puccio et al., 2018). Brainstorming dictates that judgment (which is probably mostly a matter of CT) is postponed and requires that individuals only think divergently, at least when first faced with a problem.

Cognitive theories do not agree about the actual separation of DT and CT. There is, for example, debate about blind ideational variations and how distinct they are from selections and retention processes (Campbell, 1960; Simonton, 2007; Weisberg & Hass, 2007). Still, training programs assuming a separation have had some success. Scott, Leritz, and Mumford (2004) found that training programs that involve cognitive skills were most effective, and the most often used cognitive component is DT (Fasko, 2001). Smith (1998) analyzed training programs and found that most strategies and techniques were used to support DT. Van de Kamp and colleagues (2015) observed significant changes in flexibility and fluency scores as a result of instructional support for developing meta-cognitive knowledge about DT (see also Wolf & Mieg, 2010).

In sum, DT and CT can be experimentally or psychometrically extricated, with certain controls and instructions, but that may not be how they are typically related and work together in the natural environment. We point this out because one issue running through the DT research reflects this concern over internal (controlled) vs. external validity (i.e., generalizability).

The most common view of how DT and CT are related to one another is that some moderate level of the latter is necessary for the former. Guilford (1968) referred to this relationship as *triangular* theory because scatterplots of DT and CT tend to show exactly that – a triangular distribution. The same idea is also called *Threshold Theory* (Runco & Albert, 1986), which does capture the key idea that some minimal level of intelligence is necessary for all creativity. Jauk and colleagues (2013) investigated the threshold hypothesis and found support for it with DT tasks but not with creative achievement. This is consistent with what Runco and Albert had reported more than twenty years earlier, namely that the relationship of DT and CT depends on the particular instruments used. Most early predictions pointed to an IQ of 120 as the threshold. Karwowski and Gralewski (2013) suggested an IQ of 115 but they used quite conservative criteria. Given the variety of thresholds proposed, the dependence on the measures used, and the inflation of IQ, at least in the United States (Flynn, 1990), it is probably best simply to accept the possibility that DT depends to some degree on CT but to avoid using specific IQ scores as a broadly applicable threshold. A threshold was quite clearly supported by Karwowski and colleagues (2016) in their research using a method perfectly suited to this topic. Indeed, the method is called *Necessary Condition Analysis*.

The variance shared by DT and CT has been attributed to various factors. Preckel, Wermer, and Spinath (2011) found that the relationship between DT and reasoning disappears when mental speed was controlled. Mental speed is one way to get at fluid intelligence, which is the label given to cognition that depends heavily on the efficiency of the individual's nervous system. Sviderskaya (2011) found that the relationship between DT and CT tasks was high and significant when verbal DT and CT tasks were used but not when figural DT and CT tasks were used. The association was also clear in a different study by An, Song, and Carr (2016). They compared several predictors of creativity and creative expert performances and found that general intelligence was related to both DT and creative achievement, whereas personality was more related to DT, and motivation and domain knowledge were related to creative expert performance.

Mood is also related to DT. Chermahini and Hommel (2012), for example, found that DT tends to elicit a positive mood while CT tends to lead to a negative mood. This fits nicely with findings showing that the best way to test DT is in a playful, relaxed, game-like setting. If DT tests are given in test-like and strict conditions, originality suffers (Wallach & Kogan, 1965; Runco, 1999). In fact, in test-like settings, the originality of some students is completely hidden. One explanation for the role of mood involves the breadth of attention and associative breadth, which may be wider when experiencing a positive mood. Yamada and Nagai (2015) noted that positive mood facilitated DT but not CT. There seems to be some bidirectionality in the relationship between mood and DT (see Kaufmann & Vosburg, 2002) and both might be influenced by third variables. Indeed, Campion and Levita (2014) observed increases in both positive mood and DT performance as a result of listening to music and dance.

Neuroscience and Genetics of Divergent Thinking

Neuroscientific investigations also offer insights about how CT and DT differ and overlap. Benedek and colleagues (2011), for instance, observed frontal alpha activity when participants were involved in both divergent and convergent tasks under a top-down control condition, whereas alpha activity on parietal areas of the right hemisphere was specific to DT. Convergent tasks also elicited alpha activity more on the left than right hemisphere. Fink, Schwab, and Papousek (2011) also reported that DT performance was related to higher alpha activity in the prefrontal cortex and the right hemisphere, and Jauk, Benedek, and Neubaer (2012) added that alpha activity was highest when participants were explicitly instructed to find uncommon solutions for DT tasks. Another approach used in recent neuroscientific research examines gray matter in relation to DT. Cousijn and colleagues (2014), for instance, found no relationship between gray matter or cortical thickness and performance on verbal DT tasks but cortical thickness was positively related to performance on visuo-spatial DT.

At this point, there is so much neuroscientific research on DT that reviews are possible (see Vartanian, Chapter 8, this volume). One recent review concluded that

> an increase in noradrenaline levels results in an increase of the signal-to-noise ratio of neurons, the result being reduction of available associations . . . Activation of prefrontal dopaminergic D1-receptors also leads to an increase of the signal-to-noise ratio, whereas dopaminergic D2-receptor activation leads to an unselective arousal . . . In particular, activation of the D2-receptor, giving rise to net decrease of inhibition, allows multiple representations in the prefrontal cortex (PFC) network, whereas D1-receptor activation, leading to net increase of inhibition, allows for keeping of one or a limited number of representations in the network. (Dimkov, 2018)

This is an important set of results, in part because of the connection to DT. Even more clearly,

> the unselective arousal caused by dopaminergic D2-receptors activations allows multiple representations to be held in memory in labile form (a prerequisite for divergent thinking, thus for creativity). In addition, dopaminergic D1- and D2-receptors seem to be functionally antagonistic . . . Dopaminergic D2-receptors are abundant in many regions of the limbic system (the "emotional brain") – especially nucleus accumbens, but almost absent in the prefrontal cortex . . . D1-receptors are found in large quantities in PFC . . . [and] in the limbic system and basal ganglia. (Dimkov, 2018)

Yoruk and Runco (2014) summarized the neuroscientific evidence that specifically involved DT and made the point that "according to current findings, most likely both hemispheres are involved in DT which is accompanied with both event-related increases and decreases in the neural activation. DT is accompanied by high neural activation in the central, temporal, and parietal regions as an indication of semantic processing and re-combination of semantically related information" (p. 1). This is noteworthy because, first, it is contrary to the old view that creativity is entirely a right brain activity. Additionally, it indicates that, although quite a bit of creativity research points to the prefrontal cortex, it too must work with other brain regions, including the central, temporal, and parietal regions. This in turn fits very well with what is the most realistic view of the neuroanatomical research on creativity, namely that creativity is not localized but instead requires systems and networks distributed across brain regions (Dietrich & Kanzo, 2010).

Dopamine was mentioned above and is a key part of the genetic work on DT. Yu, Zhang, and Zhang (2017), Reuter and colleagues (2006), Runco and colleagues (2011), and Murphy and colleagues (2013) all looked specifically to D2 Dopamine Receptor (DRD2), Dopamine Transporter (DAT), and Dopamine Receptor D4 (DRD4), as well as Catechol-OMethyltransferase (COMT) and Tryptophane Hydroxylase (TPH1). As you might expect, given the other lines of evidence that fluency, originality, and flexibility are relatively distinct from one another, the genetic research indicates that different alleles and receptors are related to different aspects of DT. It is complicated, especially given the suggestions that emotional intelligence is also involved (Takeuchi et al., 2015) and given the various methods used. Just to name one example, Chermahini and Hommel (2010) used eye-blinking rate (a marker of dopamine) to explore the relationship between the neurotransmitter dopamine and DT and reported that spontaneous eye-blink rate was related to flexibility but the relationship was curvilinear (an inverted-U), such that flexibility peaked at moderate levels.

In sum, it appears that the prefontal cortex plays a key role in DT, like it does in many expressions of creativity, and that dopamine is relevant, though there are moderators, and it depends a great deal on the DT test used (i.e., verbal or figural) and the index of DT (i.e., fluency, originality, or flexibility). The verbal–figural (or visual-spatial) difference uncovered by the neuroscientific research fits very well with many early theories of DT (e.g., Guilford, 1968; Richardson, 1986; Torrance, 1962) and various findings from outside the neurosciences. Runco and Albert (1985) explained differences in verbal and figural tests, with the latter tending to elicit higher originality scores, in terms of the ease with which people can associate to verbal stimuli, for these are often overlearned. As such they allow rote and therefore common associates, which translates to high fluency but low originality. Figural tests often contain abstract stimuli, and there are no rote associates, so fluency scores are low but originality scores are high. This might suggest that verbal and figural tests can be evaluated by calculating fluency:originality ratios. Indeed, those ratios tend to be smaller in figural tests. Yet ratios should be avoided when the objective of the research is validation, given that ratios are notoriously unreliable (Cohen et al., 2003; Runco et al., 1987). In addition, they are hypothetical: They hide the actual ideational output of each individual by translating raw fluency and originality scores into a standardized composite. More will be said about scoring options for DT in the section on "Psychometrics of Divergent Thinking."

The neuroscientific research on creativity is progressing as fast as any other area of research in the field of creativity and great strides are being made – but there are serious concerns. One concern is that many neuroscientific studies of DT focus on one test (e.g., Uses or Titles) and many only examine one index (e.g., fluency). This seriously limits generalizations; findings will not apply accurately to other tests nor other indices (Runco et al., 2016). Add selective participant sampling to this and you have several reasons why generalizations from the neuroscientific research on DT is frequently unwarranted. Runco (2016) expressed a related concern which can be understood by referring to the distinction used earlier between internal and external validity. Simply put, much of the neuroscientific research on DT is high on internal validity but low in external validity. This is because the research must be conducted in a laboratory, with participants actually inside an fMRI apparatus or in some way wired to equipment. People are not wired to apparatus outside of labs! So what a person does when wired or in the lab may not indicate what occurs in the natural environment. In addition, DT is easily inhibited by the wrong directions, by test-like testing conditions, and by evaluations and judgments. It is a sensitive process and the experimental conditions used for neuroscientific research are often rigid (e.g., timed tests). This may very well preclude results with external validity. Again, what we discover about DT when the individual is in the lab may not tell us much about what the same person can do when he or she is in a relaxed or even playful setting. The neuroscientific research on DT is exciting but it is in its early stages. It needs to be better integrated with the other research on DT. It may be best to view the current neuroscientific research on DT as exploratory and merely descriptive, with very low external validity.

Divergent Thinking, Personality, Attitudes, and Cognitive Style

DT seems to have personality, attitudinal, and thinking style correlates. These are best viewed as correlates because it is not perfectly clear if there is in fact a causal relationship and if personality and so on actually influence DT. Put differently, there is uncertainty that personality and the other extracognitive correlates are necessary. If they are necessary, they would be involved all of the time and, when they were not present, there would be no creativity.

There are two personality traits, and an associated attitude, where enough evidence exists to infer that they are causally and functionally tied to DT and creativity and not just mere correlates. These are openness and flexibility. We will put them into a broad context because the empirical work on personality and DT is extensive. The personality approach is in fact one of the oldest approaches used in studies of creativity (Rhodes, 1961; Runco, 2007; see also Feist, Chapter 17, this volume).

Walker and Jackson (2014) investigated correlations between DT (i.e., fluency and originality) and Big Five traits. Of the five personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism), only openness to experience was significantly related to DT (both fluency and originality). This finding replicated McCrae's (1987). McCrae found a significant relationship between DT and openness as rated by self and peers and with extraversion as rated by self-report. Batey, Chamorro-Premuzic, and Furnham (2009), on the other hand, found a significant relationship between extraversion and fluency but not openness, at least when they used the Uses DT task. This reminds us of the important point that there are differences between various DT tasks. As a matter of fact, Runco and colleagues (2016) found that Uses is not the most reliable measure of DT, even though it may be the most commonly employed. Differences among DT tests are very frequently found (Runco & Albert, 1985; Wallach & Kogan, 1965). These differences have even been used to question the construct validity of DT (Cronbach, 1970). Some variation among DT tests is to be expected, given theories of DT, but it is clear that findings from research relying on any one DT test may very well not generalize to findings from a different DT test. This is particularly true when one test is verbal and one is figural (Runco & Albert, 1985).

Getting back to personality research, Furnham and colleagues (2009) found a positive relationship between DT and extraversion and openness and a negative relationship between DT and neuroticism and agreeableness. Given what was just stated about specific tests, it should be noted that Furnham and colleagues relied on the Consequences test (one of Guilford's). Furnham and colleagues also found positive correlations between DT and extraversion, intuition, and perceiving styles from the Myers–Briggs Type Indicator.

Some of the newer research looks to particular kinds of creative potential. Lee and Dow (2011), for instance, explored the relationship between the Big Five factors and malicious DT (or MDT). Interestingly, openness was not significantly correlated with MDT but conscientiousness was significantly and negatively related to MDT. The connection to conscientiousness is important because there is indeed a surge in research on the dark side of creativity (McLaren, 1993) and creativity in the moral domain (Gruber, 1993; Runco, 1993). Much of this work is reviewed in the present volume (see Cropley & Cropley, Chapter 32). The lack of a relationship with openness is interesting because, as cited above, a correlation with openness is often reported and, indeed, openness is the most common personality correlate across measures of creativity. Openness is also logically connected to DT in that an individual who is open to diverse experiences might be expected to also be open to diverse ideas. Much the same reasoning was used by Runco and Albert (1985) to explain the correlation they found between DT and independence. There again, logic supports a connection, the independent person being likely to appreciate ideas that are original because they are unconventional (and independent of norms or conventions).

Acar and Runco (2015) recently investigated DT and personality using a new approach, based directly on personality theories of creativity. Instead of using the traditional four indices (i.e., fluency, flexibility, originality, elaboration) for DT, Acar and Runco (2015) focused on the literal definition of the term *divergent thinking*, which denotes thinking in different directions. That sounds like an obvious point, but Acar and Runco cited earlier research that defined originality ideation not in terms of divergence but just in terms of statistical infrequency. As they pointed out, in most studies of DT, a person can earn a high score even if they do not actually think divergently! The person can follow one associative pathway until remote ideas are found, and these do tend to be original. Indeed, one of the theories used to support DT early on was that of Mednick (1962) and this is exactly what he proposed – that thinking is a matter of chaining ideas together, one after another, and original ideas are remote and found only after obvious ideas. Original ideas are far removed from the starting point – that is, remote. This idea of remote associates has been supported many times over (Mednick, 1962; Milgram & Rabkin, 1980; Runco, 1986).

Acar and Runco (2015) examined ideation that did in fact depend on divergence. They began by drawing from the literature to identify categories of thought that might be used when solving DT problems. These in turn led to alternative directions of thought that could be explored by the individual who is faced with an open-ended DT task. The entire universe of possible directions of thought was called *cognitive hyperspace.* The idea of hyperspace is based on statistics and physics, where it is feasible to explore one dimension and then a perpendicular dimension. It is also possible to then explore a third dimension that is perpendicular to the first two. At this point we are only describing 3D space. But physicists and statisticians often go beyond the limits of physical space and describe a fourth dimension that is perpendicular (or orthogonal) to the first three, and then another orthogonal dimension, and another, and another. This is hyperspace; it recognizes *n* dimensions, each of which is perpendicular to the others. Acar and Runco reasoned that DT would be truly and literally divergent if it tapped various directions of thought and dimensions of cognitive hyperspace. This is very different from an associative model, where thinking takes a person from one idea, in one direction, to another idea in the same direction, and so on, down one cognitive pathway. For Acar and Runco, superior DT would be apparent in the individual generated ideas by drawing on a large number of the aforementioned conceptual categories. Their work represents a first effort to study cognitive hyperspace as it relates to DT, and they only had thirteen categories of thought. That was enough to test the predictions about literal DT (LiDT) but no doubt there are many more categories and dimensions that might be identified in future research.

The thirteen hyperspace categories were based on previous research that emphasized creative individuals' complex and paradoxical personalities (Barron, 1963; Barron & Harrington, 1981; Csikszentmihalyi, 1996; MacKinnon, 1962; Maslow, 1976; May, 1984; McMullan, 1976; Torrance & Hall, 1980). According to this perspective, creative individuals differ from others in that they are not confused or blocked by opposites or contradictions. Creative individuals are not locked into one perspective and, in fact, they sometimes use polar opposites in their thinking and problem-solving. They may approach a problem from a highly masculine point of few (or, to be more accurate, a point of view that is stereotypically masculine) but at the same time see solutions that are more consistent with a stereotypically feminine point of view. The fact that the stereotype of masculinity and the stereotype of femininity are at odds with one another does not bother or distract them, although onlookers tend to see this tolerance of opposites as paradoxical. For this reason, creative individuals are often described as having paradoxical personalities (Csikszentmihalyi, 1996; McMullan, 1976).

Each of the categories of thought identified by Acar and Runco (2015) represented a dichotomy, with two polar opposites. The original thirteen categories are presented in Table 11.1. Eleven were reliable and were used in the analyses. These recognized both polarities from the eleven dimensions, so there were twenty-two options. Each participant's ideation was coded based on the number of categories used, which was assumed to be indicative of LiDT. Acar and Runco tested the usefulness of LiDT on

Table 11.1 *Hyperspace categories in divergent thinking*

Dimensions	Focus	Description	Relevant Research
1. Originality vs. conventionality	Frequency and novelty	Although originality is key to creative thinking, creative thinkers leverage convergent and evaluative skills as part of their thinking processes.	Basadur (1995); Brophy (1998); Campbell (1960)
2. Amoral, unethical, illegal, and malevolent vs. moral, ethical, legal, & benevolent	Construction	Most people find it easy and appropriate to generate constructive ideas but creative people can go beyond that by considering most destructive options. The "dark" responses help to expand ideational capacity and provide more options.	Cropley, Kaufman, & Cropley (2008); Walczyk, Runco, Tripp, & Smith (2008); Gino and Ariely (2012)
3. Taboo vs. nontaboo	Social approval	Creative people can generate more ideas because they do not limit themselves to socially appropriate and acceptable ideas.	Rawlings & Toogood (1997); Weinstein & Graves (2002)
4. Primary vs. secondary processes	Consciousness	Creative people excel in using and balancing both unconscious (primary) and conscious (secondary) processes.	Dudek & Verreault (1989); Martindale (1973)
5. Experience vs. nonexperience	Memory	Creative people exploit past experiences but they can also use their imagination effectively to go beyond them.	Parnes & Noller (1972); Runco & Acar (2010)
6. Functional and practical vs. impractical, aesthetic, and artistic	Practicality	Superior creativity can be achieved by emphasizing both functionality or practicality and artistic or aesthetic aspects of the outcomes.	Besemer & O'Quin (1999); Bonnardel & Marmèche (2005)

Table 11.1 (*cont.*)

Dimensions	Focus	Description	Relevant Research
7. Synthetic vs. nonsynthetic	Complexity	Creativity can be typically found in simple ideas; but further reaches are possible by combining and synthesizing the ideas or solutions.	Finke, Ward, & Smith (1992); Osborn (1953); Welling (2007)
8. Breadth vs. depth	Nature of the sequentiality	Ideational productivity can benefit both from using many different categories for ideas and from focusing on a single or few categories exploit more and more ideas.	Acar & Runco (2017); Troyer, Moscovitch, & Winocur (1997); Torrance (2008)
9. Feasible, realistic, & possible vs. infeasible, hypothetical, & unrealistic	Workability	Creative people are not confined by feasible solutions under the current circumstances; they take what is yet to be possible into consideration.	Runco (1996); Torrance & Safter (1989); Csikszentmihalyi (1996)
10. Natural vs. unnatural	Objects	Consideration of both natural as well as unnatural, or man-made, things provides more environmental cues for creative thinking.	Ward (1969)
11. Humorous vs. serious and sober	Solemnity	Creative people can find humor even in serious work and they are not all impertinent.	Cundall (2007); Ziv (1976);
12. Playful, childlike, & spontaneous vs. mature & responsible.	Mindset	Creative people can merge adult perspective and maturity with childlike, naïve perspective.	Bruner (1975); Csikszentmihalyi (1996)
13. Close vs. remote	Distance in associations	Creative people can recognize connections among related things but differently than many others they make remote associations when they connections among seemingly irrelevant things.	Acar & Runco (2014); Mednick (1962)

six DT tests and investigated the correlation between LiDT scores and attitudes and values toward creativity. They found a significant and positive correlation ($r = 0.39$). This was just a first step toward operationalizing LiDT and the important contribution is the result of the theoretical reconceptualization of DT as requiring actual divergence.

Psychometrics of Divergent Thinking

The work only summarized operationalized DT in terms of LiDT but, like traditional research on DT, the key is that tests are open-ended and allow numerous associations. This is the defining characteristic of DT and distinguished it from CT (and most academic tests). It does create a challenge. It is easier to evaluate CT tests. The person gives the right answer or does not. Still, there are reliable methods for evaluating DT tests. In fact, one strength of DT tests has always been that they can be objectively scored. Even originality can be objectively scored by calculating the statistical infrequency of any single idea. If very few people give an idea, it is viewed as original. Such originality scoring is sensitive to individual differences, as well. It is not merely dichotomous (e.g., original or unoriginal). Instead, unique ideas can be given a weight representing high originality, and ideas given by few respondents but not entirely unique given a slightly lower weight. After all ideas given by any one person are weighted in this fashion, a total originality score can be easily determined.

This is only one approach and there are others. DT tasks can be scored in a number of ways (Plucker, Qian, & Schmalensee, 2014; Runco et al., 1987). Originality, for example, can be scored in terms of unique ideas, or unusual ideas, or ratings of ideas (Milgram & Milgram, 1976; Runco, Okuda, & Thurston, 1987). Ratings require that judges are employed to score DT tests but judges can and should be avoided. They are not necessary, given that there are reliable and objective methods that do not require ratings, and eliminating judges maximizes objectivity. Scoring DT tests without judges eliminates one large source of error and the need to even consider inter-judge reliability. Details of all possible scoring methods are beyond the scope of the present chapter but we should mention a highly cost-efficient method that uses an individual's entire output rather than scoring on an idea-by-idea basis. Runco and Mraz (1992) found good psychometric properties of this method of "ideational pools," with subsequent support for it offered by Charles and Runco (1993) and Silvia, Martin, and Nusbaum (2009). Charles and Runco also used this method of ideational pools to compare creativity ratings with originality and appropriateness. Why appropriateness? The reason was that creativity is usually defined in terms of originality and effectiveness and one requisite of effectiveness is appropriateness. A creative idea must be original but it must be appropriate, and perhaps even an effective solution to a problem. Runco, Illies, and Eisenman (2005) used an appropriateness score in their work on the enhancement of DT.

Computer Assessments of DT. Technological advances have contributed both to refined scoring methods for DT and to the testing of predictions found in DT theory. Acar and Runco (2014), for example, utilized the sizable lexical and associative networks that are now available online (e.g., WordNet, IdeaFisher, Word Association Network) to examine the associative processes underlying DT. The associative basis of DT has been recognized since the early days of DT testing (Mednick, 1962; Milgram & Rabkin, 1980; Runco, 1986; Wallach & Kogan, 1965), and the newer results are quite consistent with what was predicted early on. In particular, distant associations and ideas found only after some time has passed tend to be, on average, the most original. An important aspect of this methodology was that it involved no judges and thus little subjectivity. Beketayev and Runco (2016) extended this line of work on computerized scoring to include twelve different associative and semantic networks. They also looked specifically at flexibility, the idea here being that semantic networks provide information and the number of associations, which is much like the definition of ideational flexibility when it is a part of DT models and methods. Indeed, the correlation between the computerized flexibility score and the traditional flexibility score was quite high (0.7), indicating that the former could be used in the assessment of DT. This would save an enormous amount of time and effort.

Recall here that judges are sometimes used when scoring DT tests but this introduces unnecessary subjectivity. It is also time-consuming and different groups of judges tend to give different scores, which brings the results into question. When judges are used, they tend to represent homogeneous groups, which means that ratings provided by the judges may not generalize to other judges (Runco, 1989; Runco, McCarthy, & Svensen, 1994). The computer method of DT assessment offers another useful measure that is quite objective, at least in the sense that no judges are needed. Subjectivity is removed from the scoring process.

Acar and Runco (2017) used think-aloud in their work on flexibility. They tested the idea that the time elapsing between the ideas represented useful information about creative cognition. Acar and Runco also explored the possibility that latency would vary between verbal and figural tasks of DT. They found that latency was associated with ideational, semantic shifts. Latencies were 5 seconds longer when the person was shifting from one conceptual category to another. In addition, latency was 2.5 seconds longer for the figural tasks than the verbal tasks. This finding supports the claim that verbal and figural DT tasks trigger somewhat different cognitive processes (Clapham, 2004; Cramond et al., 2005; Richardson, 1986; Runco & Albert, 1985). This work on DT presents a scoring method that can be automatized. It replicated earlier findings and offered some new information (e.g., latencies between ideas) about the processes underlying DT.

Instructions for Divergent Thinking Tests, Types of Tasks, and Time Constraints

Various lines of research summarized herein used explicit instructions with DT tasks, and there is little doubt that the instructions presented to examinees are very important. They have a notable impact on the resulting ideation. There is an interesting debate about instructions. Guilford was clearly on one side of the debate and argued that inexplicit instructions should be used when testing. He felt that this would lead to ideation that was more indicative of what people actually did in the natural environment, which make sense because, in the natural environment, there are no explicit instructions. Thus, test scores resulting from inexplicit instructions should be more indicative and predictive of spontaneous, real-world creativity. Torrance (1966) disagreed with Guilford and argued that people may perform differently when they know what is expected (for more on this debate, see Cramond, 1993). Guilford's reasoning is convincing because it would be best if tests did lead to scores that were predictive of behavior in the natural environment, but Torrance's logic is also sound in that it makes sense to know what people are capable of doing, when they know what is expected of them. If you want to know how fast someone runs you may be misled by merely observing that person when they walk or jog around the block. This debate is actually an extension of one found outside of creativity research, in studies of personality. There the debate was described as pitting maximal performance with typical performance (Cronbach, 1970; Sackett, Zedeck, & Fogli, 1988). Guilford's position is aligned with typical performance approach, whereas Torrance's approach is in line with maximal performance approach. It is also consistent with the ability-related testing of Sackett and colleagues (1988).

The question of what people do spontaneously and what they are capable of is related to basic principles of external and internal validity. Results of tests and findings from research on DT are externally valid if they generalize to the natural environment, which seems to be what interested Guilford and what motivated the development of realistic tests of DT (Okuda, Runco, & Berger, 1991; Runco et al., 2016). Internal validity, on the other hand, requires control and that includes what examinees are told when they receive DT tests. They may be given explicit instructions to ensure that they use particular tactics and strategies or they may be given little information and are free to think in an uncontrolled fashion. Although externally valid results from DT tests are desirable, recall that there is an advantage of control and explicit instructions, namely reliability: People tend to be the most consistent (which translates directly to reliability) when they are behaving at the highest level. Quite a bit of research shows that a person's maximal performance is highly consistent and reliable.

Incidentally, the concern over external validity is not only apparent in the research on explicit instructions. It also motivated the development of realistic tests of DT (Okuda et al., 1991; Runco et al., 2016). Results using these realistic DT tests do support their being more predictive than standard DT tests when the criteria depend on creative behavior as it occurs in the natural environment.

There is no consensus on which type of explicit instructions should be used with DT tasks. Runco and colleagues (2005) described how *conceptual instructions*, which operationally define originality and creativity (e.g., "an idea that is unique, unusual, novel, or rare") may work well for some samples but, for others, especially young children, it may be better to provide *procedural instructions* that describe how to find an original idea (e.g., "think of things that no one else will think of").

Some previous research has used explicit instructions that focus on quantity alone (Katz & Poag, 1979; Runco et al., 2005), while others have targeted creativity

(Harrington, 1975; Johns & Morse, 1997), originality (Lee, Bain, & McCallum, 2007; Runco, Illies, & Reiter-Palmon, 2005), or quality of the ideas (Hong, O'Neil, & Peng, 2016; Lissitz & Willhoft, 1985; Paulus, Kohn, & Arditti, 2011). There is enough research in this area to allow Acar, Runco, & Park (2019) to conduct a meta-analytic investigation to compare the explicit instructions that emphasized quantity instructions with instructions targeting other things, such as originality or quality. They used multilevel analyses and found that the explicit instructions that targeted original, high-quality, or creative ideas made a statistically nonsignificant difference in ideation, compared with quantity-alone instructions. When specific comparisons were conducted between pairs of instructional types, such as creativity with quantity vs. quantity, originality vs. quantity, and quality vs. quantity, Acar and Runco discovered that when creativity and quality instructions were presented along with quantity instructions, there were increases in DT above and beyond what was obtained from quantity instructions alone. Originality and quality instructions alone (no mention of quantity) actually decreased the ideational output. Those findings lead to two conclusions. First, quantity instructions seem to be crucial and should be used in all DT testing. Instructions should say something like, "give as many ideas as you can," along with any mention of quality or creativity. Second, when something is targeted along with quantity, creativity and quality instructions are better than originality.

The impact of instructions on DT outcomes is contingent on the type of DT task (Forthmann et al., 2016; Runco, 1986; Runco et al., 2005). Forthmann and colleagues, for example, found that fluency was higher in standard quantity-based instructions than be-creative instructions when participants responded to a DT task about high-frequency objects. In addition, creativity ratings were higher with be-creative instructions than the standard instructions, at least when the DT task specified low-frequency objective. This was not the case for high-frequency objects. The idea that instructions depend on the type of task is consistent with what was stated about variations among different DT tests (Forthmann et al., 2016) . This is one of the overarching findings: There are notable differences among different DT tests.

Another consideration when testing DT is that of time limitations. A strict interpretation of DT theory suggests that there should be no time limits. That follows from the need for remote associations and the need to communicate to examinees that they can think freely and broadly. In practice, the issue is twofold: Examinees taking DT tests need time or they will not be able to get beyond rote and obvious ideas to more remote associates, but also, when told that they are being timed, examinees may be thinking about "how much time remains" and thus be distracted. It may amount to more than distraction. Being timed may imply that there is an evaluation of some sort, and evaluations and related extrinsic expectations tend to undermine creative thinking. Of course, it can be difficult in some testing environments to avoid timing, in which case time should be de-emphasized and as much time given as is practical. It is best to ask examinees to take their time and then to be generous with how much time they are given. It is inconsistent with DT theory to give them only a brief time period (e.g., 1 minute) or to tell them they are being timed.

Admittedly, there has been research implying that timed DT tests are meaningful but a careful reading of this research indicates what are probably critical mistakes. The research timing DT usually does not compare untimed and unconstrained DT with timed DT. It may compare 1 minute with 2–3 minutes, which is not an adequate comparison. Also, recall that the problem with timing DT is actually twofold. Then there is the fact that this line of research often uses only fluency scores, which ignores the benefits of untimed, unconstrained thought on originality and flexibility. It is originality that is required for all creativity, not fluency (Runco & Jaeger, 2012).

The benefits of untimed DT testing were quite clear in Wallach and Kogan's (1965) seminal investigation comparing *game-like testing* conditions with *test-like conditions*. Wallach and Kogan presented DT tasks as games rather than "tests" because of the negative and anxiety-eliciting nature of the word "test." Any mention of the word "test" may suggest to examinees that they should think in a way that will be appreciated by the examiner and this is likely to lead to CT and to disrupt DT. Wallach and Kogan were quite explicit in their instructions, which stated that the DT tasks were games and not tests. They also told students things like "take your time," "there are no incorrect answers," "the more ideas the better," "spelling does not matter," "there are no grades," and so on, again, to ensure that the DT tasks were not viewed as tests, with correct answers. Wallach and Kogan reported very clear differences between DT and CT but only when game-like instructions were used. Previous research had reported a moderate correlation between DT and CT but this probably resulted from the use of test-like instructions for the DT tests (Getzels & Jackson, 1962).

Hass (2015) investigated the impact of time limitations in a study comparing DT administered online versus in the traditional fashion (in-person). He found that fluency scores were significantly lower in the online testing than in a traditional procedure but originality did not differ in the two administrations. Not surprisingly, a time limitation influenced tasks differently (e.g., Alternative Uses vs. Instances). Although most participants used about 2 minutes in both timed and untimed condition, Hass recommended checking with participants and asking about the need for more time before terminating the testing session. That does assume that examinees can themselves assess whether or not they have gone as far as they could with their own DT but it is certainly better than simply giving examinees only 1–2 minutes. Runco and Albert (1985) told examinees to "take as much time as you want" and actually allows more than 10 minutes per task. This worked well, perhaps because the examinees were school children and they took the idea of games to heart.

Developmental Trends

Some of the ideas above about how to best administer DT tests assumes that examinees are test-wise, which in turn assumes they are of a particular age. Certainly, age is an important factor in DT. In fact, it appears that there are both changes in adulthood and changes in childhood. Simon and Bock (2016) found declines when they compared the DT of older (M = 65 yrs) and younger participants (M = 25 yrs). They compared the aggregate scores that combined fluency, flexibility, originality, and elaboration, a practice that was questioned earlier in this chapter but is consistent with the work of Torrance (1974, 1995). Palmiero, Giacomo, and Passafiume (2014) compared younger ($M = 22$) and older adults ($M = 65$) on verbal and figural DT tasks and found that younger and older adults performed similarly on all DT indices from both verbal and figural tests, with the exception of fluency from the figural DT test on which younger adults were superior to older adults. Massimilano (2015) observed changes between younger and older groups by comparing six 10-year age ranges from 20–29 to 79–80. They found that peak performance is achieved at age forty and does not decline until age seventy. For a review of the literature on changes in DT during adulthood, see Runco (2015).

Kleibeuker, De Dreu, and Crone (2013) compared four young age groups (12–13, 15–16, 18–19, and 25–30) and found no differences on fluency and flexibility. Originality on verbal DT tasks was significantly higher among the oldest group compared with the two youngest groups. Increments on DT with age were more obvious during the early years. Bijvoet-van den Berg and Hoicka (2014) found that age and both fluency and originality from DT tasks were significantly and moderately related. Wallace and Russ (2015) found similar results with children aged 9–14. Runco and Charles (1997) reviewed the literature on age differences in DT during childhood but, of course, they could only include research published before 1997.

Enhancing DT

DT is indicative of the potential for creative thinking and can be assessed in an objective and reliable fashion. It will come as no surprise, then, that quite a bit of research has focused on the enhancement of DT as a step toward enhancing creativity. Even the research on explicit instructions, summarized above (e.g., Harrington, 1975; Runco, 1986), was often justified as helping to answer questions about the best enhancement techniques. The most typical way to support DT is through training that emphasizes tactics that allow the individual to generate numerous potential solutions, embrace wild ideas, and seek novelty. Meta-analyses determined that such training is effective (Scott, Leritz, & Mumford, 2004a, 2004b). On the other hand, the practice and training of ideation per se (Runco et al., 2005) also lead to improvements in DT.

Interestingly, recent neuroscientific research indicated that DT training leads to higher alpha activity in frontal alpha activity (Fink et al., 2006). Moreover, DT training leads to functional changes on dorsal anterior cingulate cortex, dorsal lateral prefrontal cortex, and posterior regions. One specific change was increase on gray matter volume dorsal anterior cingulate cortex after the training (Sun et al., 2016). Kleibeuker and colleagues (2017) also observed changes in prefrontal cortex as a results of DT training. Ideation during DT tasks increased activation on supramarginal, angular, and middle temporal gyrus.

Computers have been used in some of the more recent attempts to enhance DT. Viriyayudhakorn, Kunifuji, and Ogawa (2011) tested the usefulness of four Wikipedia-based DT support engines to facilitate making connections on some DT tasks. They found the related keywords obtained from GETA (Generic Engine for

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Transposable Association) helps making more original associations. Using a similar method called Extenics (Yang & Li, 2012), Ni and colleagues (2014) improved DT outcomes in a way that responses were beyond participants' personal experiences. This is important because DT benefits from experience (Runco & Acar, 2010).

Runco and Acar (2010) investigated the impact of experience on DT by administering Alternate Uses and a problem-generation DT test. After ideas were generated the examinees were asked to indicate the ideas that they experienced personally or socially. Runco and Acar found that experiences explained between 30 and 44 percent of variation in fluency and 65 percent of originality. Those findings are in line with those by Behrens, Ernst, and Shepherd (2014) who found that R&D managers' DT performance increased with experience. It is thus best to recognize that experience plays a role in DT but the magnitude of its impact depends on the individual's level of ability.

If experience plays a role in DT, perhaps an intervention facilitating better use of memory would support DT performance. Indeed, research has demonstrated that episodic specificity induction, which ensures retrieving details of past experiences, promotes DT (Madore, Addis, & Schacter, 2015). More recently, Madore, Jing, and Schacter (2016) reported that this effect was observed in both young and old adults.

The type of experiences also matters, as was implied by the comparison of personal vs. vicarious experiences mentioned (Runco & Acar, 2010). In another demonstration of this Ritter and colleagues (2012) described how active involvement in diverse and unusual experiences improves cognitive flexibility. Damian and Simonton (2014) described much the same but added that diversifying experiences are beneficial for creativity in part because they challenge conventional and routine forms of thinking. Trauma, psychopathology, minority status, cognitive disinhibition, bilingualism, and multiculturalism represent some forms of diversification (see Runco, 1994). Focusing on one of these Shi and colleagues (2012) compared DT performance of migrant, rural, and urban fifth- and sixth-grade Chinese students. They found that migrant children performed significantly better than rural students but poorer than urban students. When migrant children were compared in terms of relocation time frame, mid- and long-term groups performed better than short-term groups. Those findings provide partial support to Damian and Simonton's argument but seem to underscore another factor – the availability of resources, which may be the reason why urban children performed well.

Yi, Plucker, and Guo (2015) showed that performance on verbal DT could be enhanced through exposure to highly creative models who are extremely productive. Exposure to counter-stereotypic examples also increased DT among those who had lower personal need for structure (Goclowska & Crisp, 2013). Schwind and colleagues (2012) found that exposure to dissenting information or information contrary to preferences enhanced DT (see also Jeon, Moon, & French, 2011).

Bilingualism was in the list of diverse experiences given above and is often related to DT. Ricciardelli (1992) reviewed the literature on bilingualism and creativity and found that a strong majority of the findings indicated that bilinguals are more creative than monolinguals. Kharkhurin (2009) looked specifically at DT and found that bilingualism supported the ability to find novel and unique ideas. Hommel and colleagues (2011) felt that the relationship between bilingualism and DT was not a simple one. They reported that less proficient bilinguals performed significantly better on DT fluency than highly proficient bilinguals, whereas the opposite pattern was observed for CT. They argued that bilingual proficiency is related to cognitive control and the effective use of top-down processes, which are more aligned with CT. Kim (2016) tested the prediction that the relationship between creativity and bilingualism could be explained by the fact that each is directly related to cognitive flexibility. She found that cognitive flexibility mediated bilingualism and creativity. It also helped to explain the statistical relationship between creativity and multicultural experience.

Incubation is sometimes manipulated in investigations of enhancement. Hao and colleagues (2015), for example, compared individuals who worked on DT tasks without interruption with those who were in one of three incubation conditions, including positive, negative, and neutral emotional states. They found that originality was indeed higher after incubation and highest in the positive emotion condition. Fluency was unrelated to incubation. Recall here the important point that the distinctiveness of originality from fluency is often demonstrated in experimental research like this, where the two indices react idiosyncratically to manipulations. The same thing is often found in investigations of explicit instructions. If originality depended on fluency, they would both be likely to respond in similar ways to manipulations. They do not.

Gilhooly and colleagues (2012) also examined incubation and DT and reported that the effects are larger when incubation is experienced immediately rather than delayed. Meditation is relevant in part because it can provide an opportunity for incubation. Colzato, Ozturk, and Hommel (2012) found that meditation that is based on open-monitoring (OM) enhanced fluency, originality, and flexibility from a DT test but not elaboration. In a later study, Colzato, Szapora, and Lippelt (2014) found that OM meditation's positive influence occurs regardless of prior experience.

Then there is improvisation as a method for enhancing DT. Lewis and Lovatt (2013) showed that prior verbal and musical improvisation exercises increased DT performance on an Alternate Uses test. Similar effects were found following dance and acting improvisation (Sowden et al., 2015).

Some of the work on the enhancement of DT is experimental, with controls and systematic manipulations. Some is correlational. The results are fairly clear and suggest that DT is influenced by various experiences and can be systematically manipulated by introducing and practicing relevant tactics or by creating a mood or context that supports ideation.

Judgments, Selection, and Evaluation of Ideas

The role of judgment in the creative process was mentioned several times in this chapter. It was mentioned in the discussion of brainstorming, for example, for that method requires that evaluations of ideas are postponed. There are concerns, however, due to the fact that judgments are very difficult to postpone or control in any way. Humans are social animals and often use very subtle nonverbal cues, so even if team members in a brainstorming group do not say something judgmental about an idea, group members are likely to pick up on subtle cues and infer if there is any criticism, even if it goes unstated.

The realistic view is that some judgment is involved in all creative problem-solving. It is good to have original ideas but it is also vital to know which ideas are the most original (and useful). For this reason, the more realistic and comprehensive theories of the creative process include idea evaluation as a stage or component (Basadur, 1994; Cropley, 2006; Runco & Chand, 1995), to go along with idea generation. This is not a new idea, either; Wallas (1926) had a verification stage in his model of the creative process. It followed preparation, incubation, and illumination stages.

Several investigations have examined ideation judgment as part of DT and creativity. One series of studies started in 1990 and used the results from DT tests as targets for judgments and evaluations. Runco and Vega (1990) were concerned about the fourth-grade slump in creativity (Torrance, 1968) and postulated that, when it does indeed occur, one influence may be that children become more conventional in their thinking, in response to parents' and teachers' expectations. This may make them more selective and judgmental. Runco and Vega found that their method for assessing judgments of ideas was reliable. In addition, parents did not differ significantly from teachers in their *evaluative accuracy* when judging ideas given by children. Interestingly, parents with more than one child were more accurate than parents with only one child, which suggests that experience plays a role. Adults recognized that a creative idea is in fact not a popular one, and their own DT was significantly correlated with their evaluative accuracy (Rc = 0.52), indicating the higher one's own DT, the more accurate the judgments of creative ideas. Runco (1991) used the same basic methodology, starting with DT tests, identifying original ideas given by a group of children and then creating a measure of evaluative accuracy from ideas with empirically determined levels of originality. He administered the idea evaluation tasks to 107 children and again found the measures to be reliable (0.77) and, as was the case in the sample of adults just described, correlated with DT (Rc = 0.58). The evaluative accuracy scores were negatively correlated with WISC-R intelligence test scores (−0.24), supporting their discriminant validity. Age was unrelated to evaluative accuracy, which is in a sense contrary to the theory of a fourth-grade slump. The same basic methodology was used yet again by Runco and Smith (1992) but they tested differences between interpersonal evaluative accuracy with intrapersonal evaluative accuracy. They also examined the relationship of evaluative accuracy with critical thinking. This was quite important because evaluative accuracy is a kind of judgment and it could overlap with other kinds of judgments, including those often assessed with tests of critical thinking. Runco and Smith also administered a measure of preference for ideation, from Basadur (1994), the idea being that evaluations might be influenced by the individual's attitudes about originality and ideation. Results indicated that the inter- and intrapersonal evaluative accuracy scores were significantly related to one another (Rc = 0.63), and once again evaluative accuracy was significantly correlated with DT (Rc = 0.45). The latter was, however, only true of intrapersonal accuracy and not interpersonal accuracy. There was a significant correlation between the preference for ideation measure and interpersonal evaluative accuracy (R = 0.31). Runco and Smith also gave percentages to make the accuracies interpretable: Individuals were significantly less accurate when evaluating the popularity rather than the uniqueness of their own ideas, yet they were significantly less accurate when evaluating the uniqueness rather than the popularity of ideas given by others – and all evaluative accuracy percentages were below 50 percent! The correct identification of ideas on the interpersonal evaluation was 42 percent (popular ideas correctly identified as such) and that was the most accurate evaluation. Only 21 percent of the popular ideas were recognized as such in the intrapersonal evaluations. This point should be underscored for it is yet another reason to use objective scoring of DT, as recommended by Guilford (1968), Torrance (1974), and Runco (1991), and to avoid subjective ratings and judges for the scoring of DT. One last thing: Evaluative accuracy scores were unrelated to the critical thinking scores, which is more support for the discriminant validity of the former.

Runco and Basadur (1993) examined the evaluative accuracy of a very different sample, namely managers of businesses. They collected data both before and after a training program that provided information about how ideation works. This kind of training is often highly successful; people who improve their understanding of creativity tend to become better problem solvers, at least according to convincing findings from a meta-analysis on training (Scott, Leritz, & Mumford, 2004a). Runco and Basadur took preference for ideation and "creative problem solving style" (i.e., conceptualizer, generator, optimizer, or implementor) into account as well. Analyses confirmed that the training was effective. Managers gave more accurate evaluations of the originality of ideas after training. Not surprisingly, their DT also improved after training and the style of creative problem-solving moderated training effects.

More recent work has examined idea evaluation under various conditions, including "imminent threats" (Cheng, Baas, & De Dreu, 2018). This experimental condition makes sense, given findings that people have difficulty being creative when they are evaluated or expect evaluations or criticism. Time pressure was also examined, which was justified by the research suggesting that time is an important resource when faced with a problem. As we emphasized above, when suggesting that DT tests be given with generous testing times, it takes time to find creative ideas. Interestingly, Cheng and colleagues examined the usefulness of ideas as well as originality. They found that, when threatened, the participants in the research generated and selected useful instead of original ideas and solutions. Time pressure did not moderate the impact of threats, which was a bit of a surprise. Certainly, more work on idea evaluation should be conducted, given that a realistic view of the creative process must take it into account, as well as DT proper.

Conclusions

The research on DT is extensive and diverse. This chapter covered a representative sample of that research and suggests that DT tests are reliable, though there are differences between the different DT tests and tasks (e.g., verbal vs. figural). DT tests have reasonable predictive validity, often exceeding 0.30 and as high as 0.55. DT can be enhanced with explicit instructions and is associated with diversity of experience and bilingualism. In addition, mood, attitude, and the testing context can all influence DT.

Care must be taken to ensure that such conclusions are not overinterpreted. DT can be reliably assessed with particular tests but DT tests are not tests of creativity per se. They are *estimates of the potential for creative thinking*. You might say that DT is an estimate of the potential for problem-solving but some DT tests are designed to assess *problem-finding* (or more specifically problem-generation) rather than problem-solving per se (Runco, 1994). In addition, given wide variations in the research, it is probably best to refer to fluency, flexibility, and originality when discussing DT, rather than referring to DT more generally. That is because the three indices (and the others that are occasionally brought in, including elaboration and appropriateness or usefulness) are not always highly correlated and show distinctiveness in their reaction to explicit instructions and various experimental manipulations. As a matter of fact, one suggestion is to refer to DT as a measure of ideation and, when originality is included, a measure of the ideation that fuels creative thinking. This is an interesting possibility because ideation is an important process above and beyond its role in creative thinking.

There are ongoing debates, such as the one concerning the use of explicit instructions with DT tests, and related disagreements over what individuals receiving a test of DT should be told. One view suggests that DT tests be given with explicit instructions and another suggests more ambiguous instructions that may lead to more spontaneity. Really, both of these are reasonable views. There may be times to administer DT so maximal performances are ascertained but other times when it might be best to use more general instructions so examinees' spontaneous ideation is understood. There is no controversy over ideational fluency, either. Although a number of investigations have relied on the fluency index alone and do not bother with originality or flexibility or any other index, theory and various lines of research (e.g., using partial correlations, explicit instructions, experimental manipulations, or computer scoring of DT) indicate that the use of fluency alone can be quite misleading. It may make it easier to carry out research if fluency alone is used but the results are not entirely meaningful.

Discussions of which DT indices are required is related to the question of construct validity. One simplistic view is that all tests of DT, and all DT indices, should be highly correlated with one another. This makes no sense; theory does not predict one solitary simple DT construct. Instead, the construct of DT is multifaceted. It may vary, for example, depending on how much the stimulus relates to experience or actual objects. Various stimuli (e.g., figural, graphic, visual, verbal, acoustic) are likely to tap different cognitive and neuroanatomic processes and allow experience or bottom-up processes to play more or less of a role. There are reasons to expect that not all tests will elicit ideas that suggest one underlying construct. As a matter of fact, Barbot (2018) is probably on the right track with his method for taking variations among DT tests and items into account, they key idea being that variation is itself a meaningful source of information.

The sizable corpus of research on DT means that many applications and ideas have been tested, and some retested, but there is a downside. It may be difficult to keep up with or ensure that literature searches uncover all relevant previous studies. Even the present chapter, with its focus on DT, did not cover all research and did not go into all influences, scoring options, and supporting research. Care must also be taken, then, when doing research on the topic. It may not be adequate to merely search the past few years of research on DT, at least if any new research is to do more than reinvent the wheel. This recommendation about including older research in background searches is offered because it is quite clear that studies of creativity should continue to look to DT, both as a reasonable model of one kind of creative cognition and as one useful estimate of the potential for creative ideation.

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Affective Underpinnings of Creativity

12 In the Mood for Creativity

Matthijs Baas

According to a survey among managers, entrepreneurs, and undergraduate students, a relaxed mood is one of the best stimulants of creativity (Baas et al., 2015). Yet, when asked about the typical creative person, a picture of blue and troubled artists, including novelist Virginia Woolf, painter Mark Rothko, and musician Kurt Cobain, readily comes to mind. Isn't creativity, then, more strongly associated with a sad and depressed mood? Oftentimes, people feel that an original joke or a creative solution comes easier when feeling happy and cheerful (Baas et al., 2015). Other times, people trace back their creative ideas to upsetting, fearful, or angering events. For instance, Nobel Prize laureate Max Perutz commented on his experiment that proved the alpha-helix structure: "The idea was sparked off by my fury over having missed that beautiful structure myself" (Ferry, 2007, p. 148).

These observations all suggest that mood influences our creative capacity. Yet they also seem to contradict each other. It is hard to believe that creativity is equally facilitated by opposing mood states, by calm as well as upsetting moods, and by happy as well as sad moods. This begs the question as to which observations are right: Which moods do or do not promote creative insight and original thinking? Unfortunately, the empirical evidence on the mood–creativity link does not help to solve the puzzle. Although mood stands out as one of the most widely studied predictors of creativity, the existing research on the mood–creativity relationship shows many inconsistent findings (Baas, De Dreu, & Nijstad, 2008; Davis, 2009). This is unfortunate given that naturally fluctuating moods may have a profound influence on creativity (Silvia et al., 2014; To et al., 2012). Once we understand how mood relates to creativity, we may actively seek the right circumstances that put us in a creativity-enhancing mood. For instance, if we learn that a happy mood fosters creativity, people can listen to upbeat music. If, on the other hand, we discover that a calm and relaxed mood state stimulates creativity, organizations may decide to build relaxation rooms to stimulate their employees' creative thinking. In addition, mood often serves as an intermediary state between a host of situational and personality predictors on the one hand and creative performance on the other (Baas et al., 2008). Thus, we may infer from the ways in which leadership influences employee mood, how leadership relates to employee creativity (Rego et al., 2014); and from the ways in which stressing factors influence people's moods, we may infer how these stressors relate to creativity (Byron, Khazanchi, & Nazarian, 2010).

In this chapter, I discuss recent empirical evidence on the mood–creativity link to better understand which mood states help or hinder creativity. It will become clear that people are not more creative when they are relieved, relaxed, sad, or depressed. Instead, I will argue that mood states that activate the individual promote creativity – these include happiness, anger, and, under the right circumstances, fear. I continue with a discussion of the potential mechanisms that explain *why* mood affects creativity and examine moderators that determine *when* mood affects creativity. I end this chapter with practical implications and new developments in mood–creativity research. But first, let me explain what I am talking about when I talk about mood and how the mood–creativity link is typically researched (for further information on definitions and measurement of creativity, see Kaufman & Glăveanu, Chapter 2, this volume, and Plucker, Makel, & Qian, Chapter 3, this volume).

Mood–Creativity Research

Affect, mood, and emotion all refer to emotional phenomena and are often, but incorrectly, used interchangeably. *Affect* is an umbrella term, referring to subjective feeling states that include long-lasting moods, such as cheerfulness or depressive mood, as well as more specific ones, such as anger or awe (Frijda, 1993). Mood and emotion are subtypes of affect, with emotions being more strongly directed toward a specific stimulus – be it a person, an object, or an event (Frijda, 1993). For example, someone is angry because a traffic jam frustrates the goal of attending a best friend's wedding. This quality of object-directedness is lacking in moods: People in an angry mood are just generally grumpy and not necessarily angry about anything or anyone in particular. Compared with emotions, moods also tend to be relatively enduring and less intense (Frijda, 1993; Roseman, Wiest, & Swartz, 1994).

The mood–creativity link has been studied with, roughly, three different research approaches. In experimental work, participants are typically put into an intended mood state (e.g., they watch a sad movie clip to become relatively sad, they receive an unexpected bag of candy to put them in a happy mood, or they imagine and reexperience an event that made them angry), after which they complete a standardized creativity task. For instance, they generate as many alternative brick uses as possible (Friedman, Förster, & Denzler, 2007) or think of a way to attach a candle to a wall, with a box of tacks and a book of matches, in such a way that it will burn without dripping wax on the floor (i.e., the classic Duncker Candle task; Greene & Noice, 1988). In cross-sectional studies, specific self-reported mood states (e.g., happy, relaxed, fearful mood) are correlated with performance on standardized creativity tasks or self-reported creativity levels. Finally, in longitudinal studies, both creativity and mood are repeatedly measured over the course of several days or weeks, and fluctuating levels of mood and creativity are related to identify meaningful patterns.

In early studies on the mood–creativity link, effects were interpreted in terms of a mood state's valence. In this work, the general consensus was that positive moods are associated with enhanced creativity (e.g., Ashby, Isen, & Turken, 1999;

Grawitch, Munz, & Kramer, 2003; Lyubomirsky, King, & Diener, 2005). However, this positive association was not always observed (e.g., Akinola & Mendes, 2008; Baas et al., 2008; Kaufmann, 2003). In addition, no conclusions could be drawn for the effects of negative mood states, with some studies finding negative effects, others finding no effects, and still others finding positive effects on creativity (e.g., Ashby et al., 1999; Kaufmann, 2003). In more recent work on the mood–creativity link, researchers build on the notion that specific mood states differ not only in valence, but also in terms of two other dimensions that have been linked to creativity: activation level and motivational orientation (Baas et al., 2008; De Dreu, Baas, & Nijstad, 2008; Gasper & Middlewood, 2014). Activation level refers to the increased engagement of basic motivational systems to mobilize energy to sustain attention and effort toward goal-related activities (Baas, De Dreu, & Nijstad, 2011a; Posner, Russell, & Peterson, 2005). The specific mood states happiness, cheerfulness, anger, and fear are all activating moods, whereas relief, sadness, and being relaxed are examples of deactivating moods.

Motivational orientation is another mood dimension. In an approach orientation, the individual is focused on regulating aspired goals and positive outcomes, whereas, in an avoidance orientation, the individual is focused on regulating aversive stimulation and negative outcomes (Baas et al., 2011a; Carver, 2004; Idson, Liberman, & Higgins, 2000). The specific mood states happiness, cheerfulness, and relief are all positive moods, but whereas happiness and cheerfulness share an approach orientation, relief is associated with an avoidance orientation; likewise, anger, boredom, and fear are all negative, but anger and boredom are associated with an approach orientation, whereas fear is associated with an avoidance orientation (Baas et al., 2011a; Idson et al., 2000). Because specific moods differ in terms of multiple dimensions that have been linked to creativity, a more fruitful approach to understand the relation between mood and creativity is to examine effects of specific moods. This is precisely what I will do in the next paragraphs.

Specific Positive Moods and Creativity

Happy moods. The majority of studies on the relation between positive mood and creativity examined the effects of happiness (Baas et al., 2008). Meta-analyses of the relation between happy moods and creativity show that a happy mood is associated with enhanced creativity (Baas et al., 2008; Lyubomirsky et al., 2005). This robust effect was observed in experimental work in which participants completed creativity tasks following the induction of happy moods (e.g., De Dreu et al., 2008; Hirt, Devers, & McCrea, 2008; Gilet & Jallais, 2011) as well as field studies in which fluctuating levels of self-reported happiness were related to everyday acts of creativity and creative work behavior (Conner & Silvia, 2015; Madrid et al., 2014; Silvia et al., 2014; To et al., 2012; To, Fisher, & Ashkanasy, 2015). This makes happiness the most robust predictor of creativity of all mood states. A reasonable question to ask would be, then, how strong the effect of happiness is on creativity? With a limited 3 percent of the variance explained, the relationship is small (Baas et al., 2008).

Relaxed and relieved moods. A small number of studies examined the effects on creativity of a number of deactivating and avoidance-related positive moods, including relaxed, calm, and relieved moods. Experiments show that compared with happy moods, being in a relaxed, serene, or relieved mood reduces people's creativity (Baas et al., 2011a; De Dreu et al., 2008; Gasper & Middlewood, 2014; Gilet & Jallais, 2011). In field studies, the relationship between self-reported mood and creativity was much weaker for calmness and relaxation than for happy and elated moods (Conner & Silvia, 2015). Moreover, the majority of studies in which self-reported mood was correlated with creativity showed that relaxed and serene moods did not associate with more or less creativity (Baas et al., 2008; De Dreu et al., 2008; Madrid et al., 2014) and some studies even observed a negative association (To et al., 2012). From the findings of these studies, we can conclude that people's creativity is largely unaffected by a relaxed, calm, or relieved mood state. Clearly, these results show that the widely held belief that a relaxed mood promotes creativity is incorrect (cf. Baas et al., 2015).

Specific Negative Moods and Creativity

Sadness. The majority of studies on the relation between negative mood and creativity examined the effects of sadness (Baas et al., 2008) and depressive mood (Baas et al., 2016). A meta-analysis of the relation between sad moods and creativity shows that sadness is not associated with more or less creativity (Baas et al., 2008). This lack of relationship holds for experimental work in which sad moods were induced (e.g., De Dreu et al., 2008; Gasper & Middlewood, 2014; Gilet & Jallais, 2011) as well as for cross-sectional studies in which fluctuating levels of self-reported sadness or depressive mood were examined in relation to everyday creativity (Baas et al., 2016; Conner & Silvia, 2015; De Dreu et al., 2008; Madrid et al., 2014; Silvia et al., 2014). Thus, the belief that a sad and troubled mood is required for creativity seems to be incorrect as well.

Anger. An increasing number of studies has examined the effects of anger on creativity. Experiments show that compared with mood-neutral control conditions, as well as induced sad and relaxed moods, induced angry moods promoted people's creativity (Baas, De Dreu, & Nijstad, 2011b; De Dreu et al., 2008; Gilet & Jallais, 2011; Yang & Hung, 2015). Studies that examined the relationship between self-reported negative activating moods (measured with items tapping into anger and frustration as well as anxiety and distress) and creativity showed that these moods were positively associated with creativity (De Dreu et al., 2008; To et al., 2012), but null-findings have been obtained as well (Madrid et al., 2014; Silvia et al., 2014). Moreover, although anger seems to boost creativity early on, its stimulating effect wears off over time with creative productivity declining faster in angry people than in those with sad or neutral moods (Baas et al., 2011b).

Anxiety, fear, and distress. Many studies have examined the effects on creativity of several negative, activating, and avoidance-related moods that include anxiety, fear, and distress. A meta-analysis of the relation between self-reported trait and state anxiety with creativity shows that both state and trait anxiety were associated with lowered levels of creativity (Byron & Khazanchi, 2011). This is especially the case when creativity was assessed with creativity tasks that rely on people's ability to think in a flexible and divergent way (Baas et al., 2008). One note of caution here is that trait and state anxiety are measured with items that capture anxious feelings (e.g., "I feel nervous") as well as items that focus on people's low self-esteem ("I lack confidence"). In interpreting these meta-analytic findings, the reader should know that self-esteem is not a component of mood and is an important predictor of creativity in and of itself (Liu et al., 2016).

Other findings regarding the link between anxiety, fear, and distress with creativity are less consistent. As said before, studies show that self-reported negative activating moods (including anxiety and distress) were positively associated with creativity (De Dreu et al., 2008; To et al., 2012), but null-findings have been obtained as well (Madrid et al., 2014; Silvia et al., 2014). Moreover, experiments show that compared with mood-neutral control conditions as well as induced relaxed and relieved moods, induced fearful moods enhanced people's creativity (Akinola & Mendes, 2008; Baas et al., 2011a; De Dreu et al., 2008; but see Gasper & Middlewood, 2014). To resolve these puzzling findings, some studies have looked at potential moderators that influence the link between anxious and fearful moods and creativity. For instance, induced fearful moods led to more creativity, but only if people's personality traits were consistent with the fearful moods that were induced (i.e., when they scored high on neuroticism; Leung et al., 2014). In addition, negative activating moods, including fear and anxiety, were associated with enhanced creativity when people had a stronger learning orientation, the willingness to master challenging tasks and develop competence by overcoming setbacks (To, Fisher, & Ashkanasy, 2015). These moods were also associated with enhanced creativity when followed by the experience of activating positive moods (Bledow, Rosing, & Frese, 2013) or if performance on the creativity task was facilitated by the convergent and effortful thinking that is prompted by fearful moods (Chermahini & Hommel, 2010; De Dreu et al., 2008).

Boredom. Boredom has only recently been studied by creativity researchers. A pioneering experiment by Gasper and Middlewood (2014) shows that compared with induced relaxed and fearful moods, induced boredom increased people's performance on a subsequent creativity task. Possibly, performing the creativity task provided bored participants with the means to relieve them from their boredom. Importantly, when people are bored with the creativity task itself, feelings of boredom may actually be associated with reduced creativity (Haager, Kuhbandner, & Pekrun, 2016).

Mechanisms and Moderators

By and large, findings show that creativity is promoted by happy, cheerful, and angry moods, and by boredom as well, although additional research is required to verify the robustness of this latter effect. Being calm, relaxed, relieved, or sad has little effect on creativity. Findings regarding anxious, distressed, and fearful moods are less consistent. Although trait and state anxiety are associated with lowered creativity, induced fearful moods seem to lead to higher levels of creativity for some people and under the right circumstances.

In this section, I turn to the question as to *why* some moods promote creativity and others do not. In early work on the mood–creativity relation, it was proposed that a mood state's valence determines the effect of mood on creativity (Ashby et al., 1999; Grawitch et al., 2003). According to this perspective, positive moods lead to higher creativity than negative or neutral moods because positive moods signal a satisfactory and safe state of affairs, which increases the willingness to explore novel strategies and outcomes (Fiedler, 1988), broadens and expands the scope of attention (Friedman & Förster, 2010), and enhances people's ability to think flexibly and connect and integrate a wide variety of information (Isen, 2000). However, because the empirical evidence shows that relaxed moods do not associate with more or less creativity, an interpretation of mood–creativity findings purely in terms of a mood state's valence is difficult to maintain.

Instead, only activating positive moods, such as happiness and cheerfulness, seem to promote creativity. The empirical evidence also shows that creativity is enhanced by other mood states that activate the individual, including anger and, under the right circumstances, fear and anxiety. This is in line with the proposition that a mood state's activation level determines the level of creativity (De Dreu et al., 2008). According to this perspective, creativity is a function of various cognitive functions, including flexible processing of information, task engagement, working memory capacity, and persistence, with all these functions requiring moderately high levels of activation and arousal (e.g., Baas et al., 2011a; Brehm & Self, 1989; Broadbent, 1972; Robbins, 1984). From this, it also follows that deactivating moods (e.g., relief, sadness, boredom, being relaxed) are not associated with more or less creativity. Indeed, the findings discussed in the previous section show that relaxed, calm, relieved, and sad moods and on-task boredom have minor effects on creativity. The one exception was that pretask boredom led to increased creativity (Gasper & Middlewood, 2014). Possibly, people who were initially bored were particularly activated by performing the relatively fun creativity task, which relieved them from their boredom.

The level of activation may determine the level of creativity but, interestingly, other aspects of mood appear to determine *how* these creativity-enhancing effects come about. The positive moods of happiness and cheerfulness stimulate creativity mainly through increased cognitive flexibility (De Dreu et al., 2008). This is because these moods are activating and, importantly, additionally signal a satisfactory and safe state of affairs. This, in turn, increases people's willingness to explore novel possibilities and consider and integrate different perspectives during problem-solving (De Dreu et al., 2008). Indeed, participants in happy moods tend to examine many different conceptual categories during idea generation (i.e., flexibility; De Dreu et al., 2008). For example, when generating alternative ways to improve education at the university, happy individuals tend to generate ideas in many different categories (e.g., focusing not only on ways to improve teaching but also on ways to improve infrastructure, legislation). At the neural level, this effect may be explained by increased dopamine levels in the brain, and the striatum in particular: Happy mood induction is associated with increased dopamine release in the brain, which improves the selection of, and the switching among, alternative cognitive sets (Ashby et al., 1999; Boot et al., 2017; Chermahini & Hommel, 2010). According to a different perspective by Hirt and colleagues (2008), happy people want to maintain their positive mood and strategically set out to generate many alternative responses to make a creativity task more interesting and fun, thereby sustaining or even enhancing their happy mood state.

Whereas activating positive moods stimulate creativity mainly through increased cognitive flexibility, De Dreu and colleagues (2008) proposed that the activating negative moods anger, fear, and anxiety stimulate creativity mainly through increased cognitive persistence – the extent to which the individual focuses attention and effort on the task at hand. This is because these moods are activating and additionally signal a problematic and insufficient state of affairs (Schwarz & Clore, 1996). To facilitate the improvement of this problematic situation, negative moods trigger systematic, constrained, and analytical information processing (Ambady & Gray, 2002; Schwarz & Clore, 1996) and such narrowed processing reduces distractibility while promoting focused attention and task engagement (De Dreu et al., 2008; Dreisbach & Goschke, 2004). Thus, whereas negative activating moods, such as fear and anxiety, may lead to reduced cognitive flexibility (e.g., Baas et al., 2008; Friedman & Förster, 2010), they also lead to enhanced creativity through the exploration of a few conceptual categories in greater depth during idea generation (i.e., persistence; De Dreu et al., 2008). For example, when generating alternative ways to improve education at the university, individuals in angry and fearful moods tend to generate many ideas within only a few categories (e.g., focusing only on ways to improve teaching) and ignore other potential angles on the problem topic (e.g., ways to improve infrastructure, legislation).

It thus appears that activating positive moods promote creativity primarily through enhanced flexibility, whereas activating negative moods promote creativity primarily through enhanced persistence. However, other work has shown more flexible switching between conceptual categories among angry individuals than among those in sad and fearful moods or mood-neutral conditions (Baas et al., 2011b, 2012). Moreover, bored individuals tended to be more associative in their thinking than those feeling fearful and relieved (Gasper & Middlewood, 2014). In addition to valence (positive vs. negative) and activation (activating vs. deactivating) as critical dimensions underlying the effects of specific mood states on flexibility, persistence, and creativity, we may thus need another dimension to more fully grasp the effects of mood on the creative process: approach versus avoidance orientation (Baas et al., 2008, 2011a; Gasper & Middlewood, 2014).

Approach-related traits and states associate with a broad attentional focus and promote creativity primarily because of enhanced flexibility (Friedman & Förster, 2010; Roskes, De Dreu, & Nijstad, 2012). In contrast, avoidance-related traits and states associate with creativity primarily through cognitive persistence (Nijstad et al., 2010; Roskes et al., 2012). Indeed, happiness, an approach-related mood state, is associated with increased levels of creativity and flexibility and this also seems to be the case for other mood states that are associated with an approach orientation, such as cheerfulness, anger, and boredom. Fear, an avoidance-oriented mood state, is negatively related to performance on creativity measures that rely on cognitive flexibility (Baas et al., 2008). However, under the right circumstances, a fearful mood is associated with enhanced creativity (Akinola & Mendes, 2008; Baas et al., 2011a; Bledow et al., 2013; De Dreu et al., 2008; Leung et al., 2014; To et al., 2015), mainly through persistence (De Dreu et al., 2008). Although the evidence is not conclusive, it thus appears that a combination of activation and motivational orientation may best explain mood effects on creative processes and performance.

Mood as input. That motivation plays a crucial role in the mood–creativity link also follows from the mood-as-input and related accounts (Martin & Clore, 2001). According to these accounts, the motivational implications of moods vary as a function of the situation. Negative moods signal a problematic state of affairs and this motivates people to solve problems or to invest more effort in order to meet performance standards; positive moods signal a satisfactory and benign state of affairs and this motivates people to seek stimulation and pursue incentives (Friedman et al., 2007). By implication, positive moods, relative to negative moods, should facilitate creativity on tasks viewed as "fun" and in situations in which the enjoyment of a task is being emphasized. In contrast, negative moods, relative to positive moods, should enhance effort on tasks viewed as "serious" and "important" and in contexts in which the focus is on meeting performance standards. Indeed, a meta-analysis shows that the mood–creativity link is moderated by task framing: Positive moods led to more creativity on a creativity task when the task was framed as enjoyable and intrinsically rewarding and to less creativity when the task was framed as serious and when performance standards were emphasized (Baas et al., 2008).

Other moderators. In the previous paragraph, I discussed how task frames moderate mood effects. Other moderators were also mentioned in passing. For instance, fearful moods led to more creativity but only in people scoring high on neuroticism (Leung et al., 2014). In addition, negative activating moods, including anger, fear, and anxiety, were associated with enhanced creativity when people had a stronger learning orientation (To et al., 2015) and when these negative moods were followed by the experience of a happy mood (Bledow et al., 2013).

Whether performance on a creativity task is facilitated by systematic and persistent thinking or by flexible thinking is another important moderator (Chermahini & Hommel, 2010; De Dreu et al., 2008). Whereas fearful moods may reduce creativity if performance on the creativity task requires flexible thinking (Baas et al., 2008), they may be associated with enhanced creativity if performance on the creativity task requires convergent and effortful thinking (De Dreu et al., 2008). Likewise, happy, and perhaps also angry, moods may be associated with enhanced creativity if performance on the creativity task is facilitated by flexible thinking. Evidence for this possibility comes from a study by De Dreu, Nijstad, and Baas (2011) that examined the effects of the personality trait behavioral activation, the tendency to engage in goal-directed efforts and to experience cheerful feelings when being exposed to cues of impending reward (Carver & White, 1994). People scoring high on this trait are more approach-oriented and tend to experience more joy and happiness in general, as well as anger when goal progress is frustrated (Carver & Harmon-Jones, 2009; Elliot & Thrash, 2002). Importantly, these people were more flexible and creative but only when the creativity task they were working on afforded flexible thinking (De Dreu et al., 2011). For instance, behavioral activation was positively associated with creative ideation when people worked on an idea generation task about a broad and encompassing topic (improving education at the university) but not when they worked or a narrow topic (improving classroom teaching at the university). Only the broad topic calls for the accessibility and use of many perspectives and conceptual categories (i.e., flexibility of thought). Likewise, happy people may be more original and flexible during idea generation but only when they work on an idea generation task about a broad and encompassing topic that affords flexible thinking.

Another likely moderator is emotional intelligence – the ability to effectively control and alter one's affective state, as well as intentionally harness and use affective states and information to meet situational requirements (Mayer, Caruso, & Salovey, 1999). Indeed, people scoring high on emotional intelligence maintained higher levels of excited and enthusiastic moods during situations in which creativity was required and used their moods to think flexibly and enhance their creativity (Parke, Seo, & Sherf, 2015). Higher levels of emotional intelligence may also enable individuals to manage and use the negative moods that are triggered by adversity or by negative feedback on their creative work, thereby improving their creativity (Forgeard, 2013; Zhou, 2008). The control and use of moods for beneficial effects on creativity may also be obtained by mindfulness training (Baas, Nevicka, & Ten Velden, 2014; Ding et al., 2015).

Practical Implications

How can the findings of mood–creativity research help managers, teachers, and parents boost creativity in their employees, pupils, and children? Although it is widely believed that all positive moods boost creativity (Baas et al., 2015), the empirical evidence shows that only activating positive moods, such as happiness and joy, stimulate creativity and that creativity is not affected by a relaxed and calm mood. At the same time, many companies that are undeniably creative, such as Google, do have relaxation rooms where employees can sometimes literately doze off in a bathtub. How to reconcile this anecdotal evidence with the robust finding that a relaxed mood does not seem to affect creativity? Quite possibly, other mechanisms than mood can explain why relaxation rooms may foster creativity. A relaxation room is a clear manifestation of a company culture in which things are done differently and creativity is highly valued. In turn, a creative culture and climate can positively influence employee creativity (Amabile, 1996). Relaxation rooms may also contribute to a more pleasant work environment. This may increase the likelihood that employees are more engaged with work and spend more time at the workplace, leading to more creativity as a side effect (Amabile, 1996). In addition, there is a curvilinear relationship between stress and creativity, with decreasing levels of creativity when stress levels become increasingly intense (Byron et al., 2010). Spending a few moments relaxing may bring stress down to a more optimal level. Finally, people may have a creative insight for an unsolved problem after the problem is put aside during a visit to the relaxation room (Sio & Ormerod, 2009). However, creative insights and reduced stress levels may also be facilitated by simply walking (Oppezzo & Schwartz, 2014) or meditating (Baas et al., 2014), which represent equally, if not more, effective ways to boost creativity that are much cheaper than expensive relaxation rooms.

Of all moods, happiness and cheerfulness are the most robust facilitators of creativity and yet only 3 percent of the variance in creativity can be explained by varying levels of happiness (Baas et al., 2008). This amount of variance explained by happy moods only slightly increases when people work on tasks that are framed as funny (as opposed to serious) and when task enjoyment is emphasized (Baas et al., 2008). Thus, from an applied perspective, one may wonder whether targeting happy (or other) moods is the most effective way to go when seeking the right circumstances to boost creative performance. At this point, it is good to realize that creative outcomes are unlikely the result from one critical factor. There are many factors that contribute to creativity in an additive fashion. These include expertise, intelligence, motivation, organizational climate, and leadership (see Sternberg & Kaufman, this volume; Hennessey, Chapter 18, this volume; Reiter-Palmon, Mitchell, & Royston, Chapter 24, this volume; and Mumford, Martin, Elliott, & McIntosh, Chapter 25, this volume). If creativity is desired, people can increase their chances of being creative by shaping the ideal circumstances and this includes putting oneself in the right mood, whether it is happiness, anger, boredom, or fear.

Future Directions

In this final section, I discuss some exciting developments in mood–creativity research. The first pertains to how mood affects group creativity. Although mood affects group climate and conflict, and information processing and sharing, research on the relation between mood and creativity in groups is scarce. In a pioneering study, Grawitch and colleagues (2003) had three-person groups generate ideas for the design of a hotel on the moon. Prior to idea generation, group members imagined and reexperienced a personal event that brought them into a positive or negative mood or they had to imagine an ordinary visit to the supermarket in the neutral-mood condition. The results showed that groups in a positive mood were more creative than those in neutral and negative moods (also see Shin, 2014). Other work reveals that the effect of mood on creativity in groups depends on moderator variables (To, Herman, & Ashkanasy, 2015). For instance, a positive rather than negative mood associates with increased creativity in groups, but only when trust among team members was low rather than high (Tsai et al., 2012) or when group members' moods were explicitly shared and discussed (Klep, Wisse & Van der Flier, 2011).

Future work on the effect of mood on group-level creativity may go beyond valence and study the effects of specific moods.

Another interesting development pertains to the effects of the emotions and moods expressed by people, including coworkers and leaders, on other people's creative capacity (Madrid et al., 2016; Visser et al., 2013). For instance, in a pioneering study, Van Kleef, Anastasopoulou, and Nijstad (2010) examined when expressions of anger enhance creative performance in observers. Following an initial idea generation phase, participants received standardized feedback and tips from another person that was delivered in an angry or neutral way (through facial expression, vocal intonation, and bodily posture). Participants who were highly motivated to elaborately process task-relevant information and pay attention to the feedback's motivational implications subsequently generated more creative ideas after receiving feedback that was delivered in an angry rather than neutral way; this effect reversed for those that were less motivated to process task-relevant information. In another study, a leader's displays of happiness rather than sadness enhanced follower creative performance and this effect was mediated by self-reported happiness of the followers (Visser et al., 2013). This indicates that emotional contagion partly underlies this effect (also see Madrid et al., 2016). Future work on the effects of emotional expressions on observer creativity may study other moods and emotions as well as potential mediators and moderators.

Experimental work on the mood–creativity link tends to focus on idea generation, flexible information processing, and the generation of remote associates (Baas et al., 2008). However, the creative process is more comprehensive, including the identification of the problem one wants to solve, the generation of candidate solutions, and the appreciation and selection of creative solutions for implementation (Basadur, Graen, & Green, 1982; Perry-Smith & Mannucci, 2017). Unfortunately, most research on the mood–creativity link neglects the problem identification and idea selection stages. A noteworthy exception is a study by Middlewood, Gallegos, and Gasper (2016) that showed that people who were both tired and happy showed a greater acceptance of creative ideas. Future work on the effect of mood on creativity may go beyond idea generation and study the effects of specific moods on other stages of creative problem-solving.

Conclusion

In conclusion, I began this chapter with several observations in which mood states were linked to the human capacity for creativity and I asked which quotes or observations were right – which moods do, and which do not, promote creative thinking? From the empirical findings reviewed here, it can be concluded that the mood–creativity link depends on moderators that determine the size and sometimes the sign of the relationship between specific moods and creativity. It can also be concluded that the mood–creativity link is better understood as a function of a mood state's associated level of activation and motivational orientation rather than simply in terms of a mood state's valence. Deactivating mood states, such as relaxed, calm, and sad moods, are not related to more or less creativity. This is inconsistent with the beliefs of managers, entrepreneurs, and undergraduate students that being in a relaxed mood would stimulate their creativity and with the prototypical creative person who feels blue and depressed. Instead, the available findings show that activating mood states that are associated with an approach orientation (e.g., happiness, anger) are associated with increased levels of creativity, possibly through enhanced flexibility of thought. Finally, under the right circumstances, activating mood states that are associated with an avoidance orientation (e.g., fear and anxiety) are also associated with increased levels of creativity, possibly through enhanced persistence. If you want to be creative, get activated.

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13 Emotions and Creativity

From Process to Person and Product

Zorana Ivcevic and Jessica Hoffmann

Emotions fuel creativity. The fuel analogy goes a long way; emotions spark the engine of creativity, they are used (or burned) in the process of creation, they need to be regulated to sustain the creative process, and they are elicited as by-products of creativity. Much research on the role of emotions in creativity has focused on the question of which emotion states facilitate and which emotion states inhibit creative idea generation (meta-analyses: Baas, De Dreu, & Nijstad, 2008; Davis, 2009). We take a more comprehensive approach based on emotion theory that defines multiple aspects of emotion (emotion experience and emotion regulation; Kappas, 2011; Mayer & Salovey, 1995) and based on a definition of creativity as the process from a decision to be creative through idea generation, to sustained work on often long-term projects, to the effects of creative products on the creators and their audience.

Emotion-related personality traits are at the core of one's willingness to make a decision to engage in creative work. While uncertainties inherent in creative endeavors prevent action in many, Steve Jobs was famously willing to go on with plans for the iPad in spite of popular wisdom that people would not be interested in the device (Buchanan, 2013). Personality traits also influence choice of domain of work (art or accounting?) and frequency of activity (e.g., time spent painting). The role of emotion states in the creative process has been extensively studied in relation to idea generation, especially in the context of quick tasks amenable to laboratory studies. We learned that positive activated emotions enhance creativity of ideas (although this effect disappears when people spend more than a few minutes on a task; Baas et al., 2008). More recent studies show that negative approach emotions can also enhance creativity (e.g., Conner & Silvia, 2015), as when scientists are inspired by frustrating gaps or inconsistencies in the existing literature. Creative process is further supported by emotion regulation abilities necessary to manage disappointments and frustrations stemming from obstacles to realization of one's ideas or poor evaluations of one's work. Finally, creative work engenders emotions in both the creator (e.g., pride) and their audience (e.g., aesthetic emotions from enjoyment to disgust; Silvia, 2009).

We organize this chapter into five sections. First, we describe a model of the role of emotions in creativity, starting with the decision to be creative and culminating in

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products or performances that often require long-term work, and which defines emotions as involving both experience (described by valence, activation, regulatory focus) and abilities of using, understanding, and managing emotions in support of creative work. The next three sections describe the role of emotions in the creative person, creative process, and in relation to the creative products. In the final section, we look ahead and call for the new generation of research on which we hope to report in the next *Cambridge handbook of creativity.*

Creativity and Emotions: A Comprehensive Model

Figure 13.1 depicts a model illustrating emotion influences on creativity. The figure outlines emotion influences on the levels of the creative person(ality), the creative process, and the creative product, as well as reciprocal influences among them. The goal of this chapter is to review empirical and theoretical support for this model. We will not provide an exhaustive review of the existing research but refer the reader to more complete reviews when available. Here, our goal is integrative and aspires to give direction to a disjointed field.

On the level of the creative person(ality), emotions influence creativity through emotion-related personality traits. Personality traits are predispositions to feel, think, and act in particular ways (Matthews, Deary, & Whiteman, 2003; Mayer, 2003). They influence how people select situations or activities and affect the frequency of trait-related behavior (Roberts, Wood, & Caspi, 2008). There are three major avenues through which emotion-related traits affect creativity: (1) by facilitating the decision to be creative; (2) by directing a choice of domains of work; and (3) by affecting the frequency of creative behavior.

The most consistent and strongest personality predictor of creativity is the Big Five trait of openness to experience. Both theoretically (McCrae, 1996) and empirically (Feist, 1998; Ivcevic & Mayer, 2009; McCrae, 1987; Silvia, Martin, & Nusbaum, 2009), openness is at the core of creative personality (see also Feist, Chapter 17, this volume). As one of the Big Five traits, openness is a broad disposition that includes aspects related to emotion and motivation (e.g., openness to feelings), social expression (e.g., nonconformity), cognition (e.g., imagination), and self-regulation (e.g., absorption; Feist, 1998; Mayer, 2003). As such, only some facets of openness can be considered emotion-related traits. We briefly review the role of openness-related traits in creativity and discuss two Big Five traits more closely related to emotions – extraversion and neuroticism – as well as the trait of intrinsic motivation (the tendency to be motivated by enjoyment and challenge in work) and passion for one's interests.

On the level of the creative process, we posit that there are two sources of emotion influences on creativity: emotion states (or moods) and emotion abilities. Emotion states are relatively short-lived experiences that vary on valence (positive vs. negative), activation (low to high arousal), and regulatory focus (promotion vs. prevention; Higgins, 2001; see also Baas, Chapter 12, this volume). A meta-analysis of twenty-five years of experimental research on the effects of emotion states on

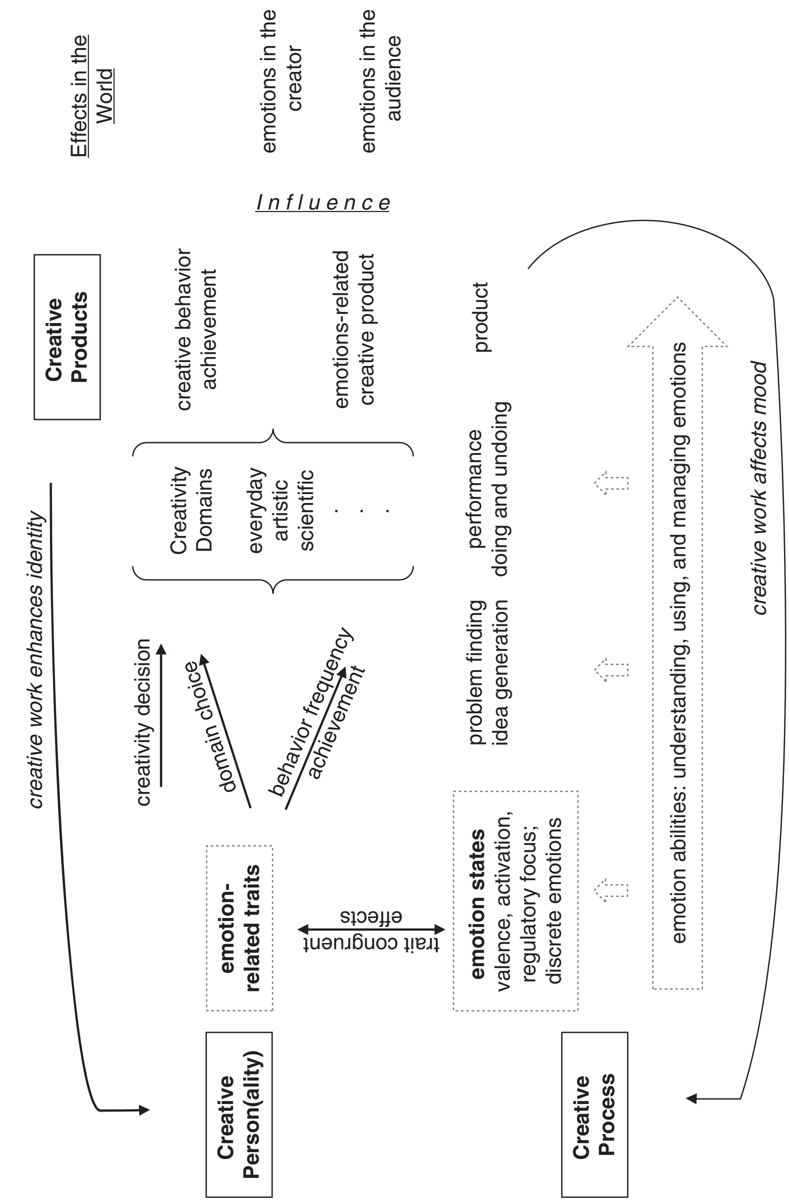

Figure 13.1 *Model illustrating the role of emotions in creativity*

creative thinking shows a beneficial effect of positive activated moods on originality and flexibility (Baas et al., 2008). Emerging research expands our understanding of emotion states in the creative process by examining a broader range of emotions, such as sympathy (Yang & Yang, 2016) and nostalgia (van Tilburg, Sedikides, & Wildschut, 2015), as well as studying the interaction of emotion states and traits (Leung et al., 2014).

Emotion-related abilities are another influence on the creative process. Emotion abilities are defined as capacities for thinking and reasoning about and with emotions (Mayer, Roberts, & Barsade, 2008). Instead of asking what emotions enhance or hamper creativity, research on emotion abilities asks how emotions are used and managed in the service of creativity. After decades of research on emotion states, it is becoming clear that "to make a difference in creative performance, manipulating mood states is not very effective and is unlikely to produce clear and visible changes in creativity" (Baas et al., 2008, p. 796). Understanding the role of abilities to use, understand, and manage emotion holds a potential for more effective influence on creativity.

On the level of creative activity and products, emotions are elicited in creators as a result of engaging in creative work (e.g., satisfaction and pride after creating a painting), they are elicited in the audience of the creative product (e.g., aesthetic emotions in art audiences), and they are a possible creative product in themselves (creativity in the domain of emotions, e.g., creative strategies to manage anger; Weber et al., 2014).

Emotions and the Creative Person(ality)

The creative person is commonly described in terms of personality traits and the most consistent personality trait predictor of creative outcomes across domains is openness to experience (Feist, 1998; Ivcevic & Mayer, 2009; McCrae, 1987; Silvia et al., 2009). Below we review the relationship between personality traits that are more centrally related to emotion and different aspects of creativity, including the decision to be creative, selection of creative domain, and frequency of creative behavior and level of achievement.

Decision to Be Creative

Creativity at its core involves defiance, either of oneself, of the crowd, or of the Zeitgeist (Sternberg, 2018). Theories of creativity define risk-taking as an essential component of such defiance (Amabile & Pratt, 2016; Sternberg, 2018; Urban, 2003). Risk is involved whenever one makes an unconventional choice (in subject matter, methods, or materials), which is associated with uncertainty and often negative emotions (anxiety or tension triggered by anticipated social consequences of risky ideas). This tension is especially prominent in evaluation situations; both children and adults who believed that they were being observed and evaluated by outside judges tended to produce less creative collages and poems than those under no-evaluation conditions (Amabile, 1996). Similarly, Pfeffer and Sutton (2000) identified fear about one's status as the basis for the "knowledge–doing gap" in organizations; this fear of social risks inhibits sharing new and original ideas and implementing innovations.

Studying risk-taking across domains of recreation, health, career, finance, safety, and social risk, Nicholson and colleagues (2005) concluded that it is possible to distinguish risk-seekers and risk-bearers. While risk-seekers are impulsive and sensation seeking, risk-bearers are not unafraid of risks but are willing to tolerate risks in the service of their goals. Tolerance of risks is conceptually akin to tolerance of ambiguity. Individuals tolerant of ambiguity are able to accept the discomfort when facing new, complex, and uncertain tasks, instead of avoiding such situations. Zenasni, Besancon, and Lubart (2008) found that tolerance of ambiguity is related to creative personality, as well as performance on a divergent thinking test and a story writing task in parents and their adolescent children.

Domain Selection

Personality traits can affect choice of occupational domains either directly or through their influence on preferences and interests. A meta-analysis comparing artists and nonartists identified a number of emotion-related descriptors; artists are less emotionally stable and less likely to be guilt-free or happy, compared with nonartists (Feist, 1998). These emotion traits have been since identified in other samples, such as when comparing visual arts students with music and psychology students (Haller & Courvoisier, 2010), as well as when comparing dancers and athletes (Thomson & Jaque, 2013), suggesting that individuals higher on neuroticism tend to select artistic domains characterized by self-expression.

Two meta-analyses identified several significant connections between personality traits and vocational interests that are relevant to understanding the creative person (Barrick, Mount, & Gupta, 2003; Larson, Rottinghaus, & Borgen, 2002). Higher extraversion (positive emotionality trait) predicted enterprising interests, including interests for highly creative occupations such as architect, entrepreneur, and fashion designer. Wille and De Fruyt (2014) followed a sample of college graduates fifteen years into their careers and found that the relationship between personality traits and occupational interests was reciprocal; personality traits influenced occupational choice but were also influenced by these choices and vocational experiences.

Frequency of Behavior and Achievement

The personality trait that most closely predicts frequency of creative behavior and level of creative achievement is openness to experience (Feist, 1998; Ivcevic & Mayer, 2009). Kaufman (2013) specifically studied openness-related emotion traits and identified a dimension of affective engagement described by openness to a broad range of emotions and preference for using gut feelings and empathy in decision-making. This dimension predicted creative achievement in the arts (music, dance, humor, theater, and film) but not intellectual domains such as science and technology.

Two Big Five traits that primarily describe positive and negative emotionality – extraversion and neuroticism – are not reliably related to criteria of creative thinking; neuroticism is largely unrelated to divergent thinking test scores and extraversion shows a mix of positive (e.g., Batey, Chamorro-Premuzic, & Furnham, 2009; Furnham et al., 2008) and nonsignificant correlations with creative thinking (e.g., Burch et al., 2006; Ivcevic, Brackett, & Mayer, 2007; Silvia et al., 2009). Although neuroticism predicts choice of an artistic domain, research to date does not show neuroticism predicting frequency of creative activity or creative achievement (Ivcevic, 2007; Ivcevic & Mayer, 2009; Kaufman et al., 2016). Extraversion predicts creative behavior in a limited set of domains, such as everyday activities (e.g., interpersonal creativity, crafts; Ivcevic, 2007; Ivcevic & Mayer, 2009) and entrepreneurship (Lee & Tsang, 2001; Zhao, Seibert, & Lumpkin, 2010).

Beyond the Big Five traits, goal and achievement-related emotion traits are especially important for creativity. Interviews with eminent creators and quantitative studies alike show that creative individuals love what they do (Amabile, 1996; Csikszentmihalyi, 1996). Intrinsic motivation – motivation based on enjoyment and challenge–drives individuals to transform their general and domain-specific creativity skills into creative behavior (Amabile, 1996; Amabile & Pratt, 2016; see also Hennessey, Chapter 18, this volume). The trait of intrinsic motivation predicts frequency of creative activities (hours of work per week doing art, number of artworks produced), as well as creativity of the work (instructor ratings of student potential as an artist; Amabile et al., 1994). Indeed, a recent meta-analysis showed a significant and moderate relationship between intrinsic motivation and product creativity (de Jesus et al., 2013).

Passion is a construct that unites a strong affective desire and commitment and dedication to an activity (Cardon et al., 2013; Fredricks, Alfeld, & Eccles, 2010; Moeller et al., 2017). Passion is more than the experience of intrinsic motivation and enjoyment in an activity; it involves intense high arousal affect associated with activities that are important to one's identity. Across interview and experience sampling studies of adolescents, many of the most frequent passionate activities were creative in nature (e.g., music, drama, art; Fredricks et al., 2010; Moeller et al., 2017). Furthermore, passion for one's interests rated by teachers predicts peer-rated creativity of high school students (Grohman et al., 2017; Ivcevic & Brackett, 2015).

Passion predicts creativity measured by employees' team leader ratings (Liu, Chen, & Yao, 2011) and creativity in performing arts students assessed by instructors and program directors (Vallerand et al., 2007). Two components of passion – intense positive feelings and identity centrality – predicted creativity and persistence in experienced entrepreneurs (all CEOs of privately owned, independent, small to medium-sized firms; Cardon et al., 2013). The specific aspects of entrepreneurship activity were important in these predictions; passion for inventing and founding business ventures predicted creativity, while passion for founding and developing/growing business ventures predicted persistence.

Emotions and the Creative Process

Emotions affect the whole creative process, from motivating creative work to idea generation to working through obstacles and persisting toward actualization of creative ideas. Much research on emotions and creativity has focused on the question of how emotion states – positive vs. negative, low vs. high arousal, promotion vs. prevention focused, as well as discrete emotions – affect creative thinking (e.g., Baas et al., 2008; see Baas, Chapter 12, this volume). Emerging research on the creative process beyond idea generation asks a different question; instead of putting the emphasis on emotional experience, research on emotion abilities puts the emphasis on the individual's ability to use and influence emotions in the service of one's goals.

Emotion States and Creative Thinking

Phenomenological studies of the creative process show a wide range of emotions across domains of creative activity. Artists, designers, musicians, screenwriters, and scientists all describe experiencing anxiety and frustration at the vagueness of their initial ideas, joy of inspiration, and pain or even anguish in the often long process of working and reworking on the way to realizing an idea in a product or performance (Botella et al., 2013; Bourgeois-Bougrine et al., 2014; Glăveanu et al., 2013).

Several decades of research on emotions and creativity addressed the question of which emotion states enhance or inhibit creative thinking.The dominant line of research examined the effects of positive vs. negative emotions on creative thinking (idea generation and insight). Laboratory studies induced different emotion states using video clips, social approval or rejection, gift giving, or autobiographical memories and examined their effects on creative ideas. This paradigm produced reliable evidence that positive activated emotions enhance performance on tests of creative thinking (Baas et al., 2008). Moreover, these findings have been replicated outside of the laboratory in experience sampling studies of college students (Conner & Silvia, 2015; Silvia et al., 2014) and in a diary study of professional adults from chemical, high-tech, and consumer product companies (Amabile et al., 2005).

Another line of inquiry showed benefits of negative emotions for idea generation (Adaman & Blaney, 1995; Clapham, 2001; Gasper, 2003). In an interview study, professional adults described that moderate levels of anger benefit creative idea generation by correcting errors and stimulating new ideas (Yang & Hung, 2015). Akinola and Mendes (2008) found that negative mood induced through social rejection resulted in greater creativity on a collage-making task. The effect was particularly strong for those with high affective vulnerability measured as level of an adrenal steroid linked to depression.

Support for the role of negative emotions in the creative process is also available from momentary assessments of emotion in everyday life. In a thirteen-day diary study, Conner and Silvia (2015) asked young adults to complete a positive and negative emotion scale, as well as to rate how creative they were each day (defined as coming up with novel or original ideas, expressing oneself in an original way, or engaging in artistic activities). As in previous research, those who reported more positive affect, especially high activation positive affect, rated their days as being more creative than those who reported less positive affect. Also, high activation negative affect (angry, hostile, and irritable) was associated with higher creativity. In another experience sampling study, college students completed online surveys three times a day over ten days, reporting on their current mood and their creative process engagement (problem identification, information processing, and idea generation; To et al., 2012). Both positive and negative activated emotion states were associated with higher concurrent creative engagement, and positive and negative deactivating moods were associated with less creative engagement. Furthermore, lagged effects were found so that activating negative moods at one time point led to more creative engagement at the next survey time point.

Studies showing effects of negative emotions on creativity have added layers of complexity to the link between emotions and creative idea generation. Kaufmann and Vosburg (2002) raised a question about the effect of time on creativity task when they found that those in a positive mood performed best early on, while those in the control and negative mood conditions performed best later in the task. Other research examined the role of how the creativity task is framed. Friedman, Förster, and Denzler (2007) found that participants induced to experience a positive mood produced more ideas when the task was framed as fun and those in negative moods produced more ideas when the task was framed as serious.

Research on specific emotions offers additional insight into the dynamics of emotion influence on the creative process. A meta-analysis of the role of stressors in creative thinking found a curvilinear relationship, such that low-level stress tended to significantly increase creative performance over no stress (Byron, Khazanchi, & Nazarian, 2010). The kind of stress made a difference. The curvilinear inverted U-shape relationship was observed for social-evaluative stress, while uncontrollability was negatively related to creative performance on laboratory tasks (e.g., divergent thinking). Furthermore, for those high in trait anxiety, stressors decreased creativity and, for those low in trait anxiety, stressors increased creativity.

Yang and Yang (2016) examined the role of sympathy in creative thinking. Because the kinds of situations that elicit sympathy are unpleasant in nature, sympathy was considered a negative emotion. Undergraduate students were induced to feel sympathy through a slide show of distressed elderly adults, then asked to complete divergent thinking idea-generation tasks and to design a floor plan for an office reception area to make it more friendly for the elderly. Compared with controls, the sympathy group showed greater originality in thinking and the beneficial effect of sympathy on creativity was moderated by trait empathy. Furthermore, persistence fully mediated the effect of sympathy on originality on the floor plan design task. Several mechanisms can explain these results. First, the study fits with previous research showing that negative emotions benefit creativity in specific contexts (George & Zhou, 2002). Second, sympathy is a reaction to other's suffering and therefore produces prosocial intrinsic motivation to generate solutions that reduce others' distress, which has been both theoretically and empirically related to creativity (Forgeard & Mecklenburg, 2013; Grant & Berry, 2011).

Several theoretical models have emerged to explain the findings about the role of emotion states in creative thinking. The broaden-and-build theory describes how positive moods broaden thinking, attention, and action, and thus enhance people's intellectual and psychological resources (Fredrickson & Branigan, 2005). By broadening attention, positive emotions increase the likelihood one will notice peripheral cues and access a wider network of mental representations that enable original thinking.

Two models speak to the role of both positive and negative emotions in creative thinking. The feelings-as-information model describes moods as a source of information that can be used to direct thinking (Clore, Schwarz, & Conway, 1994; Schwarz, 2012). Unpleasant moods signal that there is a problem that needs solving and experience of dissatisfaction signals the need to persist. Also, distress (e.g., job dissatisfaction, budget shortages) can serve as motivation for creative thinking (Anderson, De Dreu, & Nijstad, 2004). By contrast, pleasant moods signal successful performance and indicate that effort can be reduced, which sometimes can be premature (George & Zhou, 2002; Zhou & George, 2001). This signaling value of positive emotions can explain declining benefits of positive moods on creative thinking with longer time spent on task (Baas et al., 2008).

The "dual pathway" model was specifically formulated to address the role of emotions in creative thinking; it integrates existing research by positing that activating moods, whether positive or negative, should enhance creativity, albeit through different paths (De Dreu, Baas, & Nijstad, 2008). Extensive experimental and naturalistic research (with in-the-moment assessments) supports that positive activating moods benefit creativity by enhancing cognitive flexibility, while negative activating moods enhance perseverance (De Dreu et al., 2008; To et al., 2012).

Emotion Abilities and Creativity

As research on the wide range of emotions in the creative process accumulates, from interest and joy to annoyance, pain, and anger, the question in search of answers becomes what creators do with these emotions. We argue that understanding abilities to use and manage emotions during the creative process is at least as important for creativity scholarship as understanding what emotions can be beneficial or detrimental to creative thinking. Although research in this area is still relatively sparse, support for the importance of abilities to use and regulate emotions is emerging from studies of children at play (Hoffmann & Russ, 2012) to professionals at work (Parke, Seo, & Sherf, 2015).

Emotion abilities refer to one's capacity to process emotion-laden information, such as accurately identifying causes and consequences of emotion states or recognizing emotions based on nonverbal cues, as well as capacities to use emotions to enhance thinking and problem-solving, and manage emotions for specific goals (Izard et al., 2007; Mayer et al., 2008; Tamir, 2016). Methodological challenge in studying these capacities is that individuals are not able to self-report on them. The correlations between self-report of these capacities and scores on performance-based ability tests are negligible (Brackett et al., 2006), stressing the need for new ability-based tests and their widespread availability.

Using emotions to help thinking involves prioritizing and directing thinking based on experienced emotions, choosing tasks that benefit from one's emotion states, and generating emotions in the service of thinking and problem-solving tasks at hand (Mayer & Salovey, 1997; Mayer et al., 2008). People can use their current mood states as cues about the effort needed to achieve an outcome, where positive moods signal success toward a goal and negative moods signal problems that require additional effort toward a goal (Martin et al., 1993; Schwarz, 2012).

Interviews with creators show that emotions often direct thinking and problem-solving. Creators describe getting inspired by emotion-laden observations and transforming or channeling them into creative work. For instance, composers, artists, and writers describe being inspired by a need to understand the world around them and using emotionally rich observations of their environments – places, smells, interactions – to tell a convincing story (Glăveanu et al., 2013). Similarly, designers describe turning frustration and anxiety experienced when problems arise into the drive toward finding solutions (Sas & Zhang, 2010).

Huy (2002) found that managers used emotions to create commitment to innovation projects, as well as to attend to employees' emotions and support their emotional needs in a three-year study of a large IT service organization going through a major institutional change. Other prominent examples of using emotions is leaders choosing to strategically share positive emotions to stimulate original thinking or to encourage persistence toward challenging goals (George, 2000; Vallerand et al., 2003), as well as when presenting creative ideas to a relevant audience (e.g., projected entrepreneurial passion predicts evaluations of funding potential; Cardon, Sudek, & Mittens, 2009). Negative emotions can also be used to direct creative thinking. Job dissatisfaction can be used to stimulate creativity when employees have clarity about their feelings and perceive that creativity is recognized and valued (George & Zhou, 2002) or when employees receive support and useful feedback from co-workers, perceive organizational support for creativity, and are committed to the organization (Zhou & George, 2001).

Cohen and Andrade (2004) demonstrated how people can use emotions to help thinking by consciously choosing to generate moods that benefit the tasks they face. They induced positive or negative emotions by showing video clips to study participants. Next, participants were told they would be asked to complete either a task requiring precise analytic thinking or one requiring creative and imaginative thinking. Participants were given a choice to listen to happy or sad music before working on these tasks; thus, they could decide to make their mood either more positive or negative. People tended to choose music that would put them in a mood most helpful to the tasks. Those expecting to work on a creative idea-generation task tended to choose upbeat music and those expecting to work on an analytic thinking task tended to choose sad music. Thus, the study showed that people can have knowledge about which moods are beneficial to which tasks and are willing to generate these moods, even if it means creating an unpleasant emotion state.

Another way people can use emotions to enhance creativity is by generating emotions congruent with their enduring emotion-related traits. In a series of experiments, college students higher on neuroticism chose to recall worrisome (as opposed to happy) memories when facing a creativity task and thus create a more negative activated mood. Moreover, when those higher on neuroticism were induced to feel worried, they performed better on a divergent thinking task (alternate uses for a brick) and produced more creative designs (cabin of a commercial airplane; Leung et al., 2014).

People also can regulate their emotions; this ability involves influencing and changing emotions and emotional reactions in order to reach hedonic or instrumental goals (Gross, 2008; Tamir, 2016). Emotion regulation in the context of creativity is instrumental in nature; emotions are influenced and changed to facilitate creative thinking and progress toward completing creative products. To be effective, emotion regulation has to be based on understanding consequences of potential reactions in emotion-laden situations, knowledge of what actions tend to be helpful for particular goals, and an ability to evaluate what actions would be most beneficial in specific situations (Mayer et al., 2008).

Emotion regulation in creativity can be examined in two ways: (1) based on the source of emotions (task-related and nontask-related) and (2) based on emotion-related goals (e.g., upregulating or downregulating). Regulation of emotion is necessary when emotions coming from one context spill into another context, such as when a lack of support from one's family creates stress at work (Madjar, 2008; Van Dyne, Jehn, & Cummings, 2002). Furthermore, emotions need to be managed to reach a host of end-states, from minimizing undesired or unhelpful emotions (e.g., stage fright), to maintaining emotions beneficial for specific tasks (e.g., high activation positive emotions during brainstorming), to generating emotions in oneself or others (e.g., inspiring others with one's passion).

The idea that emotion regulation is important for creativity is not a new one. Freud (1925/1958) described how regulating potentially overwhelming emotions can lead to creativity through the defense mechanism of sublimation. This process involves managing inappropriate impulses and emotions by channeling them into socially desirable behavior, such as when everyday aggressive motives are expressed through art. Recent experimental studies give empirical support to this mechanism. When direct expression of emotions was blocked (e.g., requiring participants to suppress anger), rated creativity of sculptures, collages, poems, and cartoon captions was higher than in control conditions (Kim, Zeppenfeld, & Cohen, 2013).

Multiple lines of research converge in describing the role of emotion regulation in creativity. Perhaps the most dramatic consequence of an inability to successfully regulate emotions is illustrated by the phenomenon of creative mortification – loss of willingness to engage in a creative activity because of overwhelming self-conscious emotions resulting from harsh negative feedback (Beghetto, 2014). Creative mortification is more likely in children, possibly because they have not yet acquired an extensive and flexible set of emotion regulation strategies. Developmental research also shows that successful emotion regulation as reported by parents of elementary school children predicts both children's imagination in pretend play and their performance on divergent thinking tests (Hoffmann & Russ, 2012). Furthermore, poor emotion regulation mediated the relationship between disruptive behavior and lower creativity measured both by parent reports and by divergent thinking tests (Butcher & Niec, 2005).

Ethnographic interviews with designers vividly illustrate emotion regulation in creativity (Sas & Zhang, 2010). They describe the deliberate nature of emotion regulation as logically thinking about how to change emotions like frustration and give clear examples of different regulation goals, such as maintaining positive emotions for as long as they need them during the creative process, and finding a balance between being relaxed and stimulated.

Emotion regulation in itself can enhance creative thinking. For instance, a shift from a negative to positive mood is a better predictor of creativity than a shift from a neutral to positive mood (Bledow, Rosing, & Frese, 2013). This effect was observed both in a diary study of naturally occurring affect assessed in the beginning and the end of a workday and in an experimental study in which different moods were induced through recall of emotional memories. Professionals in jobs that require creativity whose moods changed from negative in the morning to positive in the afternoon rated their days as more creative than those whose moods did not show such a shift. Similarly, psychology graduate students who were induced to feel a negative and then positive mood had higher flexibility and originality on a task asking them to generate ideas for how to improve quality of teaching in their department. The negative to positive change offers an opportunity to access information available from both the negative and the positive mood states; negative moods provide information about possible limitations and pitfalls and positive moods provide remote associations helpful in generating creative ideas.

Emerging research points to the mechanisms through which emotion regulation can benefit creativity. A study of early career professionals from a variety of knowledge industries showed that abilities to use and regulate emotions contributed to creativity by increasing the experience of positive emotions (Parke et al., 2015). Ivcevic and Brackett (2015) identified another path of emotion regulation influence on creativity. In high school students, emotion regulation ability affected creativity by increasing persistence and passion. This effect was observed in those with medium or high levels of openness but not those low in openness, suggesting that emotion regulation helps transform creative potential (openness to experience as the personality disposition for creativity) into creative behavior by enabling individuals to maintain interest and effort.

Collectively, support is mounting for a wide range of emotions contributing to the creative process for different kinds of tasks, in different social contexts, and for different people (with different personality traits). Importantly, emotions are not simply imposed on individuals. People have the ability to use emotions to direct thinking (e.g., use frustration to motivate problem-solving), generate emotions to create experiences that can benefit tasks at hand (e.g., generating enthusiasm when facing a brainstorming task), and manage emotions to sustain interest and effort (important to overcome obstacles encountered in the creative process).

Emotions and the Creative Product

Creativity is studied primarily as a dependent variable and the effects of creativity – emotional or otherwise – are rarely examined (Forgeard & Kaufman, 2016). Conceptually, there are three major ways of examining emotions in relation to creative products: (1) emotions associated with accomplishment in the creators themselves, (2) affective effects of creative products in their target audiences, and (3) creativity in the domain of emotions (where the creative product itself is emotion-related, such as employing original and effective emotion regulation strategies). Below we briefly review research on the first two aspects of emotions and creative products. The third aspect, creativity in the domain of emotions, is beyond the scope of this chapter (see Ivcevic et al., 2017), as it defines a separate domain of creative expression.

Emotions Associated with Creative Work

The creativity–mood relationship is bidirectional; emotions are both predictors of creative behavior and creative behavior affects creators' emotional states. Artists describe experiencing satisfaction mixed with exhaustion when they complete their work, while scientists describe satisfaction and pride, as well as anxiety about presenting the work (Glăveanu et al., 2013). These accounts are supported by experimental and diary studies. Working on divergent thinking tasks increases positive mood (while convergent thinking tasks increase negative mood; Chermahini, & Hommel, 2012). Amabile and colleagues (2005) showed that positive affect predicted creativity at work and also found that people described positive affect as a consequence of creativity (including positive emotions such as joy, pride, satisfaction, and relief).

Conner, DeYoung, and Silvia (2016) found a lagged effect for creative behavior on subsequent mood in young adults. Creative behavior on a given day led to more positive affect (especially activating emotions like being energetic or excited) and flourishing on the next day. This effect remained significant even when controlling for the level of creativity on the second day. These authors did not find support for positive affect on one day predicting creativity on the following day, showing that the effect of creative behavior on mood is more than simply a positive affect–creative achievement loop, or an upward spiral. A multigroup randomized controlled study across five countries and four languages showed that working on creative tasks led to an increase in positive emotions through an increase in feelings of autonomy (i.e., freedom to express ideas and opinions; Bujacz et al., 2016).

Creative activities such as water coloring, writing poetry, and dance are used as therapeutic strategies to decrease negative affect and distress in clinical patients (Slayton, D'Archer, & Kaplan, 2010). In a nonclinical sample of college students, De Petrillo and Winner (2005) found that drawing based on one's feelings improved positive mood after viewing tragic images as compared with copying shapes. Moreover, mood repair effect of art making is strongest when people use it as distraction, rather than venting (Drake & Winner, 2012).

Emotions in the Target Audience

Creative products often have emotional effects on their audience. These effects have been well studied in the domain of aesthetic emotions. Tinio (2013) describes how the experience of viewing art mirrors (in reverse order) the stages of the art-making process (initialization, expansion and adaptation, and finalizing), such that viewers begin with perceiving surface features (automatic processing), move through intermediate, memory-based processing, and end with finding underlying meaning and personal relevance (aesthetic judgments and experience of aesthetic emotions).

Although much of modern aesthetics research emphasizes positive emotions in response to art, Silvia (2009) proposed that a range of less commonly researched aesthetic emotions can be generated by art: confusion or surprise (knowledge emotions), anger, disgust, and contempt (hostile emotions), and pride, shame, or embarrassment (self-conscious emotions). Silvia and Brown (2007) offered empirical support for negative aesthetic emotions; anger was associated with appraisals of goal incongruence and intentionality, while disgust was associated with appraisals of goal incongruence and unpleasantness.

Emotions are also elicited by consumer products. Horn and Salvendy (2009) found that positive affect predicts willingness to purchase innovative consumer products. Kunz, Schmitt, and Meyer (2011) went beyond individual products and examined consumers' perceptions of an entire company (e.g., Apple or Pixar). Perceptions of firm innovativeness – the extent to which consumers believe a company is capable of producing creative products – involves both functional-cognitive aspects and affective-experiential aspects, both of which impact subsequent consumer satisfaction and loyalty.

Emotion and Creativity: Future Directions

Where should we go from here? Figure 13.1 offers an outline for a systematic program of research on the effects of different emotion-related constructs on creativity. The model depicts emotion influence on the level of creative person(ality), creative process, and (effects of the) creative activity and products. Systematic study of narrower topics within the broad domain of emotions and creativity has been very fruitful (e.g., research on the effects of emotion states on creative thinking; Baas et al., 2008; De Dreu et al., 2008; also Baas, Chapter 12, this volume). The model in Figure 13.1 suggests other such avenues of research, from examining the role of emotion states on different parts of the creative process beyond idea generation to examining the role of emotions that result from creative activity and reciprocally influence creative identity and subsequent creative activity.

Much of the existing research is based on experimental methods. While these methods have an ability to isolate causal relationships, experimental tasks are by necessity short, which limits the kinds of creativity outcomes that can be studied and the ecological validity of studies (e.g., coming up with an idea about how to improve teaching in a university department vs. developing and implementing workable improvements). Research using diary and experience sampling methods offers greater ecological validity and enables examination of emotion influences on extended creative work (Conner & Silvia, 2015; Silvia et al., 2014; To et al., 2012). Self-reports of creative process engagement and self-evaluations of creativity used as criteria in these studies are a good start on this research path. A next step in this line of work should examine changes in emotions and emotion skills as people work on long-term creative projects, from problem-finding and idea generation, doing and undoing through obstacles toward realizing the idea, to the effects of creative activity on the creators.

Several technological innovations make it possible to investigate physiological and behavioral aspects of emotions in the creative process. The black box of emotion during the creative process can be opened using portable sensors that can provide continuous assessment of electrodermal activity (measure of physiological arousal; Poh, Swenson, & Picard, 2009). As this technology has been used to study group problem-solving (Chikersal et al., 2017), it can be applied to the study of creativity in real-life settings. Furthermore, there is increasing evidence for the validity of software that identifies facial expressions characteristic of a set of specific emotions (Bernin et al., 2017). This technology can be used to analyze facial expressions of emotion during the creative process and as an effect of creative activity and products.

Finally, future research should systematically examine the role of abilities to use emotions to aid thinking and abilities to understand and manage emotions in the creative process. Such research explicitly acknowledges individual agency in relation to emotions – people are able to influence the course of their emotions and mobilize them in the service of both hedonic and instrumental goals (Tamir, 2016). As an emerging area of work, this research should include multiple methods, from phenomenological studies and interviews with creators, to studies using ability tests and informant-reports of ability, to experience sampling studies that can capture the use and managing of emotions as they unfold in creative work. Many questions about emotion abilities await answers, from their role in motivating creativity (e.g., when frustration about inconsistencies between laboratory research and real-life observations inspires a novel way of asking old questions) to managing emotions in the service of creative goals (e.g., overcoming frustrating obstacles).

We conclude by referring back to the model in Figure 13.1 to inspire the next generation of research. The model describes the relationship of emotion-related traits, states, and abilities to creative person(ality), creative process, and creative products and achievement. We caution scholars that the same predictors often have different effects depending on outcomes being examined, as well as domains of creativity (poetry vs. physics), making conclusions about creativity in general suspect. The field of creativity studies would benefit from both narrow theoretical models (prime example: dual pathway theory describing the role of emotion states in creative idea generation; De Dreu et al., 2008) and broad theoretical models (going from idea generation to creative achievement and including emotion traits, states, and abilities). Empirical research to follow should continue addressing mechanisms of emotion influence on creativity and put a special focus on studies with high ecological validity. Where in this chapter we could only report on a handful of studies (e.g., the role of emotion abilities in creativity), the next edition of the handbook will be able to offer a rich description. Such research holds promise of potential practically useful suggestions and advice on how to increase creativity.

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14 Creativity and Mental Illness

Shelley H. Carson

Introduction: The Paradox of Creativity and Mental Illness

Creativity is defined as the ability to generate ideas or products that are both original and in some way useful or adaptive (Barron, 1969). At the highest level, creative ideas, processes, and products have benefited humanity by promoting adaptation to a changing environment and improving survival odds (Richards, 1990). At a more personal level, creative work in the arts, music, literature, science, technology, and medicine has reduced suffering, improved daily living, and enriched mental and physical experience. Recent research has provided evidence that simply engaging in creative activity can provide physical and mental health benefits as well (Cohen, 2006; Conner, DeYoung, & Silvia, 2016; Eschleman et al., 2014). Yet, despite these abundant benefits of creative work, the concept of a relationship between creativity and mental illness – the "mad genius" notion – is widespread and deeply engrained in contemporary culture, especially among members of the general public who rate themselves as either notably higher or lower in creativity than the norm (Kaufman, Bromley, & Cole, 2006). If creativity is so beneficial, can it also be related to increased risk for mental illness?

The creativity/mental illness question has spawned one of the most contentious debates in modern creativity research, with researchers on one side arguing that there is a large body of anecdotal and empirical evidence supporting a relationship between creativity and mental illness (e.g., Andreasen, 2008; Johnson et al., 2012; Simonton, 2010), while the other side argues that the empirical research is flawed and the relationship is a myth (e.g., Sawyer, 2012; Schlesinger, 2009, 2014).

In this chapter, I will provide a short review of Western historical attitudes concerning creativity and madness. I will then review evidence (and objections to the evidence) for a connection between creativity and mental illness, including recent evidence from the fields of neuroscience and molecular biology. I will also review the latest attempts to explain the findings, focusing on the shared neurocognitive vulnerability model of creativity and psychopathology. As we will see, the debate has moved far beyond the cliché cases of the nineteenth-century artist with a missing ear and the twentieth-century scientist with a Beautiful Mind.

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Creativity and Mental Illness: Historical Precedents

Since the time of the ancient Greeks, writers have speculated on a connection between creativity and certain types of mental illness. Plato, for example, remarked that poets, philosophers, and dramatists had a tendency to suffer from "divine madness," one of the four types of madness cataloged in his *Phaedrus* (360 BC). In Aristotle's *Problemata*, the author asked why all those who have become eminent in philosophy, poetry, or the arts tend to be melancholic (Aristotle, 1984). These appear to be the first historical references to a tendency for creative individuals to suffer from mania and depression respectively.

During the Middle Ages, there are few, if any, references to the relationship of creativity and mental illness, as creative work was paid scant attention during this era. However, during the Renaissance, the creativity/mental illness concept surfaced again and creative geniuses were described in terms of melancholia and pazzia, the Italian word for madness (Becker, 2014). What we now refer to as "artistic temperament" (including characteristics of melancholia, moodiness, eccentricity, and aloofness) was popularized, with Michelangelo as the poster child. Even the great artist's assistant called him "bizarre" (Arshad & Fitzgerald, 2004). Meanwhile, in England, Shakespeare penned the following immortal line: "The lunatic, the lover and the poet / Are of imagination all compact" (Shakespeare, ca. 1596/1891), suggesting commonalities between poets and the insane.

It was, however, the artists of the romantic era who solidified the concept of the mad genius. After the Enlightenment, during which the inspiration of genius was only considered possible in minds where reason prevailed over imagination (Becker, 2014), the romantics rebelled and espoused a concept of creative inspiration as mystical, imaginative, and emotional rather than rational. Madness, they believed, could free the imagination from the "constraints of conformity" (Burwick, 1996, p. 3). The romantics, therefore, applauded (and perhaps adopted) signs of mental illness as a proud badge of affliction that separated them from dreaded normality (Becker, 2014), and considered that the most creative work was accomplished at the border between sanity and insanity. For example, Thomas Medwin (1833) proudly wrote of his famous cousin, the romantic poet Percy Bysshe Shelley, that "Insanity hung as by a hair over the head of Shelley" (p. 101) (for more on the history of creativity, see Glăveanu & Kaufman, Chapter 1, this volume).

At the end of the nineteenth century, in response to Darwin and the scientific revolution, there was a trend to associate genius with degeneracy. Benedict Morel, a French psychiatrist, argued that creative genius was a state of biological inferiority, inherited from the same gene pool as the lowest elements of society, including criminals and lunatics. Warren Babcock, a New York physician, wrote in the *Journal of Nervous and Mental Disease*, in 1895, that the genius's "aberrant mental qualities and his physical variations from the normal" shared a common origin with the insane (p. 756). And Cesare Lombroso, Italian physician and criminologist, wrote an influential book called *The Man of Genius*, in which luminaries, such as Shakespeare, Mozart, and Dante, were shown to display symptoms of degeneracy (Lombroso, 1891/1976). Lombroso and other contributors to the genius-as-degeneracy movement had a lingering effect on public perception, even though their ideas were downplayed after the disastrous results of the eugenics movement in World War II (Kyaga, 2015).

Early evidence for the creativity/mental illness connection thus consists of observations (e.g., Aristotle, 1984) and examples from the lives of creative luminaries (e.g., Lombroso, 1891/1976). Indeed, biographical reports of the lives of creative luminaries such as William Blake, Robert Schumann, Vincent van Gogh, Virginia Woolf, William Faulkner, Ernest Hemingway, and Sylvia Plath, as well as the lives of contemporary creatives, including Robin Williams, Carrie Fisher, and Amy Winehouse, provide additional anecdotal evidence for a creativity/mental illness connection. However, the World Health Organization estimates that 450 million people worldwide suffer from mental disorders (WHO, 2013). Therefore, even if rates of psychopathology were actually *lower* among highly creative individuals than in the general population, there would still be a great many individuals (perhaps millions) who are both creative and have mental disorders (Carson, 2014a). If a genuine connection between creativity and psychopathology existed, it would need to be supported by empirical evidence, not merely by observations and examples. Empirical work on this topic began slowly in the early twentieth century and has continually gained momentum, as new methods and tools for exploration into the depths of the human psyche become available.

Creativity and Mental Illness: Empirical Evidence for a Connection

During the early part of the twentieth century, Adele Juda published research based on a study of 294 German-speaking artists and scientists and their families. Juda (1949) found that the majority of the geniuses she studied were "normal" (not insane). However, she also noted that "the geniuses and their families show a much higher incidence of psychosis and psychoneurosis than the average population" (p. 307). This work has been cited as an early attempt to compare a highly creative sample to the general population and thus determine comparative rates of mental disorders.

Controlled studies of creativity and psychopathology began to emerge with the study of creative achievers conducted at Berkeley's famous Institute for Personality Assessment and Research (IPAR), where researchers found that creative writers and architects (compared with less creative subjects in the same fields) had elevated scores on the Minnesota Multiphasic Personality Inventory (MMPI) scales of Schizophrenia and Paranoia (Barron, 1955; MacKinnon, 1962). Two additional studies from this time period are also noteworthy: First, a study by Heston (1966) reported that the adopted-away children of mothers with schizophrenia were more likely to hold creative jobs and have colorful lives than were the adopted-away offspring of mothers without schizophrenia. Second, Karlsson (1970) found that males in Iceland born between 1881 and 1910 who had a psychotic relative were almost three times as likely to be registered in *Who's Who* for excellence in a creative field as those without a psychotic relative. Karlsson suggested that "some type of mental stimulation is associated with a genetic relationship to psychotic persons" (p. 180).

These findings sparked new research, beginning in the late 1980s, into the possible connection of mental disorder and high creative achievement. This modern research has employed a number of different methods, including case studies, historiometric studies (in which historical biographical data are subjected to quantitative analysis), clinical studies (in which persons diagnosed with a psychiatric disorder are tested for creativity), psychometric studies comparing creative to noncreative groups, meta-analytic techniques, brain imaging studies that examine commonalities between the brains of creative individuals and the brains of those with mental disorders, and molecular genetic studies in which specific genetic variants or polymorphisms are found to be shared among disordered and creative subjects. The disorders most often investigated included mood disorders (depression and bipolar disorder) and schizophrenia-spectrum disorders. However, substance-abuse disorders and, more recently, attention-deficit disorders (ADHD) have also been associated with enhanced levels of creativity.

Creativity and Mood Disorders

Lifetime rates for mood disorders in the United States, according to the National Comorbidity Survey Replication Study (Kessler et al., 2005), are 3.9 percent for bipolar-spectrum disorders (a.k.a. manic depression) and 20.8 percent for all mood disorders combined. If there is a connection between creativity and mood disorders, then we would expect to see higher rates of these disorders in creative individuals than in the general population.

Three studies have been influential in suggesting that risk for mood disorders may be elevated among highly creative individuals. Andreasen (1987), using a case-study format, found that authors of the prestigious Iowa Writers Workshop were four times more likely to suffer from bipolar disorder than matched controls and that 80 percent of the writers reported suffering from a mood disorder. Jamison (1989) also used case studies to examine mood disorders and found an unusually high percentage of mood disorders generally (38.3 percent), as well as bipolar disorder specifically (6.4 percent), in award-winning writers and artists in the United Kingdom. Finally, Ludwig (1994) reported that rates of both depression (56 percent) and mania (19 percent) were higher in a group of fifty-nine female writers in the University of Kentucky National Women Writer's Conference than those of controls matched for age and education. However, these studies have been cited for methodological flaws. For example, critics of the creativity/psychopathology connection point out that Andreasen selected all the writers and control subjects, as well as conducting all the psychiatric interviews herself, in her 1987 study, without independent corroboration. Jamison's (1989) study did not include a control group and, again, she selected all the subjects herself, which could have led to a bias in selecting those with signs of mood disorder (Sawyer, 2012; Schlesinger, 2009, 2014).

Several studies have also examined mood disorders and creativity from a historiometric perspective, utilizing biographical information to assess mental disorders in creative luminaries. Post (1994) examined the biographies of 291 eminent men and found that the creative subjects in all professional categories, especially writers, demonstrated higher rates of mood disorder (43.3 percent) than members of the general population. Ludwig (1992, 1995), using biographical data, analyzed psychiatric symptoms in over 1,000 deceased individuals in nineteen different professions and reported significantly higher rates of mood disorders among persons who were known for their creative contributions than among those from other professions. Schildkraut and his colleagues (1994) studied biographical information on abstract expressionist painters from the New York School and found that 57 percent suffered from mood disorders. Wills (2003) studied the biographies of forty musicians who were considered innovative in the jazz industry and reported that 28.5 percent suffered from mood disorders. Kaufman (2001) found that, in a sample of over 1,600 prominent writers, female poets had the highest rates of mental illness. This finding, dubbed the "Sylvia Plath Effect," was supported by a second study in which female poets had greater rates of mental illness than other categories of prominent women listed in a dictionary of eminence. Again, these historiometric studies have not gone without criticism. While the Ludwig (1995) study has been cited for employing very "permissive" diagnostic criteria (Sawyer, 2012), historiometric studies in general have been criticized for making diagnoses based primarily on anecdotal accounts that may represent a personal agenda of the biographer of the famous person in question (Schlesinger, 2014).

In the two largest studies of creativity and mental illness, Kyaga and colleagues (2011, 2013) examined creative professions and psychopathology status listed in Swedish population registries. They found that individuals in artistic occupations had higher rates of bipolar disorder than those in noncreative professions, while writers had higher rates of unipolar depression (as well as other forms of psychopathology) than nonwriters. Family members of those diagnosed with bipolar disorder were more likely to be in creative professions than those who did not have a psychiatric family history. Critics, however, have also found fault with these studies, claiming that having a creative profession is not an adequate measure of creativity. Many artists or writers are not necessarily creative, while people in other professions, such as sales or medicine, may be very creative. Further, it is possible that artistic professions are associated with an idiosyncratic lifestyle that may attract the mentally ill, irrespective of creative characteristics (Sawyer, 2014).

Examining creativity and mood disorders from the clinical research perspective, Johnson and colleagues (2015) found that bipolar subjects tended to have higher levels of creative achievement than control subjects and also had significantly larger variations in their level of creative achievements (Johnson, Tharp, & Holmes, 2015). Richards and colleagues (1988) studied creativity across the bipolar spectrum and found that subjects who had a less severe form of the illness (cyclothymia), as well as family members of subjects who had bipolar disorder, had greater creative accomplishments and interests than either control subjects or the full-blown bipolar subjects themselves. The results of the Richards and colleagues (1988) study suggest that milder forms of mood disorder or a family risk for disorder may enhance creativity, while full-blown bipolar disorder may be detrimental to creativity. This inverted "U" hypothesis of creativity and psychopathology (Richards et al., 1988) is supported by additional studies that have found hypomania (a subclinical measure of bipolar tendencies) to be associated with higher creativity scores (e.g., Johnson et al., 2012; Vellante et al., 2011; Zabelina, Condon, & Beeman, 2016).

In preparation for conducting a meta-analytic study, Baas and colleagues (2016) found over 1,800 articles that addressed the topic of mood disorder and creativity on professional online databases, indicating both the amount of research and the degree of professional interest to be found on this topic. In a meta-analysis of twenty-eight studies, Baas and colleagues (2016) found a positive and significant relationship between bipolar disorder and creativity; however, their thirty-nine-study meta-analysis of unipolar depression found a smaller negative and less significant relationship with creativity (Baas et al., 2016).

In summary, a number of different methods have been employed to study the relationship of creativity and mood disorders. Many, but not all, of the studies examining this topic have been criticized for methodological limitations (Sawyer, 2012; 2014; Schlesinger, 2009, 2014). Examining the body of research as a whole suggests (1) there is an elevated risk for mood disorders (especially bipolar disorder) among highly creative people and people in creative professions; (2) mood disorders and creative tendencies may run in families; and (3) individuals with subclinical levels of disorder or familial risk seem to exhibit greatest creative enhancement.

Creativity and Schizophrenia-Spectrum Disorders

Biographers have long noted psychotic and odd or eccentric behavior in a number of creative individuals. The composer Robert Schumann, for example, believed that Beethoven and Mendelssohn were channeling musical compositions to him from their graves (Jensen, 2001; Lombroso, 1892/1976). The visionary poet and artist William Blake described having hallucinations since childhood, believing that many of his poems and paintings were imparted to him by spirits or daemons (Galvin, 2004). And Nikola Tesla, the scientist credited with developing alternating electrical current, became convinced that he was telecommunicating with Martians (Tesla, 1901). However, biographers also point out that, even when creative luminaries suffer from psychotic episodes, they do not produce quality creative work during psychotic states (e.g., Nasar, 1998; Westfall, 1994). Indeed, most studies have not found higher rates of schizophrenia in creative persons but studies *have* found higher rates of familial schizophrenia in creative persons than in controls (e.g., Heston, 1966; Karlsson, 1970). In their Swedish population study, Kyaga and colleagues (2011) found that while people with schizophrenia were underrepresented in creative professions, their siblings were more likely than the norm to hold creative positions. These findings suggest that inheriting part, but not all, of the schizophrenia genotype may be beneficial to creativity.

Both relatives of people with schizophrenia and people who score high on divergent thinking measures of creativity are also more likely to display traits of schizotypal personality or schizotypy (Brod, 1987; Claridge, 1997). Schizotypy is part of the schizophrenia spectrum. While persons who are high in schizotypy are not necessarily mentally disordered, they may display odd behaviors and beliefs, they may be socially aloof, and they may appear eccentric. A number of past studies found that creative subjects had higher schizotypal personality scores than less creative subjects (Brod, 1987; Cox & Leon, 1999; Green & Williams, 1999; Poreh, Whitman, & Ross, 1994; Schuldberg et al., 1988).

Recent studies divide schizotypal personality into *positive* and *negative* schizotypy, roughly based on subclinical facets that correspond to positive (hallucinations and delusions) and negative (anhedonia and asocial behavior) symptoms of schizophrenia. Positive schizotypy, or psychosis-proneness, includes unusual perceptual experiences (e.g., hearing voice-like noises in the wind) and magical thinking (e.g., paranormal beliefs). Negative schizotypy is characterized by social anhedonia (lack of desire or pleasure in socializing with others) and cognitive disorganization (e.g., inability to concentrate) (Mason & Claridge, 2006).

Studies indicate that artists and poets display elevated positive schizotypy but not negative schizotypy traits (e.g., Burch et al., 2006; Nettle, 2006; O'Reilly, Dunbar, & Bentall, 2001), while negative schizotypy may be elevated among scientists and mathematicians (Nelson & Rawlings, 2010; Nettle, 2006; Rawlings & Locarnini, 2008). A meta-analysis of forty-five studies yielded a significant positive relationship between positive schizotypy and creativity; negative schizotypy was inversely and weakly related to creativity (Acar & Sen, 2013).

As with mood disorders, there is some evidence for an inverted-U relationship between creativity and the schizophrenia spectrum. Kinney and colleagues (2000–2001) found that schizophrenia-spectrum traits tend to run in families and that creativity levels were higher in subjects who had two or more positive schizotypal traits than in subjects with either no schizotypal traits or with full-blown schizophrenia.

The research on schizophrenia-spectrum disorders and creativity indicates that actual schizophrenia is not elevated among highly creative groups but that subclinical aspects of the schizophrenia spectrum are elevated (positive schizotypy and psychosis-proneness) and that highly creative individuals may be more likely than members of the general population to have a close relative with schizophrenia (e.g., Karlsson, 1970; Kyaga et al., 2011).

Creativity and Alcoholism

Alcohol has been noted as a method of summoning the muse since the time of the ancient Greeks. In his drama *The Knights*, Aristophanes (424 BC) has the character of Demosthenes utter "Come, bring hither quick a flagon of wine, that I may soak my brain and get an ingenious idea." Modern research on creativity and alcoholism points to a greater prevalence of alcoholism in creative groups, especially creative writers, than in the general population. While the National Comorbidity Survey Replication Study estimates the lifetime risk for alcoholism in the United States at 5.4 percent (Kessler et al., 2005), 30 percent of the writers from Andreasen's (1987) Iowa Writers Workshop study suffered from alcoholism (compared with 7 percent from the control group), and 14 percent of the writers, composers, and artists from

Post's (1994) biographical review of famous men met diagnostic criteria for alcoholism. In Ludwig's (1992, 1995) study of over 1,000 deceased individuals in nineteen different professions, alcoholism was elevated in the creative professions: artists (22 percent), composers (21 percent), musical performers (40 percent), actors (60 percent), fiction writers (37 percent), and poets (30 percent). Finally, Dardis (1989) noted that of the eight American novelists who had won the Nobel Prize for Literature before 1990, five were confirmed alcoholics.

Experimental studies indicate that low-to-moderate doses of alcohol can facilitate certain aspects of creativity (Jarosz, Colflesh, & Wiley, 2012; Norlander, 1999), particularly in the insight or idea generation phase of the creative process. This beneficial effect of alcohol may be due to its ability to disinhibit executive control centers of the brain, allowing more diffuse stimuli to enter into conscious awareness for creative combination (Carson, 2014b). As with other disorders, there is evidence for an inverted-U association between alcoholism and creativity. Moderate drink may facilitate creativity (e.g., Jarosz et al., 2012) but full-blown alcoholism is detrimental to creative efforts. Ludwig (1990) reviewed the effects of alcohol on thirty-four heavy-drinking creative achievers and found that, while the majority believed alcohol benefited their work during the early phases of their drinking, 75 percent believed that alcohol negatively affected their creative work in the later phases of their drinking careers.

Creativity and ADHD

Attention-deficit disorder (ADD; now known as ADHD) was officially recognized as a mental disorder in 1980 (APA, 1980). Thus, it has a shorter history than other disorders that have been associated with creativity. Nevertheless, signs of attention deficit or hyperactivity have anecdotally been attributed to creative luminaries throughout history. According to Cramond (1995), these include Thomas Jefferson, Robert Frost, and Frank Lloyd Wright. A growing number of studies have reported increased scores on divergent thinking task measures of creativity in children or adolescents with ADHD (Abraham et al., 2006; Cramond, 1994; Fugate, Zentall, & Gentry, 2013; Gonzalez-Carpio, Serrano, & Nieto, 2017; Shaw & Brown, 1991; Zentall, 1988). Studies also point to elevated levels of ADHD symptoms in creative or gifted children (Fugate et al., 2013; Healey & Rucklidge, 2006). Adults diagnosed with ADHD score higher than non-ADHD controls on both cognitive (White & Shah, 2006; 2011) and real-world creative accomplishments (White & Shah, 2011). And Kyaga and colleagues (2013) found higher rates of ADHD in members of the writing profession than in nonwriters in the Swedish population.

In support of the inverted-U hypothesis of creativity and psychopathology, a recent meta-analysis of ADHD and creativity indicated that, at the level of everyday creativity, full-blown ADHD may be detrimental (Paek, Abdulla, & Cramond, 2016). These authors note that, when ADHD symptoms are measured at clinical levels, they tend to disrupt everyday creativity; however, when symptoms of inattention and hyperactivity are self-reported or observed by others, they tend to be associated with increased measures of creativity. Healey and Rucklidge (2006) also report that, in a group of highly creative children, 40 percent had elevated scores on a measure of ADHD symptoms but none of these gifted children met full criteria for an actual ADHD diagnosis.

ADHD is associated with a pattern of mind-wandering (as opposed to purposefully controlled thought) that appears to be under bottom-up, rather than top-down, control (Seli et al., 2015). Mind-wandering has been shown to be important to the creative process, with several studies linking this state to an increase in creative problem-solving (Tan et al., 2015; Zedelius & Schooler, 2015). Mind-wandering is linked to activation of specific regions of the brain known as the default mode network, which brings us to some of the neuroscience that has examined the creativity/mental illness connection.

Creativity and Brain Imaging Associations with Mental Illness

Brain imaging studies have also found some evidence for a connection between creativity and certain types of psychopathology (see also Vartanian, Chapter 8, this volume). In general, when people are engaged in a cognitive task, the executive network of the brain (associated with deliberate, consciously directed thinking) becomes active, while the default mode network (associated with mind-wandering) becomes deactivated. Activation of the two networks is more or less mutually exclusive (Buckner, Andrews-Hanna, & Schacter, 2008). However, two brain imaging studies have found that, in highly creative people, part of the default mode network remains active during cognitive tasks (Fink et al., 2014; Takeuchi et al., 2011), a pattern similar to that found in patients with schizophrenia (Whitfield-Gabrieli et al., 2009) and those who score high on a measure of schizotypy (Fink et al., 2014). These studies suggest that both highly creative people and those who are prone to psychosis may have difficulty inhibiting or suppressing cognitive activity irrelevant to the task performance.

White matter in the brain is formed by tracts of axons that connect neurons to each other. Jung and colleagues (2010) found reduced white matter integrity in portions of the prefrontal cortex of creative individuals that were similar to those found in schizophrenic and bipolar patients.

A positron emission tomography (PET) scan study found that high divergent thinkers had unusual dopamine D2 receptor densities in the thalamic region of the brain, similar to the pattern found in patients with schizophrenia (deManzano et al., 2010). The authors speculate that this pattern may lower the thalamic gating threshold, allowing more information to flow into cortical regions for processing. “Leaky” sensory gating, considered as a biological marker for schizophrenia, is another mechanism that allows greater than normal sensory information into awareness (Zabelina et al., 2015). In related work, Zabelina and colleagues (2015) reported that high creative achievers (but not high divergent thinkers) displayed “leaky” sensory gating, as measured by event-related potentials (P50s) in electroencephalogram (EEG) recordings.

Brain imaging studies of creativity and psychopathology, then, seem to be converging on evidence that a propensity for high levels of creativity may share brain characteristics with mental disorders that include a failure to appropriately suppress the contents of consciousness.

Creativity and Genetic Variations Associated with Mental Illness

Although everyone has the ability to be creative, there is a genetic component to the degree of creativity that one naturally expresses. Creativity appears to be influenced by multiple genetic variations (Kozbelt et al., 2014), as do the types of mental illness associated with creativity (Purcell et al., 2009). If there is a connection between creativity and mental illness, then we would expect to find an overlap in some of these genetic variants. Researchers have indeed reported such overlaps.

Kéri (2009) examined a variant in the promoter region of the neuroregulin 1 gene (NRG1) that has been linked to increased risk for psychosis and found that it was also linked to creative achievement in individuals with high intellectual and academic achievement. Reuter and colleagues (2006) found that a variant in the DRD2 gene (associated with dopamine D2 receptors) was linked to certain forms of creativity. This variant (the TAQ 1A allele) has also been associated with schizophrenia and addiction (Golimbet et al., 2003; Noble, 2000). An allele of the D4 dopamine receptor (DRD4) gene, implicated in novelty seeking, has been associated with both creativity and ADHD (Takeuchi et al., 2015).

Imagination is considered a main component of creativity. Crespi and colleagues (2016) measured thirty-three common genetic variants associated with risk for schizophrenia in a large sample of nondisordered university students and found that higher genetic risk for schizophrenia predicted better scores on a measure of imagination.

In a series of large genome-wide association studies (GWAS) using Icelandic, Danish, and Swedish population samples, Power and colleagues (2015) found higher composite risk scores for both schizophrenia and bipolar disorder were associated with measures of creativity, including membership in an artistic society, a creative profession, or high creative achievement scores.

These gene variants and polymorphisms have been shown to have complex interactions relative to creativity that we are only just beginning to understand. Research findings suggest that there is a genetic connection between creativity and certain forms of mental disorder, even if the specific nature of that connection has yet to be unraveled.

Creativity and Mental Illness: Reviewing the Evidence

The evidence summarized in this chapter indicates that there is a large and growing body of research that is investigating the interface between creativity and different forms of mental illness, including mood disorders (especially bipolar disorder), schizophrenia-spectrum disorders (especially schizotypy or psychosis-proneness), alcoholism, and, more recently, ADHD. However, it is also the case that the there is a dose-dependent or inverted-U relationship between creativity and psychopathology, with milder or subclinical versions, rather than more severe forms of disorder, conferring creative benefit. In the same vein, first-degree relatives of severely mentally ill people, who may have inherited some but not the entire genotype for a mental disorder, may reap the bulk of creative advantage. Studies do not support the idea that all – or even most – highly creative individuals suffer from mental illness but that they merely have a somewhat greater risk for disorder than the general population. Indeed, a closer look at the studies (e.g., Paek et al., 2016) suggests that the relationship of creativity with psychopathology is found to be more pronounced on the very high end of creative achievement and less prominent or nonexistent at the lower end of everyday forms of creative accomplishment and activity. Finally, there are critics who have found fault with much of the research in this field. They have brought attention to legitimate methodological limitations of some of the work and believe that the connection between creativity and madness has been over-hyped (e.g., Sawyer, 2012; Schlesinger, 2009). However, the convergence of so much evidence from such a large variety of scientific approaches suggests that, even in the face of certain methodological flaws, there is evidence of some form of connection between high levels of creativity and a risk for certain types of mental disorder (Silvia & Kaufman, 2010; Simonton, 2014; Thys, Sabbe, & De Hert, 2014). Next, we discuss possible explanations for this connection.

Explanatory Models of the Creativity/Mental Illness Connection

A number of sociocultural theories have been proposed to account for the higher incidence of certain forms of psychopathology among highly creative individuals (e.g., Becker, 2001; Richards, 1990). First, the cultural expectation model theorizes that the mad genius stereotype is engrained in our cultural expectations and that, by exhibiting "symptoms" of mental illness, creative people are either purposely enhancing their creative credentials or unconsciously acting out the part that the culture has assigned to them. Second, the "social drift" model suggests that people with mental illness tend to drift away from standard nine-to-five occupations that generally require rule-based behaviors and, in turn, drift toward creative professions such as writing, art, or music that are more lenient toward unconventional lifestyles (Ludwig, 1995). A third sociocultural theory suggests that labeling a creative person as deviant may be a method of silencing innovative ideas that threaten the status quo (e.g., Brower, 1999).

Sociocultural theories likely explain a portion of the overlap between creativity and psychopathology. However, many studies show heritability patterns of creativity and psychopathology (e.g., Heston, 1966; Jamison, 1993; Karlsson, 1970; Kyaga et al., 2013), underlying brain correlates of creativity and psychopathology (e.g., de Manzano et al., 2010), and common genetic alterations of creativity and mental illness (e.g., Kéri, 2009), suggesting that there may be an underlying biological relationship.

Looking at the evidence from a biological perspective, Baas and colleagues (2016) presented a model of creativity and psychopathology based on behavioral approach and avoidance systems. Their model suggests that creativity is positively associated with disorders of the approach system (including bipolar disorder, positive schizotypy, and ADHD) and negatively associated with disorders of the avoidance system (including unipolar depression, anxiety disorders, and negative schizotypy). Note that the approach system is mediated by the neurotransmitter dopamine and dopamine plays a central role in bipolar disorder, schizophrenia, and ADHD (Baas et al., 2016), as well as alcoholism (Volkow et al., 2013). Dopamine has also been implicated in many studies of creative functioning (e.g., deManzano et al., 2010; Reuter et al., 2006a; Zabelina et al., 2016). However, dopamine is likely not the entire story underlying the connection between creativity and risk for mental illness, or a greater percentage of people with mental illness would be making their mark creatively.

A final model, the shared neurocognitive vulnerability model, suggests that psychopathology and creativity may share genetic components that are expressed as either psychopathology or creativity depending on the presence of other moderating factors (Carson, 2011). This model suggests an explanation for why highly creative individuals are at greater risk for psychopathology than the general population. It also explains why not all highly creative individuals express psychopathology and, conversely, why not all mentally ill individuals express unusual creativity. Additionally, it may explain the increased levels of creativity in first-degree relatives of individuals with serious psychopathology (e.g., Heston, 1966; Karlsson, 1970; Kyaga et al., 2013). Finally, it may explain why certain mental disorders remain in the gene pool despite their obvious negative consequences for humanity and the lower incidence of reproduction among those who suffer from them. The shared neurocognitive vulnerability model suggests that facets of the genotype of these disorders may confer positive advantage for the species by increasing creativity when coupled with protective factors, thus promoting human adaptability.

The Shared Neurocognitive Vulnerability Model of Creativity and Psychopathology

The disorders that have been associated with creativity are both heritable and polygenetic (Berrettini, 2000; Whitfield et al., 1998) and may indeed have some genetic underpinnings in common with each other (e.g., Sharp et al., 2014). Although inheriting the entire genotype for a given disorder may predispose a person to illness, inheriting a subset of that genotype may lead to cognitive effects that are beneficial to human experience, especially when this subset is combined with certain protective factors. For example, one such cognitive effect is entry into an altered brain state that allows access to material that is normally filtered from conscious awareness. This altered brain state could be associated with psychosis in full-blown mental illness but, when combined with protective factors such as high IQ, this state could provide a neurobiological pathway through expanded *doors of perception* (Huxley, 1954), thereby promoting experiences of creative insight.

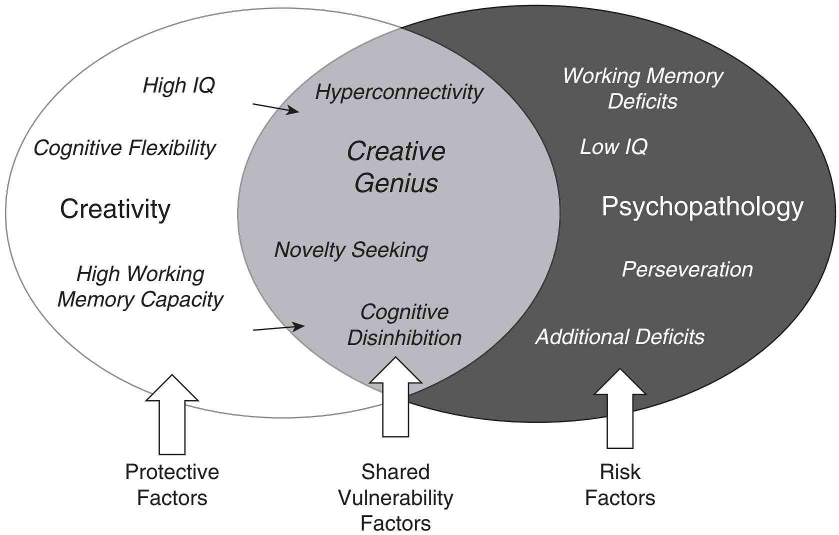

Figure 14.1 *The shared neurocognitive vulnerability model of creativity and psychopathology (from Carson, 2018)*

A predisposition to mental disorder may allow a creative person to process ideas in an unusual way to solve creative tasks (Carson, 2014a). A number of biographical accounts of the creative process (see Ghiselin, 1952) include descriptions of creative ideas that arose from unknown sources and were experienced in a manner somewhat similar to delusional "thought insertion." For example, Nobel Prize winner (and diagnosed schizophrenia patient) John Forbes Nash said that his creative mathematical breakthroughs and his delusions about outer space aliens giving him commands "came to me in the same way" (Nasar, 1998, p. 11). It seems possible, as the genome-wide studies suggest (Power et al., 2015), that some part of the polygenetic risk for psychotic disorders is contributing to the experience of creative insights.

The original shared vulnerability model (see Figure 14.1) proposed several mechanisms associated with psychopathology that could enhance creativity (Carson, 2011):

- *Cognitive disinhibition* – a condition that may promote access to material normally outside of conscious awareness. Filtering mechanisms, which typically limit the contents of awareness to stimuli relevant to current tasks, are absent or diminished in states of cognitive disinhibition. A type of cognitive disinhibition, called reduced latent inhibition, has been associated with schizophrenia, schizotypal personality, psychosis-proneness (Baruch, Hemsley, & Gray, 1988a-b; Lubow et al., 1992), ADHD (Lubow & Josman, 1993), and alcoholism (Fink et al., 2012). In short, reduced latent inhibition has been noted in virtually all the mental disorders associated with creativity. This form of cognitive disinhibition has also been associated with high creative achievement scores in high IQ samples (Carson, Peterson, & Higgins, 2003; Fink et al., 2012; Kéri, 2011).

- *Novelty-seeking* – a condition that may provide motivation to pursue novel or original tasks. Creative individuals tend to be novelty seekers (McCrae, 1993; Reuter et al., 1995). However, novelty seeking is also associated with alcohol abuse and addiction (Grucza et al., 2006), ADHD (Lynn et al., 2005), and with comorbid states of bipolar disorder and alcoholism (Frye & Salloum, 2006).
- *Neural hyperconnectivity* – a condition that may lead to unusual associations or odd combinations of preexisting information. Unusual patterns of cortical connections, both hyperconnectivity and hypoconnectivity, have been associated with schizophrenia (Whitfield-Gabrieli et al., 2009), bipolar disorder (e.g., Favre et al., 2014), schizotypal personality (Folley & Park, 2005), and ADHD (Hoekzema et al., 2014). Unusual neuronal connectivity patterns have also been noted in high-scoring creativity subjects, as well as persons with a predisposition to disorder (Fink et al., 2014; Folley & Park, 2005; Jung et al., 2010; Takeuchi et al., 2012). Additionally, hyperconnective patterns have been noted in neuroimaging studies of synesthesia, the tendency to make associations across sensory modalities such as hearing colors or smelling musical notes (Hubbard & Ramachandran, 2005). Synesthesia is seven to eight times more prevalent among highly creative individuals than in the general population (Ramachandran & Hubbard, 2001).

These are shared vulnerability factors that, when combined with protective factors, can enhance creative outcomes even while increasing risk for mental disorder. Currently identified protective factors include:

- *High IQ* – a condition that allows the individual to process and manipulate (rather than be overwhelmed by) additional stimuli and connections accessed through shared vulnerability factors. High IQ acts as a protective factor for many mental disorders (Barnett et al., 2006). My colleagues and I (Carson, Peterson, & Higgins, 2003) found that high IQ combined with reduced latent inhibition predicted creative achievement in a sample of high functioning subjects. This result has been replicated in a Hungarian sample (Kéri, 2011).
- *Enhanced working memory (WM) capacity* – a condition that allows the individual to hold information in mind, to process it, and to manipulate it (Diamond, 2013). A large body of research indicates that better WM functioning is associated with reduced symptoms in the mental disorders associated with creativity (e.g., Fried et al., 2016; Lee & Park, 2005). DeYoung and colleagues (2008) found that WM for abstract forms was associated with solving creative insight problems, and Carson (2001) reported that high scores WM for abstract forms combined with reduced latent inhibition predicted creative achievement scores in a group of high-achieving subjects.
- *Cognitive flexibility* – allows a person to change perspectives and also to disengage from common problem solutions to find less common solutions. Although cognitive flexibility is an important aspect of creative thought (Baas et al., 2008), it is often lacking in people with schizophrenia (Thoma, Wiebel, & Daum, 2007) and ADHD (Kramer et al., 2001). It may therefore serve as a protective factor to allow creative individuals with shared vulnerabilities the flexibility to move between states of cognitive disinhibition and cognitive control (Carson, 2014b).

Although shared vulnerabilities allow the person access to material normally unavailable in consciousness, protective factors may provide the means to process and manipulate that material to form original and adaptive ideas and products rather than becoming overwhelmed by the excess stimuli. The shared vulnerability model is fluid and will continue to expand as our knowledge of brain function and gene interactions increases.

Creativity and Psychopathology: The Paradox Explained

We began by noting the paradox of creativity and mental health. On the one hand, creativity is a crucially important human trait. Creative activity, at least the everyday variety (Conner et al., 2016), is associated with positive mental health. On the other hand, we have seen quite a large body of evidence (although certainly all of it not undisputed) for increased risk of mental illness in high-level creative achievers. Simonton (2014) has labeled this the “mad genius paradox.” He suggests that, across the spectrum of creative accomplishment, creativity is related to positive mental health. However, as the level of creative achievement increases, the risk for psychopathology also increases, with the greatest risk for mental disorder carried by those at the highest end of the creative achievement distribution. This theory fits well with the shared neurocognitive vulnerability model. Individuals who have protective factors but lack the shared vulnerability factors represent the large group who contribute to everyday forms of human creativity. However, that smaller group of creators with shared vulnerability factors *and* protective factors not only may be at greater risk for psychopathology but may also be in a position to make the most original and outstanding creative contributions, taking creativity from the realm of everyday magic to that of genius.

Despite some methodological flaws, the bulk of evidence – from anecdotal accounts to brain imaging and molecular genetic research – suggests that, at the highest levels of creative achievement, there may an increased risk for certain disorders, especially bipolar disorder, psychosis-proneness (schizotypy), alcohol dependence, and ADHD. The evidence also suggests that there is a genetic component to both creativity and the forms of mental disorder that are associated with creative achievement. The evidence further suggests that milder, perhaps subclinical, versions of these disorders are more beneficial to creativity than are full-blown manifestations of disorder. However, even though the evidence points to an increased risk for these disorders among highly creative individuals, it is just that – an increased risk. The research does not suggest that all, or even a majority, of those who achieve high levels of creative accomplishment suffer from mental illness; the majority of highly creative people are in the nondisordered category, perhaps manifesting some subclinical trait presentation. A shared neurocognitive vulnerability model appears to account for the current data in this field.

Research on the relationship between creativity and mental illness is ongoing. As we learn more about how both creativity and psychopathology manifest in the human brain, we will hopefully be able to design interventions to increase protective factors in those individuals who demonstrate shared vulnerability factors, thereby increasing their chances of making original and adaptive contributions and decreasing their chances of suffering from the demons of full-blown mental illness. Creativity has been and continues to be our pathway to survival, adaptation, and a life of rich and full experience. Continuing research into the mechanisms of creative thought, whether associated with mental illness or mental health, will inform our journey on that pathway.

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15 Creativity and Healing

Marie Forgeard

Writer and social worker Gerri Luce started composing her first memoir during a psychiatric hospitalization. She later explained that writing allowed her "to develop an identity that would transcend [her] illness" (Luce, 2012, para. 3). In spite of the severity of her difficulties, Luce found a path to health by investing energy into a creative project, leading her to conclude that "creativity has the ability to heal wounds, to soothe pain" (Luce, 2012, last para.). Luce's words echo those of many others who previously reported that creative work helped them cope with suffering. From writers Virginia Woolf, Graham Greene, or Anne Sexton to painters Vincent Van Gogh, Paul Klee, or Frida Kahlo (among many others), many eminent creators have described the therapeutic effects of engaging in creative undertakings (Caramagno, 1992; Sandblom, 1997; Van Gogh, 1889), defined as activities during which individuals generate potentially novel and useful ideas or products (Sternberg & Lubart, 1999). In parallel with these anecdotal reports, clinicians also noticed that some individuals receiving treatment for severe psychiatric difficulties display high levels of motivation and inspiration for creative projects. Soon after World War I, German psychiatrist Hans Prinzhorn built a well-known collection of art created by individuals hospitalized in Heidelberg for psychiatric reasons. His book became a bestseller, and the art of the mentally ill, judged to have a raw and pristine creative quality, would inspire that of twentieth-century expressionist artists throughout Europe (Thys, Sabbe, & De Hert, 2013). Building on this potential source of strength and opportunity for self-expression, clinical treatment programs typically offer patients opportunities to engage in artistic activities using various modalities (e.g., the visual arts, music, drama, dance, or play) (Malchiodi, 2013).

The relationship between creative behavior and healing may be especially important in artistic fields, as past historiographic/biographical studies have shown that individuals working in such fields tend to experience higher than average levels of lifetime adversity, including but not limited to psychological difficulties (for reviews, see Johnson et al., 2012; Kaufman, 2016; Ludwig, 1995; Simonton, 1994; also see Carson, Chapter 14, this volume). Many explanations have been given for this link, including the idea that vulnerability to difficulties (in particular, bipolar disorder) may also confer advantages for the creative process (e.g., increased energy, drive, or motivation to produce creative work) (Johnson et al., 2012). However, this link may also be explained by the hypothesis that people who are suffering are compelled to engage in creative activities specifically because they may bring relief and have therapeutic effects (Forgeard & Elstein, 2014) and bring improvement in well-being (Cropley, 1990, 1997; Richards, 2007).

The goal of this chapter is to review empirical evidence supporting the claim that creative activities and behaviors have the capacity to heal suffering and to critically evaluate both the strengths of past research and the important gaps and unanswered questions in this area of scholarship. Because much of the research addressing this claim has been carried out in the discipline of art therapy, the chapter begins by reviewing evidence pertaining to the usefulness of creative artistic activities for psychopathology and well-being, focusing on visual arts and poetry/creative writing (many other modalities exist, including music, drama/theater, dance/movement, humor but, for brevity, they are not reviewed here). Second, this chapter examines a number of psychological processes that could explain why the generation of novel and useful ideas or products appears to be helpful during the healing process. In doing so, this chapter examines a key gap in the literature: Although a growing body of research supports the idea that creative activities have therapeutic effects, little empirical evidence to date has shown that it is specifically because of their creative nature that relief is obtained. Throughout, this chapter suggests future directions for scholarship to further understand when and how creative behavior has healing effects.

Usefulness of Interventions Utilizing Creative Modalities

Art therapy. As explained, the bulk of evidence demonstrating that creative activities have therapeutic effects consists of findings from the art therapy literature. In art therapy, individuals are, by definition, provided with a space to potentially come up with novel and meaningful ways of expressing themselves. Art therapy is typically delivered by a master's-level clinician with specialized training, though individuals receiving treatment in a number of settings (e.g., hospital, community health center) may also engage in artistic activities with other staff members (e.g., mental health workers, psychologists, physicians, nurses). According to the American Art Therapy Association (2017), art therapy can help address a wide range of challenges (e.g., challenges related to illness, trauma, or other difficulties) and consists of using artistic activities to increase awareness of and reflect on personal experiences, stimulate cognition, and engage in a potentially pleasurable activity. Art therapy is often (but not always) offered as a supplementary adjunctive intervention, and approaches to art therapy vary widely according to the training and approach pursued by the clinician (e.g., psychoanalytic, cognitive behavioral, supportive, narrative approaches) (AATA, 2017; Malchiodi, 2013).

Interventions using visual arts activities have documented that art therapy may be beneficial for a range of problems and populations. Efficacy studies examining their usefulness using randomized controlled trials have found significant improvements for an array of outcomes, though effects tend to be small (Maujean, Pepping, & Kendall, 2014; Reynolds, Nabors, & Quinlan, 2000; Slayton, D'Archer, & Kaplan, 2010). Uncontrolled and/or nonrandomized studies assessing the effectiveness of art therapy have also evidenced varying degrees of usefulness for the psychological functioning of individuals experiencing mood disorders and symptoms (Gussak, 2006, 2007, 2009; Thyme et al., 2007), psychosis (Meng et al., 2005; Richardson et al., 2007), trauma (Eaton, Doherty, & Widrick, 2007; Lyshak-Stelzer et al., 2007; Ottarsdottir, 2010; Steele & Raider, 2001), or dementia (Rusted, Sheppard, & Waller, 2006), among other difficulties. Art therapy may also be useful for individuals experiencing health problems, including cancer (Bar-Sela et al., 2007; Geue et al., 2010; Monti et al., 2006; Puig et al., 2006; Svensk et al., 2008) and asthma (Beebe, Gelfand, & Bender, 2010). Although evidence pertaining to the benefits of art therapy is promising and growing, other studies have not found positive effects (e.g., Crawford et al., 2012), suggesting the need to further investigate the circumstances under which art therapy is or is not helpful and the best methods to test outcomes of interventions that utilize creative modalities.

Interventions using writing (poetry or prose) as a medium have also shown that this modality has therapeutic effects. Writing poetry may provide an avenue for healing and personal growth through experiencing and expressing emotions in a condensed and organized format (Carroll, 2005; Mazza, 2016). Specific features of poetry (e.g., the use of metaphor and imagery) may be particularly well suited to express emotional experiences that are hard to describe, including painful ones, into words (Andrews, 2011). Qualitative and quantitative studies have shown beneficial effects of writing poetry for individuals suffering from psychosis (Miller, 1978), addiction (Springer, 2006), and posttraumatic stress (Brillantes-Evangelista, 2013; Boone & Castillo, 2008; Springer, 2006), as well as for the well-being of individuals facing cancer (Tegner et al., 2009) or infertility (Tufford, 2009). In doing so, poetry may help both enhance positive emotion and provide meaning, purpose, and empowerment (Croom, 2015; Ingram, 2003). The benefits of writing prose present similarities, and the relative looseness of constraints for writing prose (compared to poetry) may also provide additional opportunities to explore both positive and painful personal experiences (Burton & King, 2004, 2008; Lyubomirsky, Sousa, & Dickerhoof, 2006; Philips, Linington, & Penman, 1999). A large body of studies has shown that expressive writing enhances a wide range of health outcomes, including physical health markers, mood symptoms, and cognition (Frattaroli, 2006; Pennebaker, 1997; Sexton & Pennebaker, 2009; Smyth, 1998; cf. Meads & Nouwen, 2005). During an expressive writing task, individuals describe past events they have experienced and are provided with the opportunity to process difficult personal experiences. Participants are not explicitly prompted to write in a creative manner (i.e., to generate novel and/or useful writing), though participants may come up with unique insights and produce creative texts in the process. One limitation of this body of evidence is that effects appear to be stronger in healthy samples (Harris, 2006). In addition, benefits may be most notable for males and for processing past traumatic experiences, as well as when writing is done in the laboratory (vs. at home) and with high frequency (Frattaroli, 2006).

Processes at Play

How might the opportunity to engage in creative thinking and/or behavior promote healing? Although some of the research reviewed in the previous section has suggested potential processes, additional scholarship is needed to delineate what variables account for observed benefits. Relevant studies may help shed light on the degree to which benefits of creative activities are accounted for by general processes or by specific processes inherently tied to the creative process (Forgeard & Elstein, 2014). So far, research documenting the specificity of the benefits of creative activities is scarce.

Affect. Perhaps the best-studied process is the degree to which creative activities may directly influence positive and negative affect. Developmental research has shown that pretend play abilities are related to emotion regulation in children (Hoffmann & Russ, 2012). In addition, a body of experimental research using healthy populations has shown that artistic activities enhance short-term mood and can help counteract the effects of negative mood inductions. By manipulating instructions (e.g., asking participants to draw in order to vent negative emotions vs. to distract oneself), these studies have also shown that creating to distract oneself is especially effective, standing in contrast with the psychodynamic idea that catharsis, the venting of negative emotions, accounts for the therapeutic effects found (Dalebroux et al., 2008; DePetrillo & Winner, 2005; Drake et al., 2011).

Recent research using intensive longitudinal data also supports the idea that creative behavior enhances well-being through its associations with affective processes. In a sample of art students, the likelihood that participants were engaging in creative activities during their everyday life was related to two aspects of positive affect – how happy and how active they felt (Silvia et al., 2014). Similarly, Conner and Silvia (2015) found that daily reports of self-perceived creativity were associated with positive/activated emotions such as excitement, especially for participants high in the personality trait of openness to experience. Baseline individual differences in creativity may also generally predispose individuals to regulate stress and emotions more effectively, a claim supported by research focusing on the personality trait of openness of experience. This trait reflects "individual differences in the ability and tendency to seek, detect, comprehend, utilize, and appreciate complex patterns of information, both sensory and abstract" (DeYoung, 2014, p. 2) and is one of the best predictors of creative achievement (Feist, 1998). Importantly, openness to experience also predicts more adaptive affective responses to stress (McCrae & Sutin, 2009; Williams et al., 2009). Thus, being open and curious about new perspectives, a tendency associated with creativity, may help with stress regulation by preventing maladaptive suppression or avoidance-based coping strategies (e.g., Schneider et al., 2012; Weinstein & Ryan, 2011; Williams et al., 2009).

Meaning-making and growth following adversity. Creative activities may also be particularly well suited to help participants make meaning out of difficult experiences. Studies of expressive writing to improve health (see previous section) have shown that writing seems to be most effective when participants use this activity to reappraise past adverse events, as indicated by the proportion of words used describing cognitive activities (Pennebaker & Seagal, 1999; Sexton & Pennebaker, 2009). Thus, describing personal experiences may provide an opportunity to come up with new insights or ways to make meaning out of adversity. Research pertaining to psychological growth following adversity has also begun to investigate the degree to which individuals subjectively perceive changes in their own creative capacities following highly stressful events. The types of adversity examined in literature on constructs such as *posttraumatic growth* (PTG), *stress-related growth*, or *benefit-finding*, among others (Helgeson, Reynolds, & Tomich, 2006; Park, Cohen, & Murch, 1996; Tedeschi & Calhoun, 2004) range in types and intensity but generally consist of impactful life events that have the potential to be very stressful or traumatic and life-changing. Such events may force individuals to reconsider assumptions or beliefs they previously took for granted about themselves and their lives and to engage in deliberate cognitive processing to make meaning out of past experiences (Cann et al., 2011; Janoff-Bulman, 1992, 2006). Researchers in this area have shown that individuals tend to report five main types of growth following adversity, namely improved interpersonal relationships, new possibilities for one's life, enhanced feelings of personal strengths, heightened appreciation for life, and renewed spirituality (Tedeschi & Calhoun, 2004). Increased creativity may also be part of this phenomenon (Aldwin & Sutton, 1998; Bloom, 1998; Zausner, 1998). One study showed that for a group of participants suffering from cancer, taking part in an arts program was associated with increases in self-reported posttraumatic growth (Garland et al., 2007). More recently, another study found that when asked to think about the most impactful stressful event they had ever experienced, participants in an online sample who reported higher levels of distress associated with the event also reported larger self-perceived increases in creativity (Forgeard, 2013). This preliminary research is limited by the retrospective nature of reports (obtained at a single time point), which represent people's perceptions of their own creative abilities but may or may not reflect their behaviors.

Retrospective and subjective perceptions of growth (in creativity or other domains) are likely to be biased by a number of concerns (Frazier et al., 2009). These include potential self-deception, ongoing attempts to cope with negative events experienced, social desirability, conformity with the cultural narrative that adversity should make one stronger, and, importantly, difficulty remembering and calculating change (i.e., growth) since adverse events occurred and difficulty evaluating the degree to which the event truly caused perceived changes, among others (for reviews, see Jayawickreme & Blackie, 2014, 2016). Recent historiographic work has nonetheless demonstrated that developmental adversity predicted artistic and scientific success in a sample of eminent African American individuals (Damian & Simonton, 2015; see also Ritter et al., 2012). Experimental research looking at more minor forms of adversity has also shown that the experience of social rejection can foster enhanced creative performance for people holding an independent self-concept by increasing people's motivation to differentiate themselves from others (Kim, Vincent, & Goncalo, 2013). Additional research utilizing multimethod and longitudinal measurement approaches is needed to further examine the claim that adversity is associated with increased creativity. Importantly, and most relevant to the theme of this chapter, additional work is also needed to support the claim that creative activities may reflect a way in which individuals heal and/or make meaning from difficult experiences.

Creative and general self-efficacy. Another process that has started to garner attention is the degree to which creative activities can enhance participants' sense of self-efficacy. One hypothesis is that creative activities may influence individuals' perceptions of their own creative capacities – in other words, their creative self-efficacy. This construct, which is defined as the subjective belief that one is able to come up with novel and useful (i.e., creative) ideas, products, or behaviors (Beghetto, 2006; Tierney & Farmer, 2002), is associated with well-being (Karwowski & Lebuda, 2016). This psychological process is especially interesting because it is directly linked to the core process hypothesized to be responsible for healing – that is, the capacity to engage in creative thinking and/or behavior. For example, in one study, students' sense of creative self-efficacy during extracurricular activities related to indices of psychological adjustment for some types of activities (e.g., athletic, prosocial) but not others (e.g., artistic, academic) (Forgeard & Benson, in press). Importantly, these findings also controlled for feelings of general self-efficacy, defined as the degree to which individuals perceive that they can control events in their lives and take action to solve problems (Bandura, 1997; Pearlin & Schooler, 1978). Simultaneously, accounting for the roles of creative and general self-efficacy is important because these processes are likely closely related (i.e., individuals who feel efficacious about their ability to be creative are also likely to be confident about their abilities in general) and because general self-efficacy is a known predictor of psychopathology and well-being (Bandura et al., 1999; Chorpita, Brown, & Barlow, 2016).

Other general processes. The role of other general processes is important to note, although research on their role is relatively scarce. For example, several authors have noted that creative artistic activities lend themselves particularly well to practicing mindfulness (Clark, 2016; Monti et al., 2006; Rosal, 2016) by providing a fertile space to pay "attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 2013, p. 4). Mindfulness is a key skill in third-wave therapies (e.g., Hayes & Lillis, 2012; Linehan, 1993; Segal, Williams, & Teasdale, 2012). By focusing on one's experience while creating an original product, participants may learn to manage internal experiences (Chambers, Gullone, & Allen, 2009).

Another process worth investigating when creative activities are conducted in a social setting (i.e., with a facilitator/clinician or in a group setting) is the opportunity to promote feelings of social connectedness, a known therapeutic process (e.g., Martin, Garske, & Davis, 2000; Marziali, Munroe-Blum, & McCleary, 1997). Past research suggests that group creative activities can decrease feelings of isolation and provide opportunities for sharing of experiences and to offer/receive help (e.g., Johnson & Sullivan-Marx, 2006; Levine-Madori, 2013). In general, much more research is needed in order to understand the effects of creative behavior on psychological adjustment processes and to determine whether such behavior confers unique benefits. Such research can help maximize the benefits of creative activities by assessing the circumstances under which they are helpful and also investigate individual differences that may affect the degree to which healing occurs.

Conclusions

This chapter summarized the state of research, examining the claim that creative activities have the potential to enhance well-being and mental health outcomes. A growing body of research suggests that interventions based on their use are useful across a range of problems and populations. Further scholarship using a variety of methods (e.g., randomized controlled trials, effectiveness studies, qualitative research) will continue to bolster scientific evidence by replicating and extending previous findings. This chapter also proposed that process-focused research investigating how creative activities enhance well-being is needed in order to better understand whether and how interventions utilizing creative activities differ from more general interventions. Finally, future research should also more thoroughly examine relationships between creativity in nonartistic domains and well-being. To date (and as a reflected in this review), most of the research in this area has focused on artistic activities, perhaps because lay conceptions of creativity tend to emphasize art to the detriment of other domains – a phenomenon known as the “art bias” (e.g., Glăveanu, 2014). Examining the potential benefits of other applications could both help expand the common understanding of this important psychological process and yield new insights into the value of creativity in a wide range of domains. These might include everyday manifestations (e.g., resolving interpersonal dilemmas, coping with daily life problems), scholarly pursuits (e.g., preparing arguments for a debate), and science/invention (e.g., building something) (Kaufman, 2012; McKay, Karwowski, & Kaufman, 2017). Such research can also help enhance the development and implementation of new interventions utilizing a wide range of creative modalities, as well as explore individual differences in preference for, and response to, such interventions.

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PART III

Differential Bases for Creativity

Individual Differences in Creativity

16 The Relation of Creativity to Intelligence and Wisdom

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Creativity is often studied in isolation from other principal mental skills and attitudes but it is closely related, especially to intelligence and wisdom (Sternberg, 2003c) as well as insight (Sternberg & Davidson, 1982). Creativity is one's ability to generate ideas that are novel, surprising, and compelling (Kaufman & Sternberg, 2010). In addition, intelligence is one's ability to learn, to think, and to adapt to the environment (Sternberg & Kaufman, 2011). Lastly, wisdom is one's ability to seek a common good, to understand multiple points of view, and to balance one's own interests with those of others and of larger entities (Sternberg & Jordan, 2005). The three attributes would seem to be connected, but how?

We will first discuss implicit theories of creativity, intelligence, and wisdom. Next, we will highlight key theories of intelligence that incorporate creativity, discussing relevant empirical research for each theory. We will then discuss theories of wisdom that incorporate intelligence and creativity. Finally, we draw some conclusions based on these discussions.

Theories of the relation of creativity to intelligence and wisdom are of two kinds – implicit theories (folk conceptions) and explicit theories. We consider each in turn.

Implicit Theories of Creativity, Intelligence, and Wisdom

One way to study the relation of creativity to intelligence and wisdom is to ask people about the relationship between the two. Instead of merely asking for their opinions, however, one can collect data that are more likely to shed light on people's conceptions, or implicit theories, of their relationship.

Sternberg (1985b) performed a series of studies to investigate the relationships among intelligence, creativity, and wisdom. In a prestudy, participants were asked merely to list behaviors that characterized an ideally intelligent, creative, or wise person. The lists of behaviors collected then served as a basis for subsequent studies conducted.

In the first study, sortings of intelligence, creativity, and wisdom were multidimensionally scaled to yield underlying dimensions of each construct. For creativity, the underlying dimensions (and polarities, or extremes) were

- *Nonentrenchment* – someone who thinks in a nonconformist, unorthodox way, and who takes chances and is not afraid to defy conventional ways of thinking
- *Integration and intellectuality* – someone who makes connections, as well as distinctions between ideas and things, who can synthesize information in a new way, and who can grasp abstract ideas
- *Aesthetic taste and imagination* – someone who has good taste and aesthetic imagination, who has good taste, and an appreciation of art, music, and related forms of expression
- *Decisional skill and flexibility* – someone who weighs the pros and cons of a decision but then follows his or her gut feelings, and who has the ability to change direction in his or her thinking – who does not get stuck in ways of seeing things

These dimensions were somewhat different from those for either intelligence or wisdom. For intelligence, the dimensions were practical problem-solving ability, verbal ability, intellectual balance and integration, goal orientation and attainment, contextual intelligence, and fluid thought. The need for integration was common to both creativity and intelligence, and fluid thought is important to both as well. For wisdom, the dimensions were reasoning ability, sagacity, learning from ideas and environment, judgment, expeditious use of information, and perspicacity. Creativity came out in the dimensions as less similar to wisdom than to intelligence. Certainly, reasoning and learning from ideas and environment would be relevant to creativity but, in terms of the dimensions, there was not much overlap.

It was possible from this first study to examine correlations between rated behaviors for the participant samples of the study, who were drawn from professors of art, business, philosophy, and physics, and from laypersons. The correlations between pairs of ratings are shown in Table 16.1.

If we were to summarize the results, we would point out the following. First, overall, the participants saw creativity, intelligence, and wisdom as positively correlated (with one exception, which is mentioned below, regarding the relationship between intelligence and wisdom for participants in business). Second, creativity is viewed in implicit theories across groups as more related to intelligence than to wisdom. Third, there is a rather stunning *negative* correlation between creativity and wisdom among the business professors. Therefore, the business professors tended to view creative individuals as unwise; or, they viewed wise individuals as uncreative. Fourth, business professors and laypeople (to some extent) saw creativity as only weakly related to intelligence; contrastingly, philosophy professors see them as fairly highly related.

In a second study, participants rated themselves on behaviors related to intelligence, creativity, and wisdom; these ratings were correlated with scores on tests of intelligence and of social intelligence. If you view Table 16.2, the results are fairly straightforward. First, the two tests of fluid intelligence correlated significantly with ratings of intelligence but not with ratings of creativity or wisdom. Second, the tests of social intelligence correlated with ratings of wisdom but not with ratings of creativity. For the next correlation, the results were mixed: correlations of the

Table 16.1 *Intercorrelations of ratings based on implicit theories of intelligence, creativity, and wisdom*

Art			
	Intelligence	Creativity	Wisdom
Intelligence	1.00	0.55	0.78
Creativity		1.00	0.48
Wisdom			1.00
Business			
	Intelligence	Creativity	Wisdom
Intelligence	1.00	0.29	0.51
Creativity		1.00	−0.24
Wisdom			1.00
Philosophy			
	Intelligence	Creativity	Wisdom
Intelligence	1.00	0.56	0.42
Creativity		1.00	0.37
Wisdom			1.00
Physics			
	Intelligence	Creativity	Wisdom
Intelligence	1.00	0.64	0.68
Creativity		1.00	0.14
Wisdom			1.00
Laypersons: Ideal			
	Intelligence	Creativity	Wisdom
Intelligence	1.00	0.33	0.75
Creativity		1.00	0.27
Wisdom			1.00

Data adapted from Sternberg (1985b). All correlations were statistically significant.

social-intelligence tests with ratings of intelligence; one correlated significantly and the other did not. Overall, neither the tests of fluid intelligence nor the tests of social intelligence were good measures of ratings of creativity.

Do the results of a study of implicit theories of creativity, intelligence, and wisdom hold much value? After all, the results reflect what people thought about the

Table 16.2 *Correlations of prototype scores with ability tests*

	Intelligence	Creativity	Wisdom
Cattell & Cattell Test of *g*	0.48***	0.17	−0.01
Embedded Figures	0.54***	0.04	−0.14
George Washington Social			
Intelligence Test	−0.06	−0.06	0.38**
Chapin Social Insight Test	0.43**	0.19	0.46***

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

constructs, not for what the constructs actually were. It is worth keeping in mind that explicit (formal) theories of psychological constructs also have their origins in implicit theories, namely of the designated experts who propose the theories. Furthermore, the overwhelming majority of judgments people make in their lives are not based on results from ability tests (Spear-Swerling & Sternberg, 1994) but rather on their implicit theories as revealed in their everyday interactions. In other words, they make their evaluations based on informal criteria that allow them to implement their implicit theories. When people judge each other as creative, intelligent, or wise, it probably will not be as a result of a test score but as a result of implicit theories that are manifested in their daily or special interactions with others. However, as one could expect, explicit theories can tell us a great deal as well.

Explicit Theories of Intelligence That Include Creativity and Wisdom

There are various theories that could be cited that deal with relations among intelligence, creativity, and wisdom. One key question to consider is whether we seek theories of intelligence that account for creativity and wisdom, theories of creativity that include intelligence and wisdom, or theories of wisdom that encompass creativity and intelligence (e.g., Sternberg & O'Hara, 1999). Given that there is already a chapter covering creativity theories in detail (see Kaufman & Glăveanu, Chapter 2, this volume), we limited ourselves to theories (and supporting research) of intelligence and wisdom. Although there are many theories of intelligence, we have selected five that we believe offer different perspectives on how creativity is related to intelligence: the Structure of Intellect model (Guilford, 1967), the Cattell–Horn–Carroll theory (Horn & Cattell, 1966), the PASS model (Luria, 1970), the Multiple Intelligences (MI) model by Gardner (2011a), and the Wisdom-Intelligence-Creativity Synthesized (WICS) model by Sternberg (2003b). These five accounts are described in detail below.

Structure of Intellect (SOI): Guilford's Pioneering Model

Guilford's Structure of Intellect model was perhaps the first that explicitly showed the relationship between intelligence and creativity; however, it did not attempt to account for wisdom.

J. P. Guilford (1967, 1982; Guilford & Hoepfner, 1971) proposed a model with 120 distinct abilities (it was increased to 150 in 1982 and to 180 in later manifestations of the model). The basic theory arrays abilities along three dimensions: operations, products, and contents. In the best-known version of the model, there are five operations, six products, and four contents. The five operations are cognition, memory, divergent production, convergent production, and evaluation. The six products include units, classes, relations, systems, transformations, and implications. The four contents are figural, symbolic, semantic, and behavioral. Since these dimensions are completely crossed with each other, they yield a total of 5 × 6 × 4, or a total of 120 different abilities. For example, inferring a relation in a verbal analogy (such as the relation between BLACK and WHITE in BLACK : WHITE :: HIGH : LOW) would involve cognition of semantic relations.

In Guilford's model, creativity is especially related to divergent production. It could involve divergent production of semantic content (e.g., word fluency in writing), of symbolic content (e.g., in generating a new mathematical proof), of figural content (e.g., painting pictures), or of behavioral content (e.g., an unexpected gesture toward another person). Guilford's tests of creativity (discussed in Plucker, Makel, & Qian, Chapter 3, this volume) were generally divergent thinking tests; for example, for unusual uses of a paperclip. According to Guilford, therefore, creativity can largely be understood as part of the general structure of intellect.

Guilford supported his model by a type of confirmatory factor analysis that has not fared well psychometrically. Horn and Knapp (1973) showed that random theories could generate support equal to Guilford's model when the same type of rotation was used as Guilford – a so-called Procrustean rotation. Horn (1967) showed that equal support could be obtained with Guilford's theory but with data generated randomly rather than with real data. These demonstrations do not prove the model wrong: They show only that the psychometric support that Guilford claimed for his model was not justified by his methods. Although Guilford's model is not well supported empirically, it was one of the first models, perhaps *the* first, explicitly to take on the relationship between creativity and intelligence.

Cattell–Horn–Carroll Theory: Origins in *g*, Development and Use

Much of the early work on intelligence assumed the existence of a general intelligence factor, or *g* (Spearman, 1904). Although some current researchers still rely largely or exclusively on *g* (e.g., Gottfredson 2016), most have moved to more nuanced approaches. Unfortunately, much of the research on the relationship between intelligence and creativity is based on studies that use a *g* approach.

For example, studies that use the *g*-factor to measure the relationship between intelligence and creativity have found a mild positive correlation (Barron &

Harrington, 1981; Wallach & Kogan, 1965). The threshold theory, once accepted wisdom, posited that there was a positive relationship between creativity and intelligence up until a person's IQ of about 120 (Getzels & Jackson, 1962). Kim's (2006) meta-analysis found that the (small) correlation between creativity and intelligence did not change depending on a person's IQ. Again, however, her meta-analysis was largely based on studies using a *g* measure. Slowly, creativity research is moving beyond *g*: a theory used in many current studies is the Cattell–Horn–Carroll (CHC) theory (Kaufman, 2015; Kaufman & Plucker, 2011; Kaufman, Kaufman, & Plucker, 2013). This theory grew out of the Cattell–Horn theory of fluid (*Gf*) and crystallized (*Gc*) intelligences (Horn & Cattell, 1966), and Carroll's (1993) Three-Stratum Theory, which proposed a hierarchy of intellectual abilities (McGrew, 2009; Schneider & McGrew, 2012). Both theories had their roots in *g*.

The Cattell-Horn theory started with Raymond B. Cattell and his student, John L. Horn, drawing on the general ability factor (*g*), and expanding it to fluid intelligence (*Gf*), and crystallized (*Gc*) intelligence. According to the model, fluid intelligence involves inductive, deductive, and quantitative reasoning with new content and systems to be learned. Fluid intelligence can help a person in solving novel problems, as well as encoding their short-term memories. Crystallized intelligence, on the other hand, includes the process of knowledge acquisition and learning new skills; these new skills can also be applied to solving problems (Willis, Dumont, & Kaufman, 2011). Batey and Furnham (2006) suggested that *Gf* and *Gc* in creativity may vary according to the age of a creative person. They theorized that *Gf* might be more important earlier in life, as a person might be in the mini-c and little-c stages (Beghetto & Kaufman, 2007), while *Gc* would be more valuable later on in life, as the person would be in the Pro-c stage (Kaufman & Beghetto, 2009). Many studies that aim to move beyond *g* stick to *Gf* and *Gc*. Some find that creativity is more related to *Gf* than *Gc* (e.g., Batey, Chamorro-Premuzic, & Furnham, 2010; Batey, Furnham, & Safiullina, 2010), whereas others find *Gc* is more related to creativity (e.g., Cho et al., 2010).

The contradictory results may reflect that *Gf* and *Gc* are now only part of a larger theoretical model. Carroll created a theory of cognitive abilities involving three strata of abilities that were intended to include all types of intelligences, and to account for the individual differences in intelligence, as well as how these individual differences are related to each other (Schneider & McGrew, 2012). The CHC theory expanded the original model to incorporate broad and narrow abilities. At this writing, there are sixteen different abilities incorporated in the model, including six broad abilities, four acquired-knowledge abilities, and six domain-specific sensory and motor functions (van Aken et al., 2017). The six broad abilities include fluid intelligence (*Gf*), short-term memory (*Gsm*), long-term storage and retrieval (*Glr*), processing speed (*Gs*), decision speed/reaction time (*Gt*), and psychomotor speed (*Gps*). The four abilities that focus on knowledge acquisition are crystallized/comprehension intelligence (*Gc*), domain-specific knowledge (*Gkn*), reading and writing knowledge (*Grw*), and quantitative knowledge (*Gq*). Finally, the six domain-specific sensory and motor functions are visual processing (*Gv*), auditory processing (*Ga*), olfactory (*Go*), tactile (*Gh*), kinesthetic (*Gk*), and psychomotor abilities (*Gp*) (for a fuller description of the model, see van Aken et al., 2017; Schneider & McGrew, 2012).

Curiously and counterintuitively, the new CHC model places creativity within the *Glr* ability (Kaufman, 2015; Plucker et al., 2014). *Glr* is comprised of two components: learning efficiency and fluency. The underlying logic is that being creative entails encoding and remembering a wide variety of information and then being able to remember relevant information that may solve a problem at hand (Kaufman, Kaufman, & Lichtenberger, 2011). This process would be similar to Associational Theory (Mednick, 1962), which argues that bigger semantic differences can represent remote associations. Someone with a wide range of knowledge to draw from and the ability to connect disparate concepts could be more creative. There have been studies linking *Glr* to rated creative performance (Avitia & Kaufman, 2014) and divergent thinking (Benedek, Könen, & Neubauer, 2012; Silvia, Beaty, & Nusbaum, 2013). Avitia and Kaufman (2014) supported Kaufman and colleagues' (2011) hypothesis that the fluency component would be related to creativity but not the learning efficiency component.

Although *Glr* is clearly related to creativity in some way (particularly given the small, but notable, empirical support), it seems simplistic to take such a limited view of the construct. In addition to the research on *Gc* and *Gf*, there have also been studies that connect *Gs* to creativity (e.g., Vartanian, Martindale, & Kwiatkowski, 2007). Yet our concern is not alleviated by creativity's various relationships to three additional abilities. All of these connections conceptually are focused on small aspects of creativity (working with something new, using acquired knowledge, being able to retrieve the right information at the right time). Until the CHC theory is expanded further, creativity is poorly represented (Kaufman, 2016).

The Planning, Attention, Simultaneous, & Successive (PASS) Model

IQ tests based on theory use either CHC or the Planning, Attention, Simultaneous, and Successive (PASS) model. Derived from Luria's (1970) neuropsychological framework, the PASS model promotes the idea that there are three major functional units of the brain: one unit that focuses and sustains attention, the second that receives and stores information successively and sequentially, and the third that makes decisions, self-monitors, and plans (Das, Naglieri, & Kirby, 1994). The third functional unit is theorized to be related to creativity (Naglieri & Kaufman, 2001). One study found that people who spent time planning a project, which represents the third functional unit of the PASS model, were more creative and more productive (Redmond, Mumford, & Teach, 1993). Another study found that mind-wandering can help both planning and creativity, again related to the third functional unit (Mooneyham & Schooler, 2013).

Multiple Intelligences Theory (MI – Gardner)

The MI theory (Gardner, 1983, 1995, 2006, 2011b) holds that intelligence is not a single thing, but rather that intelligences are multiple. In the current version of the theory (Gardner, 2011b), there are eight distinct multiple intelligences:

Linguistic intelligence. Linguistic intelligence is involved in the use of words and language in general. Linguistic intelligence allows us to listen, read, speak, and write effectively. This intelligence is needed to understand poetry, novels, speeches, debates, and verbal media. Most IQ tests measure linguistic intelligence, as do many achievement-oriented tests, such as the SAT and the ACT. School achievement tests often draw heavily on linguistic intelligence.

Logical-mathematical intelligence. Logical-mathematical intelligence is used to solve logic and mathematical problems. It is heavily involved in school subjects, such as arithmetic at the lower grade levels, and later on in Algebra, Geometry, Calculus, and Trigonometry. It is also involved in causal reasoning. Logical-mathematical intelligence is measured by many intelligence tests, as well as by achievement-oriented tests, such as the SAT and ACT. School achievement tests also often draw heavily on logical-mathematical intelligence.

Visual-spatial intelligence. Visual-spatial intelligence is involved in mentally rotating objects in one's head – for example, imagining how to fit suitcases into the trunk of a car, imagining what a building project will look like when it is done, solving jigsaw puzzles, making sense of maps and routes planned using maps, and finding one's way from one place to another without the use of a map. When we drive, we use visual-spatial intelligence to navigate from place to another. Also, when we get lost, we use – or at least try to use – visual-spatial intelligence to find our way back to the correct route. It is quite comparable to CHC's ability of *Gv.*

Bodily kinesthetic intelligence. This kind of intelligence involves the control and management of one's bodily movements and the positioning of them in space. It is used in sports, such as dance, basketball, soccer, swimming, and tennis. However, it also is used by hunters to position themselves for a shot and by prey to position themselves to avoid harm by predators. Unlike the three intelligences discussed above, bodily kinesthetic intelligence is not measured by conventional tests of intelligence.

Interpersonal intelligence. This intelligence is used to relate to other people and is crucial to interpersonal relations. It involves recognizing other people's emotions, moods, and motives and then responding appropriately. It overlaps with the construct of *emotional intelligence* (Mayer et al., 2003). Interpersonal intelligence would be especially important for people in jobs that heavily involve understanding and relating to other people, such as salespeople, managers, or therapists.

Intrapersonal intelligence. Intrapersonal intelligence is involved in understanding oneself. People who are high in intrapersonal intelligence are self-reflective and understand their strengths, as well as their weaknesses. They are introspective and continually question whether they are using their knowledge and skills to their own advantage.

Musical intelligence. Musical intelligence involves understanding and production of music. It is used in singing, playing musical instruments, reading music, and appreciating music. Cultures differ widely in the extent to which they promote musical intelligence, ranging from cultures that widely appreciate music to cultures in which music is largely banned.

Naturalist intelligence. Naturalist intelligence is used to recognize patterns in nature. Examples would include recognizing kinds of rocks, classifying plants, differentiating among the leaves of different kinds of trees, and distinguishing harmful from harmless animals. This intelligence would be important for hunters but also for naturalists, botanists, ecologists, meteorologists, and similar careers that involve nature.

Gardner (2011a) has used MI theory as a basis for understanding creativity. Specifically, he has illustrated how each of the seven great creators used one of the intelligences to pursue an extraordinarily creative career. For example, Gardner has suggested that Stravinsky was extremely high in musical intelligence, Martha Graham in bodily kinesthetic intelligence, Einstein in logical-mathematical intelligence, and so forth.

The MI theory certainly has provided a new view of intelligence. Although it seems that each of the great creators Gardner cites was very high in what Gardner calls to be a distinct intelligence, there probably have been tens of thousands of other individuals very high in these intelligences who were not able to translate the intelligences into creative work in the way that the individuals cited by Gardner did. Therefore, it is not clear exactly by which mechanisms intelligences are translated into creative work.

The empirical evidence for the central claim that the intelligences are independent appears to be weak. Visser, Ashton, and Vernon (2006) conducted an investigation of the theory and failed to find evidence for the independence of the intelligences. Psychometric evidence comparing different abilities overwhelmingly suggests that – under most circumstances – most mental abilities are at least moderately correlated with each other. Moreover, current neuropsychological evidence (Haier, 2016) runs exactly counter to Gardner's theory. It suggests that various abilities are widely distributed across the brain: that rather than there being distinct areas of the brain responsible for particular skills, many different parts of the brain contribute to each of the variety of the skills we obtain.

Some scholars might be inclined to minimize or even dismiss Gardner's MI theory because the predictive evidence has not been particularly favorable. However, we believe there are three important things to keep in mind regarding the theory.

First, when the theory was originally published (Gardner, 1983) – and even today – there was (and still is) a tendency to dwell on general intelligence, sometimes to the exclusion of other abilities. Gardner made a strong statement that there is more to a person's intelligence and, in fact, to a person, than his or her general intelligence. Second, Gardner emphasized the importance of converging operations (the use of multiple methods of analysis) in understanding intelligence. Prior to his work, many workers in the field had relied almost exclusively on psychometric methods. Third, Gardner's theory proved to be useful to teachers in a way that general-intelligence theory probably never could be. If an educator is given merely an IQ or related score, there is not much one can do as an educator with the information. What traditionally was done was to group students by ability levels but such groupings did not do much to suggest how to teach students in one group versus another. Gardner's theory, however, opened up new avenues to teachers to support learning. If a student was not learning concepts well verbally, perhaps the concepts could be taught in another way – for example, with more emphasis on spatial or naturalistic presentation. Many teachers reacted to the theory with enthusiasm because they believed they could use the theory in a way that they could not have used previous theories.

Wisdom-Intelligence-Creativity Synthesized (WICS – Sternberg)

Sternberg (2003a, 2003b, 2003c, 2005a, 2007, 2009) has proposed a model called WICS, or Wisdom, Intelligence, Creativity, Synthesized. Of existing models, it is perhaps the one that most directly addresses the relationship between creativity and intelligence, on the one hand, and creativity and wisdom, on the other (see also Niu & Sternberg, 2003).

The theory proposes that there is a set of information-processing components that underlie all higher cognitive processes, including those of metacomponents (executive processes), as well as performance components (which execute the instructions of the metacomponents) and knowledge-acquisition components (which learn how to solve the relevant problem in the first place) (Sternberg, 1984, 1985c, 1986). The metacomponents include (1) recognizing the existence of a problem, (2) defining or redefining the problem, (3) mentally representing the problem, (4) formulating a strategy for solving the problem, (5) monitoring problem solving while it is ongoing, and (6) evaluating the problem solving after it is done.

In the original version of the theory (Sternberg, 1984), these components are used for creative, analytical, and practical thinking. They are used creatively for relatively novel tasks and situations. They are used analytically for somewhat familiar but abstract problems. They are used practically to adapt to, shape, and select real-world environments (Sternberg, 1985a, 1985c, 1997; Sternberg & Hedlund, 2002; Sternberg & Smith, 1985). In the augmented version of the theory (Sternberg, 2003), the metacomponents are used for wise thinking as well. In other words, people are creative when they generate new, surprising, and compelling ideas; analytical when they evaluate whether their ideas are good ones; practical (showing common sense) when they implement their ideas or persuade others of the value of the ideas; and wise when they apply the ideas for a common good, balancing their own interests with others and higher-order interests, over the long-term, as well as the short-term period, through the infusion of positive ethical values.

Sternberg (2010; Sternberg & the Rainbow Project Collaborators, 2006) implemented the original theory by administering tests of creative, as well as analytical and practical skills, to high school seniors and college freshmen from the United States. The students varied widely in geographic area, socioeconomic status, and ethnicity. The creative tests loaded on a factor separate from that of analytical tests. However, the only creative tests that were successful were the performance-based ones. Multiple-choice creative tests proved to load onto *g*, much as the analytical tests. The creative tests roughly doubled the prediction of freshman-year GPA. Moreover, including tests of creative and practical thinking reduced ethnic-group differences, although they did not eliminate these differences completely.

Therefore, in the revised WICS theory, creative and wise thinking are included in the augmented theory of successful intelligence. However, this theory does not give a full picture of the nature of creative or wise thought, leaving us with the question: Why?

Creativity involves quite a bit more than creative intelligence. Largely, it represents an attitude toward life (Sternberg, 2000, 2005b). In other words, creative individuals are creative not just because of their creative intelligence but also because they are willing to defy the crowd – as well as their own past lives – and the presuppositions of the surrounding Zeitgeist (Sternberg, 2018). Similarly, wisdom involves not only the ability to think wisely but the willingness to adopt a wise attitude toward life (Sternberg, 2008). One needs not only to be able to think wisely, an ability, but also to want to apply one's wisdom to one's everyday problems.

According to Sternberg's balance theory of wisdom (Sternberg, 1998, 2001a, 2001b), a part of WICS, wisdom is defined as the application of intelligence, creativity, and knowledge, as mediated by positive ethical values toward the achievement of a common good through a balance among the following: (1) intrapersonal, (2) interpersonal, and (3) extrapersonal interests, over (1) short- and (2) long-term periods.

Wisdom is not only about maximizing one's own or someone else's self-interest but also about balancing various self-interests (intrapersonal) with the interests of others (interpersonal) and of other aspects of the context in which one lives (extrapersonal), such as one's city or country or environment or even religious beliefs, including God. Wise people, such as Nelson Mandela, Eleanor Roosevelt, or Martin Luther King, see far beyond their own personal interests to the interests of others and of society as well.

A person could be practically intelligent but, at the same time, use his or her practical intelligence toward bad or selfish ends. In wisdom, one may seek good outcomes for oneself but also one seeks common good outcomes for others. If one's motivations are to maximize certain people's interests and minimize others', wisdom is not involved. In wisdom, one seeks a common good, realizing that this common good may not be equally good for all – it may be better for some than for others.

Problems requiring wisdom involve at least some of each of intrapersonal, interpersonal, and extrapersonal interests. For example, when a president decides to go to war, or a CEO decides to introduce a whole new product line, or a university president decides to open a new school (e.g., a law school or a medical school), the consequences are large and affect many people, as well as institutions. The decision always has to be made in the context of what the whole range of available options includes. However, wisdom can apply in smaller decisions as well, such as whether to move to a new location to take a new job when one's spouse is already happily employed in the place where the couple already lives.

What kinds of considerations might be included under each of the three kinds of interests? Intrapersonal interests might include wanting to be more popular, gain prestige or power, to earn more money, to learn about a wide variety of areas, to be more spiritual, to increase one's well-being, and so forth. Interpersonal interests might be similar, only, instead of applying to oneself, they apply to other people. Extrapersonal interests might include the desire to help one's school or organization, volunteering in one's community, serving one's country or God, and so forth. Different people balance these interests through different methods. At one extreme, a dictator might strive for power and wealth, whereas an altruistic person might focus only on serving other people.

Although Sternberg has amassed a large body of evidence to support his theory, the theory is not without its critics. For example, Ree, Earles, and Teachout (1994) and Gottfredson (2003) have argued that the evidence for a separate construct of practical intelligence is not sufficiently compelling. These are legitimate arguments over questions regarding data. However, one simply might ask oneself whether the academics one knows with very high IQs are equally impressive, on average, in their practical intelligence – in their relations with others or perhaps their self-understanding. How many of the most successful academics, for example, would be equally successful CEOs or even vice presidents for public relations? There is still much to debate in this area.

Conclusion

Despite the extensive research on cognitive components of creativity (Benedek & Jauk, Chapter 10, this volume; Ward & Kolomyts, Chapter 9, this volume), creativity is poorly represented in the intelligence field. Intelligence theories in active use tend to fall into two categories. The first includes the theories embraced by IQ and achievement tests, which instigate most research studies. These include the *g*, CHC, and the PASS models. There is an allowance for creativity in CHC and PASS but it is narrow and often tangential; furthermore, creativity is barely present (if at all) in tests derived from these theories (Kaufman, 2010, 2015; Kaufman & Sternberg, 2010). The second category includes theories that incorporate creativity as an integral part of intelligence, such as MI and WICS. These theories have had a real-world impact in their school-based adoptions; WICS has been used for admissions purposes. However, they are still not represented in standardized IQ and achievement tests, which have the most real-world impact. Given the resistance to change demonstrated by many test publishers, the best hope for widespread, mass-adopted measures of intelligence may need to come from elsewhere. Given the increased technological and multimedia advances that continue to emerge, researchers themselves may be able to devise tests that are engaging and appeal to potential users, not just the existing institutional structure (e.g., Kim & Shute, 2015; Shute & Ventura, 2013).

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17 The Function of Personality in Creativity

Updates on the Creative Personality

Gregory J. Feist

The first edition of this chapter was published in 2010 (Feist, 2010). The main thrust of the review was to argue for a functional model of the creative personality, that is, that traits of personality, such as openness to experience and introversion among others, lower the thresholds for creative thought and creative behavior. More specifically, I put forth a model that posited the following causal sequence: Genetic and epigenetic forces influence brain qualities (structural and chemical), which in turn influence cognitive, social, motivational-affective, and clinical personality traits associated with creative thought and behavior.

The topic of creativity and personality stands on solid scientific ground (Feist, Reiter-Palmon, & Kaufman, 2017). Less than a decade is not a long time but, in the context of modern science, thousands of new articles on a given topic can be published in such a time frame and that is precisely what has happened in the research on personality and creativity. Doing a quick literature search on PsychINFO with the key terms "personality" and "creativity," and limited to English and peer-reviewed articles, I found that 1,262 articles were published since 2011 and more than 500 just since 2015! Using the more inclusive "Google Scholar," more than 69,000 publications have the words "personality" and "creativity" in them between 2011 and 2018. I will not even try to review the majority of this literature but instead will bring into relief some of the major trends. If I could make two broad generalizations from the post-2010 literature on personality and creativity, I would say that, first, much more research has focused on brain structure and process and the creative personality and, second, there has been a significant increase in the literature coming from Asia, especially China (e.g., Chiang, Hsu, & Shi, 2015; Lin et al., 2012; Liu, Lin, & Tsai, 2016; Liu et al., 2017; Niu & Kaufman, 2013; Wang, Chen, & Deng, 2017; Yang et al., 2017; Yu, Zhang, & Zhang, 2017). A tertiary generalization would be an increase in research on the "dark side" (psychopathy) and creativity (see also Cropley & Cropley, Chapter 32, this volume).

In the current chapter, my primary goal will be to incorporate the new trends from this literature and determine how much of the functional model has been confirmed and how much of it needs revising. First, let me summarize (and then update) the original functional model of personality and creativity and its corresponding literature.

Original Model and Supporting Literature: Personality and Creativity

The topic of the creative personality has a long and auspicious history. Almost every major personality theorist of the twentieth century developed a theory of the creative person: Freud (1908/2001), Jung (1923), Rank (1932), Maslow (1959), Rogers (1959), Fromm (1959), May (1959), Kelly (1955), Cattell (Cattell & Drevdahl, 1955), Eysenck (1995), and even Skinner (1972) (cf. Woodman, 1981). The empirical work on the creative person began in earnest around 1950 with J. P. Guilford's (1950) American Psychological Association (APA) presidential address and the establishment of the University of California's Institute of Personality Assessment and Research (IPAR) under the direction of Donald MacKinnon. Other IPAR researchers included Frank Barron, Harrison Gough, Ravenna Helson, Richard Crutchfield, and Wallace Hall. Often using the famous live-in and extensive weekend-assessment, these researchers studied the personalities of creative scientists, writers, architects, mathematicians, and graduate students (Barron, 1955, 1963; Gough & Woodworth, 1960; Hall & MacKinnon, 1969; Helson, 1971; Helson & Crutchfield, 1970; MacKinnon, 1960, 1962, 1970, 1978).

By the 1990s, enough empirical literature on the topic had accumulated for the first meta-analysis to be conducted (Feist, 1998). As I first proposed in the late 1990s, personality facilitates creativity by lowering behavioral thresholds (1998, 1999b, 2010, 2017). My functional model built ties between biology and personality and argues for the causal primacy of biological factors in personality in general and the creative personality in particular (Feist, 2010). To be clear, the model of the creative personality included six main latent variables, in order of causal priority:

- Genetic and epigenetic influences on personality
- Brain qualities
- Cognitive personality traits
- Social personality traits
- Motivational-affective personality traits
- Clinical personality traits

By combining the biological and the function of traits arguments, I proposed a model for the paths from specific biological processes and mechanisms to psychological dispositions to creative thought and behavior. The basic idea is that causal influence flows generally from left to right, with genetic and epigenetic influences having a causal effect on brain influences. Brain-based influences in turn causally influence the four categories of personality influence: cognitive, social, motivational, and clinical. These traits individually and collectively lower thresholds for creative thought and behavior, making each more likely in those individuals who possess that cluster of traits. For example, the trait of being open to new and varied experiences, ideas, and values seems to make having novel and meaningful ideas more likely.

Evolutionary and Genetic Influences on Personality and Creativity

How do creative ideas and behaviors come about? Many animals exhibit some levels of creativity but none as much as *H. sapiens*. Creativity is one of the trademark traits, if not the trademark trait, of the human species. Darwin and Wallace's idea of natural selection is well known: Traits that serve some adaptive purpose for survival get selected over the generations and become more common in a species, sometimes even creating new species. Less well known, but also very important, is Darwin's idea of sexual selection: Members of the same sex compete for mating opportunities and the opposite sex finds attractive certain competitively successful traits and qualities. Over generations, these attractive traits also become more common and characteristic of the species.

Some have argued that sexual selection is most relevant for explaining species-wide traits like intelligence and creativity. Geoffrey Miller (2000), for instance, put forth the most comprehensive theory that sexual-selection processes are behind the evolution of human creativity (Haselton & Miller, 2006); Feist (2001), however, argued for a finer distinction: Natural selection pressures have shaped applied forms of creativity (technology, science, engineering), whereas sexual selection pressures have shaped ornamental forms of creativity (art, music, dance, writing).

An evolutionary theory of creativity was proposed by Miller (2000), who argued that creativity and intelligence are sexually selected traits. Research supports the general model in that wit, intelligence, charm, and creativity are attractive qualities in a potential mate, especially in men (Beaussart, Kaufman, & Kaufman, 2012; Haselton & Miller, 2006). Feist (2001) modified this theory and argued that different forms of creativity (ornamental vs. applied) are differentially attractive (Feist, 2001).

Brain Structures and Processes Involved in Creativity

As is true in most every domain of psychology, the neuroscience of creativity has witnessed an explosion of research over the last twenty years (see Vartanian, Chapter 8, this volume). One general conclusion from this literature is that there is no one brain region where creative activity occurs. By way of introduction to the neuroscience of creativity, let me first review the basics of the creative process. The creative process really has two major phases: generation of novel ideas and evaluation and selection of the most meaningful and useful ones (Simonton, 2013). Idea generation involves wider, more defocused, behavioral and cognitive disinhibition, divergent cognitive processes, whereas the evaluation and selection of those ideas involves more behavioral and cognitive excitation, cognitive control and focused attention. Recent research suggest distinct personality traits are associated with the two phases of the creative process (Fürst, Ghisletta, & Lubart, 2016). Classic and recent research into the neural substrates of creative thought generally supports this two-phase model of creative thought (Chen et al., 2014; Jung et al., 2013; Martindale, 1999).

Some of the first theory and research on the brain structures and processes involved in creative thought and behavior came from Hans Eysenck. Eysenck's (1967, 1995) theory of introversion and extraversion argues for low cortical arousal in extraverts compared with introverts. Research into the association between cortical arousal, extraversion, and creative thought generally supports the view that extraverted and original people show the lowest levels of cortical arousal while solving creative problems (Fink & Neubauer, 2007).

The causal nature of brain influences is precisely what the model of creativity assumes. These brain differences make creative traits more or less likely, which in turn make creative thought and behavior more or less likely. Therefore, personality traits mediate the relationship between brain and creative thought and behavior. By having genetic dispositions that create central nervous system (CNS) differences that in turn facilitate creative thinking, highly creative people also develop a set of personality traits consistent with their biological dispositions.

Personality Influences on Creativity

As put forth in the model, evolutionary, genetic, and brain processes are causally prior to, and influence, personality traits. My model integrates personality dimensions both before and after the Big Five or the Five Factor Model came to dominate the field of personality during the 1980s and forward (Costa & McCrae, 1992; Feist, 1998; John, 1990). Simply put, the five major dimensions of personality (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) emerged empirically from decades of uncovering the structure of human personality. Building on the qualitative and quantitative reviews of the personality and creativity literature from the last fifty years, I used my own taxonomy to cluster the personality traits most consistently connected to creativity, namely cognitive, social, motivational-affective, and clinical categories.

Cognitive personality traits. Feist (1998) classified particular traits as "cognitive" because they deal with how people habitually process information, solve problems, and respond to new situations. Chief among the cognitive personality traits connected to creative thought and behavior is "openness to experience" or the disposition to explore, be curious, and enjoy novel experiences. Classic research demonstrated the consistent and strong association between openness and creativity (Dollinger, Urban, & James, 2004; Feist, 1998). Open people tend to be imaginative and curious and so it is not surprising that open people are more creative.

Cognitive flexibility is another trademark of creative thought and achievement. Flexibility involves fluidly switching and moving between different categories of ideas or coming up with many ideas from distinct categories (Guilford, 2016). Although a cognitive ability, flexibility is also part of the personality constellation of openness to experience. In alignment with the classic view of Frank Barron (1963) that creative people can traverse a wide latitude of cognitive and personality states, recent research suggests that creative individuals are both more controlled and more flexible in their cognitive processing (Baas, et al., 2013; Zabelina & Robinson, 2010).

Social personality traits. Social traits of personality involve first and foremost behaviors and attitudes that concern one's relationships to other people, such as questioning or accepting what authority figures say (norm-doubting and nonconformity), being comfortable or uncomfortable around strangers and large groups of people (extraversion), being warm or hostile toward others (agreeableness), and believing one is better or worse than others (dominance, confidence, and arrogance).

After openness, extraversion is the personality trait with the strongest and most robust association with creativity (Feist, 1998; Furnham et al., 2008). As Feist (1998) argued, however, the general factor of extraversion does not quite reflect its accurate relationship with creativity. When one splits extraversion into two of its main components, sociability-gregariousness and confidence-assertiveness, a clearer association emerges. Highly creative people are generally not more sociable and outgoing, but rather more independent, confident, and assertive. In fact, there is some evidence that in many domains (e.g., science, literature, art, poetry, and musical composition), creative people are more introverted, autonomous, and socially withdrawn than sociable and outgoing (Feist, 1999a).

Autonomy and independence are the opposite of conformity and conservatism. Creative people tend to doubt and buck social norms and question tradition and authority. Rubinstein (2003), for instance, examined authoritarianism and creativity in Israeli college students (design, behavioral science, and law). Rubinstein found strong negative relationships between creativity and authoritarianism as well as a linear relationship between career choice (major) and authoritarianism. As Feist (1998) reported in his meta-analysis, highly creative people in the arts and sciences doubt, question, and often reject norms, traditions, and conservative ideologies. Indeed, one could argue these findings validate both constructs, for creativity concerns producing novel and unusual ideas and conservatism/authoritarianism values tradition.

Motivational-affective personality traits. Motivational traits are defined by a person's desire to persist in activities and to be successful in his or her activities. Trait terms characteristic of motivation are *persistent*, *driven*, *ambitious*, and *impulsive*. That some people are driven to be creative is both undeniable and perplexing. Why do people want to create? Some people are willing to forgo social relationships and economic well-being to create lasting works.

If those who have a desire to produce works that leave a mark on the world are to succeed, they also need to be driven, focused, and ambitious. They are not the kind of people who give up easily in the face of hindrances and roadblocks. And that is generally what the research on drive and creativity continues to show: Creative artists, businesspeople, and scientists are driven, ambitious, and persistent (Amabile, 1996; Batey & Furnham, 2006; Ceci & Kumar, 2015).

But what kinds of things motivate them? Need to know? Self-expression? Success? Recognition? Money? Joy from the process? It could be each of these depending on the nature of the creative task. Scientists are probably driven more by the need to know and artists more by the need for self-expression. And both are often driven by the pleasure the process of discovery or expression brings, otherwise known as intrinsic motivation. Indeed, intrinsic motivation is often associated with highly creative thought or behavior and quite a body of research supports this idea (e.g., Amabile, 1996; see also Hennessey, Chapter 18, this volume). That is, when the drive and energy for carrying out a task is pleasure and excitement, then the end product often is more creative than if the drive is lacking or extrinsic. Amabile's classic work on motivation and creativity has reported that often extrinsic motivation (reward, surveillance, or recognition) has a detrimental effect on creative achievement.

In addition to motivation, both trait- and state-level positive affect can broaden one's cognitive processes and associations and under some circumstances be positively correlated with creative thought and problem-solving (Feist, 2012; Fredrickson, 2001; Rogaten & Moneta, 2015). Similarly, milder degrees of mania (hypomania and/or cyclothymia) are also associated with creative thought (Jamison, 1993; Ludwig, 1995). The theory is that the increased fluency of thought during hypomania makes original and even meaningful associations more likely.

Clinical traits. Classic research has suggested that certain affective disorders do appear to be consistently connected to high levels of creative achievement, especially in the arts (Ludwig, 1995). Bipolar disorder, for instance, is found in many highly creative writers, musicians, artists, and poets (Andreasen, 1987, 2008; Andreasen & Glick, 1988; Bowden, 1994; Jamison, 1993; Richards & Kinney, 1990). In addition, both theoretically and empirically, there is a link between psychoticism and creativity, especially in artists and the general population (Eysenck, 1995; Feist, 1998; Ludwig, 1995). Psychoticism is the disposition toward lack of impulse control, unusual and over-inclusive thinking, and being cold and impersonal (Eysenck, 1995). Results, however, have been mixed and these inconsistent results have led some researchers to propose that psychoticism is too broad and general a construct and, in fact, its relationship to creativity would be better understood if broken down into specific components, such as latent inhibition and schizotypy (Batey & Furnham, 2008; Mason, Claridge, & Jackson, 1995). Current conceptualizations consider schizotypy to exist on a continuum in the general population and define it as consisting of the following core traits: unusual experiences (i.e., hallucinatory and/or magical thinking), cognitive disorganization (i.e., difficulty concentrating, feelings of worthlessness, and social anxiety), introvertive anhedonia (i.e., lack of enjoyment), and impulsive nonconformity (i.e., violent and self-abusive behaviors; Mason et al., 1995). Indeed, a consistent body of literature reveals a positive connection between schizotypy and creativity (Batey & Furnham, 2008; Claridge & McDonald, 2009; Claridge, Pryor, & Watkins, 1990; Nettle, 2006).

Updated Literature: Consistencies with the Functional Model of Personality and Creativity

As I just summarized, the major predictive influences on creative thought and behavior in the model are: genetic/epigenetic, brain, and personality (cognitive, social, motivational-affective, and clinical). In this section, I now briefly review the

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research since 2010 that has borne out these predicative relationships with creativity (see Feist et al., 2017).

Genetics and creativity. Twin-adoption research into the heritability of creative behavior has found that creative achievement, especially artistic, has a sizable genetic component (Barbot & Eff, Chapter 7, this volume, Hur, Jeong, & Piffer, 2014; Nichols, 1978; Piffer & Hur, 2014; Velázquez, Segal, & Horowitz, 2015). For instance, in a study of more than 160 pairs of twins, more than 50 percent of artistic creative achievement could be explained by genetic influence and nearly 40 percent of scientific creative achievement (Hur et al., 2014).

Consistent with Miller's theory of creativity being a sexually selected trait, recent research has reported that wit, intelligence, charm, and creativity are attractive qualities in a potential mate, especially in men (Beaussart, Kaufman, & Kaufman, 2012; Haselton & Miller, 2006). Furthermore, twin-adoption research has revealed creativity to be a sexually selected trait (Verweij, Burri, & Zietsch, 2014). New research, however, also supports Feist's modification of the sexual selection-creativity model. More specifically, evidence is consistent with the theory that ornamental-aesthetic behaviors were rated as more sexually appealing than applied-technical creative behaviors (S. Kaufman et al., 2014). Additional support for this view comes from findings showing that successful male creative artists have more sexual partners than less successful ones (Clegg, Nettle, & Miell, 2011). Moreover, the personality trait of openness to experience was the strongest predictor of those who found aesthetic creative behaviors sexually attractive (Kaufman et al., 2014).

Brain activity and creativity. Research on brain activity and creative thinking generally supports the notion that creative thought and problem-solving are associated with distinct activity differences in various parts of the brain, although how creativity is measured affects the specific conclusions (Arden et al., 2010). These in turn confirm the assumption of the original functional model. Most specifically, the prefrontal cortex, the default brain network and the connectivity between the two hemispheres are most active during creative problem-solving (Beaty et al., 2014). Recent lines of neuroscientific research into the brain bases of creative thinking reveal important and telling differences between right and left hemisphere functioning (Kounios & Beeman, 2014, 2015). Neural networks in the left hemisphere (especially near the language centers) are activated in smaller and tighter brain regions, whereas in the right hemisphere the networks are weakly activated in a broader and wider region. The left hemisphere, therefore, is more likely to make narrower and more converging associations, whereas the right is more likely to make broader, wider, and more diverging associations. Insights, solutions, and inferences are outcomes of these wider and more diffuse neural networks of the right hemisphere (more specifically the right anterior region of the temporal lobe). Moreover, directly stimulating – with transcranial direct current stimulation (tDCS) – the right frontal-temporal cortex while simultaneously inhibiting left frontal-temporal cortical activity enhances the odds of insight solutions (Kounios & Beeman, 2014). It also appears that higher levels of neural integration in the frontal, parietal, and temporal lobes are associated with creative thought (Jung et al., 2013; Takeuchi et al., 2010).

In addition, there is research that examines the interplay between brain, personality, and creativity. Beaty and colleagues (2015), for example, examined the association between the brain's default mode (its efficiency) and the personality trait of openness to experience (the most consistent personality correlate of creative behavior). In two separate studies, they found a positive association – the more efficient the default mode was, the higher the participants were in openness to experience. This line of research suggests a biological foundation of openness to experience.

Recall the two phases of the creative process, namely generation and elaboration. This two-phase model of the creative process is also consistent with the dual-processing brain model that integrates more automatic cognitive flexibility with more deliberative cognitive processes of creative thinking (Baas et al., 2013; Chen et al., 2014; Li et al., 2015; Zabelina & Robinson, 2010).

Jung and colleagues (2013), for example, argued that idea generation involves the default network (DN), which is a disinhibitory network of brain regions that interact and are involved when people are not responding to stimuli from the outside world, that is, when they are just daydreaming or engaged in "mind-wandering" (Raichle et al., 2001). Some researchers refer to this spontaneous and self-generated thought as "defocused attention," and, more colloquially, we might say "not paying attention." These networks have hubs in the frontal, parietal, and temporal lobes, and much neuro-imaging and lesion evidence suggests integrated activity between these networks during creative thought (Durante & Dunson, 2018; Jauk et al., 2015; Jung et al., 2013; Kühn et al., 2014).

The second phase, namely evaluation and selection of novel ideas, involves brain regions known as the cognitive control network (CCN), which is an excitatory network of brain regions in the prefrontal cortex and the anterior cingulate (which, among other things, is involved in error detection and attention; Jung et al., 2013). The CCN is activated when we are focused on stimuli from the outside world. Jung and colleagues reviewed neuroscientific evidence that the CCN is mostly involved in the second – idea evaluation – phase of the creative process. Indeed, of the major dimensions of personality, openness is the most strongly associated with brain regions associated with creativity, such as the right temporal gyrus and prefrontal cortex (Jung et al., 2010; Li et al., 2015; Passamonti et al., 2014; Takeuchi et al., 2010). The latter region is particularly relevant since it is involved with encoding, maintaining, and updating information involved in adaptive behaviors. This evidence is consistent with the model's proposal that personality mediates the relationship between brain activity and creative thought and behavior.

Personality traits and creativity. Some new research supports the associations between extraversion and creativity (Chiang et al., 2015; Karwowski & Lebuda, 2016; Puryear, Kettler, & Rinn, 2017; Tan, Lau, & Lee, 2017; Tyagi et al., 2017), neuroticism (ego strength/emotional stability) and creativity (Kirsch, Lubart, &

Houseemand, 2015), conscientiousness and creativity (Chen, 2016), motivation and creativity (Ceci & Kumar, 2015; Grohman et al., 2017; Martinsen, 2011), and agreeableness/hostility and creativity (Hunter & Cushenberry, 2015). For example, recent research suggests an inverse-U relationship between agreeableness and imagination, with imaginative ability in designers peaking with moderate levels of agreeableness (Chang et al., 2014; Kaufman et al. 2015). The strongest new evidence, however, concerns the cognitive trait of openness to experience and the clinical traits of schizotypy and the mood disorders.

Cognitive traits. Recent research solidifies the association between the open personality and creative thought and behavior (Agnoli et al., 2015; Chang et al., 2014; Chen, 2016; Ivcevic & Brackett, 2015; Karwowski & Lebuda, 2016; Kaufman, 2013; Kaufman et al., 2015; Martinsen, 2011; Tan et al., 2016). It is becoming increasingly clear that Openness to Experience, among all Big Five personality dimensions, is the strongest and most robust correlated of creative thought.

And yet research suggests the relationship between openness and creativity is also a complex one. Openness has two major components, namely Openness and Intellect (S. B. Kaufman et al., 2016; Oleynick et al., 2017). The Openness component is most strongly associated with artistic creativity, whereas the Intellect component is most strongly associated with scientific creativity (Kaufman et al., 2016). Moreover, the openness–creativity relationship is moderated by breadth of attention, as measured by the tendency to look at less relevant stimuli (Agnoli et al., 2015). That is, the relationship was only significantly positive for people who looked longest at irrelevant visual stimuli. Like its relation to creativity, openness also predicts the tendency to be more moved by aesthetic experiences and to more readily experience awe (Silvia et al., 2015).

Clinical traits. Recent research tends to suggest that creativity and psychopathology have a more complex relationship with one another than previously reported. For instance, research suggests that some pathologies are positively associated with creativity and others negatively associated creativity (Baas et al., 2016) and other research suggest that the relationship depends on whether pathology is seen as a cause or effect of creativity (Taylor, 2017). Specifically, Baas and colleagues (2016) proposed an approach-avoidance model of motivation, with positive schizotypy and risk for bipolar disorder being approach-based psychopathologies, and anxiety, depression, and negative schizotypy being avoidance-based psychopathologies. In a meta-analysis of more than twenty-eight studies and more than 7,000 participants (from children to seniors), Baas and colleagues found a small to moderate positive effect size ($r = 0.224$) between bipolar disorder and creativity and a small negative effect size ($r = -0.064$) between depression and creativity. In addition, Taylor (2017) conducted meta-analyses that separately examined whether creativity was a potential cause, effect, or covariate of mood disorders. She found that creative people did have higher levels of mood disorders compared with less creative people (cause model) but little evidence that people with a mood disorder are more creative than those without the disorder (effect model). Even this last finding was somewhat moderated by domain, with those with a mood disorder showing elevated rates of creativity in verbal and performance domains only. In sum, there is no one overall conclusion concerning the association between psychological disorder and creativity.

As discussed above, Eysenck's theory and research linking psychoticism and creativity have continued to receive moderate support (Acar & Runco, 2012). And yet, due to the (overly) broad conceptualization of psychoticism, more and more researchers have focused on a specific component of psychoticism, namely schizotypy (LeBoutillier, Barry, & Westley, 2016). The eccentricity and impulsive nonconformity components of schizotypy are considered "positive schizotypy," whereas the cognitive disorganization and lack of social interest and pleasure components are considered "negative schizotypy." In a meta-analysis of forty-five articles and 268 effect sizes, Acar and Sen (2013) reported median effect sizes between creativity and positive schizotypy ($r = 0.14$) and negative schizotypy ($r = -0.09$), meaning that there is a small but robust finding that creative people are more eccentric and impulsive and less socially withdrawn and cognitively disorganized than less creative people.

The association between schizotypy and creativity may be universal and a result of sexual selection. There is cross-cultural evidence that the association between creativity and schizotypy exists in Asian and European cultures as well (Batey & Furnham, 2008; Landgraf et al., 2015; Wang et al., 2017). Beaussart, Kaufman, and Kaufman (2012), for example, present evidence that the schizotypy–creativity relationship may be a sexually selected trait, in that it is associated to short-term mating success in men. Finally, brain activity was lower in the prefrontal cortex, right angular gyrus, left insula when people high in schizotypy solved a creative problem (Park, Kirk, & Waldie, 2015).

In addition to the schizotypic personality disorder, recent research continues to support the finding that various mood disorders are also regularly associated with creative thought and behavior (Paek, Abdulla, & Cramond, 2016). The mood disorders with the strongest association to creativity are milder forms of bipolar and depression. Writers, for example, are at a higher risk for depression and suicide (Kyaga et al., 2013). One of the stronger relationships between a psychological disorder and creativity seems to be bipolar disorder (Gostoli et al., 2017; Johnson & Frederickson 2011; Johnson, Tharp, & Holmes, 2015; Johnson et al., 2015; Kyaga et al., 2011, 2013; Ruiter & Johnson, 2015). For example, Kyaga and colleagues (2011) analyzed data from an exhaustive national registry of nearly 300,000 Swedish people diagnosed with schizophrenia, bipolar disorder, or unipolar depression. They cross-tabulated these diagnoses against creative professions (both art and science) and accountants–auditors and found that those with bipolar or who were siblings of someone with schizophrenia were overrepresented in the creative professions. Those suffering directly from unipolar depression were not more likely to be in creative professions compared with controls. Ruiter and Johnson (2015) reported a positive association between hypomania and lifetime creativity but not on a creativity-insight task. Additionally, Zabelina, Condon, and Beeman (2014) reported that hypomania and psychoticism (but not ADHD, autism spectrum, or schizotypal personality) predicted real-world creative achievement but not with lab assessments of creativity (divergent thinking).

To integrate the overall findings of and to provide a general model for the creativity–mental illness relationship, Carson (2011, 2014; see also Chapter 14, this volume) proposed a shared vulnerability model, visually represented as a Venn diagram with the two overlapping circles of Creative Genius and Psychopathology. Protective factors in the genius circle are high IQ, working memory skills, and cognitive flexibility, whereas risk factors in the psychopathology circle are low IQ, working-memory deficits, and perseveration. Shared vulnerabilities are in the overlapping region and include cognitive disinhibition, enhanced novelty salience, emotional lability, and hyperconnectivity. Genius has unique protective factors and psychopathology has unique risk factors but there is enough overlap between the two to account for their association (cf. Park et al., 2015).

Updated Literature: Inconsistencies with the Functional Model of Personality and Creativity

To be sure, much of the literature since 2010 confirms the model. Yet some new research calls into questions some of its basic assumptions. Two assumptions are most clearly challenged. First, the assumption that brain mechanisms cause personality differences with no influence going from personality to brains has been called into question. Second, the assumption that creativity is only positive and that dark personality traits are not involved has been challenged.

Causal direction. One of the long-standing assumptions of the model is the "bottom-up" view of causal influence – from genetic and brain processes to personality and creativity. But, of course, causal direction could also go the other direction ("top-down"). For example, creative behavior could influence personality or personality could influence brain activity.

Indeed, there is evidence that personality differences can lead to differences in brain activity. For example, a longitudinal study provides some of the first evidence that being high in the personality trait of openness buffers the loss of gray matter in the right parietal lobe, which is associated with both working memory and creativity (Taki et al., 2013). More specifically, 274 healthy adults (mean age of fifty-five) were assessed on the NEO-PI-R on all five dimensions of the Big Five. Holding age, gender, and cranial volume constant, the rate of decline in gray matter in the parietal lobe was less for those high in openness compared with those low in openness to experience. This finding makes clear that the causal direction from brain to personality traits may be too simplistic. It is of note that no other Big Five personality dimension was associated with changes in the amount of gray matter in the parietal lobe. But the finding on openness suggests that personality traits can also influence brain functioning and its age-related decline.

It is important to point out, in short, that the causal direction is not always unidirectional but in fact also could be bidirectional. Creative thought and behavior can also influence personality and personality traits – insofar that they shape experience – and can even affect gene expression through the process of epigenetics. It's best to see this model as being somewhat simplistic but a first step toward how personality and creativity affect each other.

Dark triad and creativity. In addition to the causal direction, another challenge to the model stems from a new line of research being published in the last ten years on the dark side of creativity. Not all creativity is toward positive goals and with benign intent. Cropley and colleagues (2008) define “malevolent creativity” as behavior that is original, useful, but has the intent to harm others. Cropley refers to this as “malevolent creativity” (Cropley et al., 2010; Cropley, Kaufman, & Cropley, 2008; McBain, Cropley, & Kavanagh, 2017).

The dark triad consists of subclinical levels of narcissism, Machiavellianism (the manipulative personality), and subclinical levels of psychopathy (Paulhus & Williams, 2002). The triad in general is comprised of dispositions toward self-promotion, deception, emotional coldness, and aggressiveness. At its core, the dark triad is a disposition toward unethical behavior. In this sense, the dark triad stands at the crossroads of normal and pathological personality qualities, having elements of both. In sum, the bulk of the research on the dark triad and creativity warrants a modification to the model (Galang et al., 2016).

Although Feist’s model proposed clinical personality traits as well as hostile and arrogant tendencies as associated with creative output, it did not emphasize the “dark triad” traits that are gaining in empirical momentum in the creativity literature (Cropley et al., 2008, 2010; Furnham, 2015; Kapoor, 2015; Mai, Ellis, & Welsh, 2015). Some research reports varied associations between the components of the dark triad (narcissism, psychopathy, and Machiavellianism) and creativity, with narcissism accounting for most of the association (Jonason, Richardson, & Potter, 2015). Others have found that it is especially the elements of lying and deception (components of psychopathy) that most strongly correlate with creativity (Beaussart, Andrews, & J. C. Kaufman, 2013; Cropley et al., 2008, 2010; Eisenman, 1999; Gino & Wiltermuth, 2014; Kapoor, 2015). Deception, as it turns out, is consistent with a classic finding in the literature on personality and creativity, namely that creative people doubt, question, and flaunt social norms and rules (Feist, 1993, 1998; Galang et al., 2016).

The association between unethical behavior and creativity appears to be more than correlational. Gino and Wiltermuth (2014), in a series of controlled experiments, demonstrated that holding prior differences in creative ability constant, those who cheated the most were the most creative and that, when assigned to dishonest conditions, people’s creativity increased. Moreover, they also found that it was the act of breaking rules that accounted for the relationship between deception and creativity. In fact, the causal direction seems to be bidirectional. Gino and Ariely (2012) also conducted a series of quasi-experiments in which creative people, both experimentally and correlationally, were more prone to deception and cheating.

There is inconsistent evidence for whether light or dark personality traits are the strongest predictor of creativity. For example, Furnham (2015) reported that the dark triad explained variance in creativity over and above the Big Five personality dimensions. Yet Dahmen-Wassenberg and colleagues (2016) reported the opposite. They found that that nondark aspects of personality (e.g., openness) explain more variance in creativity than the dark triad. Further research is required before drawing any firm conclusion about the relative predictive strength of light and dark personality traits on creative thought and behavior.

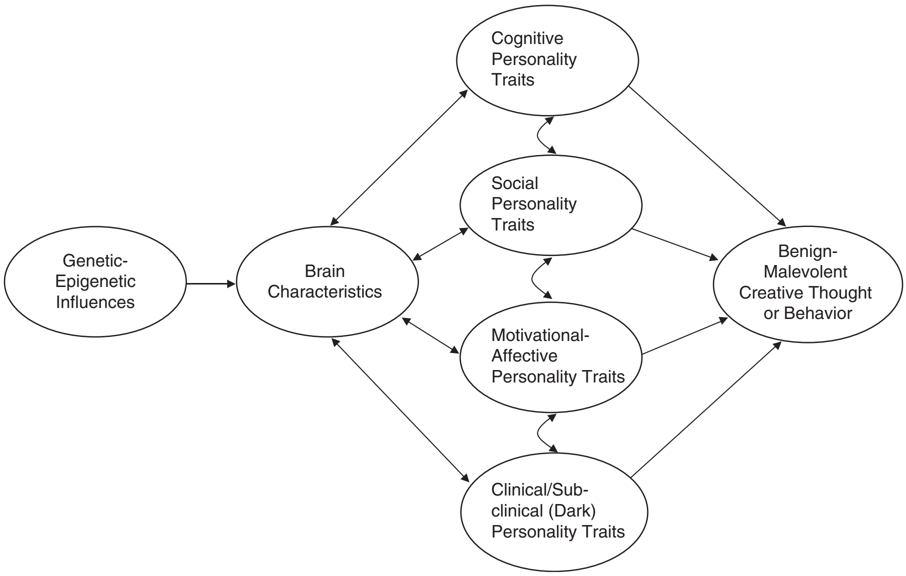

Figure 17.1 *Updated functional model of the creative personality (after Feist, 2010; reprinted with permission from Cambridge University Press)*

Conclusions

Overall, the core assumptions of the functional model of creativity have been strengthened with the new research since the original chapter was published in 2010. That is, genetic and epigenetic factors affect brain structure and function, which in turn affect personality differences. These differences in personality, especially the cognitive (openness) and clinical traits (e.g., schizotypy and mood disorders), affect creative thought and behavior.

And yet, the model needs some modification, given the most recent empirical evidence. One of the major conclusions from this review is that the original 2010 model was a bit vague and general. To simply have constructs such as "genetic/epigenetic," "brain activity," and "clinical personality traits," for example, is too broad. Research since 2010 is now converging on more specific components of genetic, neuroscientific, and personality influences. The best example of this is clinical traits. Schizotypy, cyclothymia, and now the dark triad are the specific personality traits most strongly associated with creative behavior. In addition, two assumptions of the original model have been questioned, namely there is no influence from personality to brain processes and that creativity is only positive with no influence by the darker side of personality on creative thought and behavior. In light of these two challenges, I have modified the original 2010 model both to be more specific and to incorporate bidirectional influences between personality and brain activity (see Figure 17.1). As with all scientific models, the functional model of personality and creativity is a work in progress. It will be most interesting to see what the next ten years will tell us about the functional model of personality and creativity.

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18 Motivation and Creativity

Beth A. Hennessey

Motivation is powerful. Motivational orientation determines the boundary between what we are capable of doing and what we will actually do in any given situation. Without the right kind of motivation, we are unlikely to play with ideas, take risks, or feel at all comfortable with the possibility of failure. Without the right kind of motivation, creativity is nearly impossible.

Researchers and theorists have long appreciated this association between aspects of performance, including creativity of performance, and motivational orientation. As early as 1913, Dewey identified the link between student interest or curiosity and effort expended in the classroom. Another early investigation to establish the connection between motivation and performance focused on the effects of expected reward on preschooler's motivation for using magic markers (Lepper, Greene, & Nisbett, 1973). Children who contracted with experimenters to make a drawing in order to receive a Good Player Award spent significantly less time using markers during subsequent free-time periods than did their peers who had been randomly assigned to either a no reward or an unexpected reward condition; in addition, a subsequent systematic assessment of the globally assessed quality of the drawings showed that products produced under expected reward conditions were of significantly lower quality than products made by the unexpected reward or control (no reward) groups.

These early groundbreaking investigations did not target creative performance per se but researchers soon moved on to explicitly investigate the interplay between motivational orientation and creativity. Hundreds of empirical studies and meta-analyses targeting classroom situations as well as workplace environments have been carried out and, up until fairly recently, it was believed by many that the overall message was crystal clear. The expectation of a reward could be expected to undermine both intrinsic task interest and creativity of performance. In fact, the promise of a reward was not the only killer of task interest and creativity to be identified by researchers. A variety of performance incentives including expected evaluation, time limits, and competition have also been shown to have deleterious effects (Amabile, 1988, 1996; Hennessey, 2003, 2010, 2015b; Hennessey & Amabile, 1998). Over time, experimental paradigms, most especially reward contingencies, have become increasingly sophisticated and nuanced. It is now clear that the imposition of a reward or other extrinsic constraint cannot be expected to impact everyone in the same way. In one paper, Wiechman and Gurland (2009) reported that personality differences appeared to explain a polarizing effect of extrinsic rewards on intrinsic motivation, with some study participants showing a *temporary* enhancement of task intrinsic motivation, a sort of "pressured persistence," after the receipt of reward. Researchers investigating gender have reported that females displayed higher levels of overall motivation and intrinsic motivation than did males (Chen & Zhao, 2013), and students from higher socioeconomic backgrounds were also found to have higher levels of intrinsic motivation as compared to their less advantaged peers. This intrinsic motivation gap, in turn, had a significant effect on students' creativity (Dai et al., 2012). Recognizing the powerful impact of motivational orientation, some investigations have also contrasted trait and state intrinsic and extrinsic motivational orientations (e.g., Moneta, 2012; Moneta & Siu, 2002; Prabhu, Sutton, & Sauser, 2008). Still other investigators have explored individual differences in confidence (Cho & Lin, 2011), psychological empowerment (Zhang & Bartol, 2010), creative self-beliefs (Putwain, Kearsley, & Symes, 2012), developmental dispositions (Upadhyay & Dalal, 2013), optimism (Icekson, Roskes, & Moran, 2014), and the way in which a promised reward is construed (Friedman, 2009; Malik, Butt, & Choi, 2015).

Over time, there have also appeared investigations and theoretical pieces challenging the notion that rewards (and other extrinsic constraints such as evaluation) must be seen as detrimental to intrinsic task motivation and creative performance. This debate first surfaced in the mid-1990s, prompting researchers from within and outside the behavioral psychology tradition to publish a series of strongly opposing commentaries, critiques, and replies (see Eisenberger & Cameron, 1996, 1998; Hennessey & Amabile, 1998; Lepper, 1998; Sansone & Harackiewicz, 1998). We have now learned that rewards conveying competence information may not impact intrinsic motivation (and creative performance) in the same way as rewards that convey only controlling information. Importantly, however, many of the experiments cited by Eisenberger, Cameron, and colleagues as evidence of the positive effects of reward were structured very differently than the investigations that generally showed a negative effect. Study participants in the Eisenberger and colleagues studies were typically provided with continuous information about their performance as they progressed through a task. Discrepancies in the ways in which creativity was measured (paper-and-pencil assessments with questions resembling closely items taken from a standard IQ test or items from a test of divergent thinking) and operationalized may also have played a part in determining study results. In fact, some of the target activities used in investigations conducted by researchers influenced by the behavior-modification perspective have had relatively clear and straightforward paths to completion. Most creativity theorists would argue that such tasks do not really measure creativity, which by its very nature defies algorithmic solution.

What is needed are experimental measures that offer many, if not infinite, paths to completion and no one "right" or "best" solution. In addition, it only makes sense to expect an undermining of intrinsic motivation when the target task is initially intrinsically interesting. Innate levels of interest in the target creativity task constitute one crucial distinction between many of the empirical studies showing negative versus positive effects of reward on task motivation and quality of performance. Yet, as we are reminded by George (2007), "Rather than assume that intrinsic motivation underlies creativity, researchers need to tackle this theoretical linkage more directly and in more depth" (p. 445). Based on what we know today, the experimental evidence tying intrinsic motivation to creative performance remains, in the opinion of many, open to interpretation (Grant & Berry, 2011).

An Exploration of Intrinsic and Extrinsic Motivation

Intrinsic motivation is most often operationalized in the literature as the motivation to approach a task out of sheer interest in the activity itself and excitement about the challenges that lie ahead. When fueled by intrinsic motivation, people perceive that their involvement is free of strong external control; they get the sense that they are playing rather than working (e.g., West, Hoff, & Carlsson, 2013). The solution to a problem or the eventual outcome of a project may not be at all obvious; but deep down inside, the individual is fueled by the conviction that they have the requisite skills necessary to get the job done. Extrinsic motivation, on the other hand, is the motivation to do something for some external goal, some incentive outside of the task itself, such as an impending evaluation or the promise of a reward.

In situations where creativity is the goal, intrinsic motivation has frequently been shown to be preferable to extrinsic motivation. And, in fact, intrinsic motivation has been linked to a variety of other learning and performance benefits as well. For adults, cognitive flexibility and complexity have been shown to be highest under conditions of strong intrinsic motivation (Amabile, Hill et al., 1994; McGraw, 1978). Supplementing these findings, Conti, Amabile, and Pollak (1995) reported that college students who undertook a learning task with intrinsic motivation demonstrated superior long-term retention of information as compared with their extrinsically motivated peers. For younger students in elementary and secondary school classrooms, intrinsic motivation has also been shown to be preferable to extrinsic motivation (Grolnick, Ryan, & Deci, 1991; Guay & Vallerand, 1997; McGraw & McCullers, 1979). Children who are intrinsically motivated toward an activity are more likely to undertake that activity voluntarily and they are also more likely to learn complex material effectively (see Deci & Ryan, 1985b). More recent classroom-based fieldwork also shows that students who approach new learning material with intrinsic goals engage more deeply and persist longer (Vansteenkiste, Lens, & Deci, 2006). Generally speaking, when compared with intrinsic motivation, extrinsic motivation has consistently been shown to lead to better performance only on tasks requiring rote recitation, precise performance under strong time pressure, and the completion of familiar, repetitive procedures. An intrinsically motivated state, characterized by deeply focused attention, enhanced cognitive functioning, and increased and persistent activity, leads to deeper, more long-lasting learning and better problem-solving on open-ended tasks (McGraw & McCullers, 1979). In fact, a large number of related investigations have demonstrated that when individuals approach new concepts with high levels of curiosity and interest, information is better learned and remembered (Flink, Boggiano, & Main, 1992; Gottfried, 1990; Harter & Jackson, 1992; Hidi, 1990; Lepper & Cordova, 1992; Tobias, 1994).

Importantly, intrinsic motivation promotes far more than cognitive function, memory, and persistence. Motivational orientation also helps to determine the kinds of activities that individuals will choose to pursue in the first place. When given a choice of open-ended problems requiring a creative solution, extrinsically motivated students tended to opt for the easiest possible tasks (Condry & Chambers, 1978; Pittman, Emery, & Boggiano, 1982). Intrinsically motivated persons are more likely to take risks and explore solutions to questions or problems that represent for them an appropriate level of difficulty and challenge. Why might intrinsic interest engender the kind of exploration and risk-taking that has been shown to be so necessary for creative performance? Some theorists have proposed that one of the most important functions of task motivation is the control of attention. Only when we become lost in or consumed by a problem can we hope to have a creative outcome.

Motivational Mechanisms

Given the many empirical demonstrations of the role played by intrinsic motivation in the selection of tasks, perseverance at those tasks and deeply focused attention, it makes sense that intrinsic motivation would be especially conducive to creativity. As summarized by Amabile's Intrinsic Motivation Principle of creativity and accompanying Componential Model, highlighting the confluence of necessary domain skills, creativity skills, and intrinsic task motivation (Amabile, 1988), intrinsic Motivation is necessary for creativity and extrinsic motivation is almost always detrimental. According to this essentially hydraulic, either-or conceptualization, as extrinsic incentives increase, intrinsic motivation and the likelihood of ensuing creativity are bound to decrease.

But can extrinsic constraints be expected to consistently kill intrinsic task motivation and creative performance? As explained by Beghetto (2005), the answer to this question is that it depends. In recent years, the position taken by many researchers and theorists on this issue, including Amabile herself, has become far more nuanced. The focus has shifted from a fairly simplistic attempt to distinguish between intrinsic and extrinsic motivational orientations, or to define intrinsically motivated behaviors as those that occur in the absence of extrinsic motivators, toward efforts to capture distinctly different forms (and impacts) of extrinsic motivation. One area of theorizing that has garnered particular attention focuses on the phenomenon termed "motivational synergy." In the literature, motivational synergy is operationalized as the interaction between intrinsic and extrinsic motivation. This conceptualization holds that, especially in situations of high intrinsic motivation, extrinsic motivation can under certain specific circumstances combine with intrinsic motivation in promotion of the creative process (Amabile, 1993, 1997). Some of the earliest work in this area proposed that there were at least two mechanisms underlying this combining of intrinsic and extrinsic motivation: (1) extrinsic factors can sometimes support one's sense of competence without undermining self-determination and (2) the motivation–work cycle match, where intrinsic and extrinsic motivational orientations have additive effects (Amabile, 1993).

In 1996, Amabile published a revision of her original models, including a reworking of the Intrinsic Motivation Principle. Although many extrinsic motivators in the workplace and other environments often appear to undermine intrinsic motivation and creativity, some may not. If rewards or other motivators are presented in a controlling fashion, leading people to feel that they are being bribed or dictated to, the undermining effects are likely to occur. However, if rewards confirm people's competence (e.g., by recognizing the value of their contributions), or enable them to become more deeply involved in work they are excited about (e.g., by giving them more resources to do that work effectively), intrinsic motivation and creativity might actually be enhanced (see Deci, Koestner, & Ryan, 2001; Friedman, 2009; Yoon et al., 2015). A recent meta-analysis carried out by Cerasoli, Nicklin, and Ford (2014) corroborated this view with the finding that intrinsic motivation and extrinsic incentives, most notably rewards, are not necessarily antagonistic and went on to make the recommendation that these factors should be considered together, allowing for the possibility of interactive effects, when exploring performance outcomes.

A series of three related "immunization" studies (Hennessey, Amabile, & Martinage, 1989, Studies 1 & 2; Hennessey & Zbikowski, 1993) demonstrated just this sort of interaction. In a 1 (Training/No Training) × 2 (Reward/No Reward) experimental paradigm, elementary school students given intrinsic motivation training as to how they might keep extrinsic constraints such as the promise of reward in perspective, subsequently showed significantly higher levels of intrinsic task motivation than did children randomly assigned to a control/no-training condition. Moreover, the creativity of products produced by children who had received training and were promised a reward for their task participation was higher than that of any other design group. In fact, these study findings are in keeping with a growing body of evidence in the form of laboratory experiments (Amabile, Hennessey, & Grossman, 1986), nonexperimental studies (Amabile, Phillips, & Collins, 1994; Amabile, Hill et al., 1994; Baer, 2012), and theorizing (Amabile, 1997; Amabile & Pratt, 2016), demonstrating how, under certain circumstances, extrinsic motivation can play a facilitative role in the creative process.

In an especially extensive diary study involving 12,000 entries composed by 238 employees in seven companies, Amabile and Kramer (2011) uncovered real-world evidence of how reward and recognition can sometimes confirm competence without undermining intrinsic motivation. However, not all of the scholarship in this area points to the possibility of a straightforward synergistic effect. In one recent study of Taiwanese research-and-design engineers and their managers, for example, it was found that extrinsic motivation positively impacted creative performance. Importantly, however, this relation was observed to be very much dependent on the strength of an individual's intrinsic motivation. When extrinsic motivation was low, there was a strong positive relation between intrinsic motivation and creativity. However, when extrinsic motivation was high, accompanying high levels of intrinsic motivation were not found to lead to higher levels of creativity. There was no synergistic effect; instead, the relation between intrinsic motivation and creativity was slightly negative when extrinsic motivation was high (Zhu, Gardner, & Chen, 2016).

In another recent study, this time targeting amateur musicians, Eisenberg and Thompson (2011) found that musical improvisations were judged as more creative under competitive rather than noncompetitive conditions. Here, too, motivational patterns revealed effects that could not be explained by a simple additive process. Musicians randomly assigned to a competition condition were found to be both more intrinsically motivated than their peers in the no-competition condition and more stressed. Moreover, the musicians who were competing against one another also produced more creative improvisations than their peers in the no-competition group (for somewhat similar study findings, see also Vansteenkiste & Deci, 2003). How is it possible that placement in a competitive situation could simultaneously lead to both higher levels of stress and increased levels of creativity and intrinsic motivation? What might be the cognitive mechanism(s) behind this effect?

Self-Perception Underpinnings: Self-Determination Theory

Much of the foundational research and theorizing in this area have explored the relevance of self-perception processes to motivational orientation (and creative performance). Early investigations revealed that, in situations where both a plausible intrinsic and extrinsic explanation for our actions are available, each of us tends to dismiss the internal cause in favor of the external cause. Social psychologists variously referred to this process as "discounting" (Kelly 1973) or "overjustification," a formulation derived from the attribution theories of Bem (1972), Kelley (1973), and deCharms (1968). Subsequent research efforts supplemented these discounting and overjustification models with Cognitive Evaluation Theory (CET) (Deci 1975; Deci, Cascio, & Krussel, 1975; Deci & Ryan 1985a); and, building on this work, Deci and Ryan more recently offered a conceptual refinement of the CET Model in the form of Self-Determination Theory (SDT) (Deci & Ryan 1985a, 1985b, 1996, 2000, 2008a, 2008b; Ryan & Deci, 2017).

SDT focuses on innate psychological needs and the degree to which individuals are able to satisfy these basic needs as they pursue and attain their valued goals. Integrating a variety of literatures, this model offers a synthesis of what, for many years, had been a conglomeration of related but distinct motivational approaches (including considerations of intrinsic motivation and internalization). SDT operationalizes extrinsic motivation as a construct far more complex than the simple absence of intrinsic motivation. Focusing on causality orientations, or characteristic ways that each of us develops for understanding and orienting to inputs, Deci and Ryan have hypothesized that individuals vary in the degree to which they exhibit three orientations: "autonomy," "control," and "impersonal." These same researchers then have gone on to argue that these individual differences have important implications for a variety of motivationally involved processes, including creative performance.

Within this SDT framework, extrinsic motivation (termed "controlled motivation" by Deci and Ryan) and intrinsic motivation (termed "autonomous motivation") are viewed as the anchors of a highly complex and multilayered continuum. Across time and situational context, individuals are seen to differ in the degree to which they integrate environmental constraints and behavioral regulations and come to view them as part of themselves rather than as limits that have been externally imposed. This focus on the process of internalization has now shifted the attention of many researchers and theorists away from the intrinsic/extrinsic motivation distinction and toward a new dichotomy that emphasizes the fundamental differences between autonomous and controlled motivation. Importantly, autonomous motivation does not always signal that persons are acting entirely independently. Instead, this motivational orientation stems from a need to act with a sense of choice and volition, even if behavioral decisions are in compliance with the wishes of others (Van den Broeck et al., 2016). At the core here is the individual's need to act with a sense of psychological freedom and ownership of their own behaviors (Deci & Ryan, 2000; Ryan & Deci, 2017). In addition to the need for autonomy, the SDT framework also underscores two other basic psychological needs: competence and relatedness (Deci & Ryan, 2000). Individuals acting with competence feel a sense of mastery over their environment and a confidence about developing new skills. The need for relatedness, on the other hand, revolves around the need to feel connected to at least a few others – to love and care for them and to feel their love and care in return. As operationalized by the SDT framework, each of these needs is innate (rather than socially transmitted) and both students and workers of all ages will be driven to meet them.

Since its inception, SDT has enjoyed a great deal of attention in the empirical research literature. Investigators all over the world have attempted to address questions and criticisms concerning the cross-cultural generalizability of SDT, with perhaps the bulk of these studies targeting students at the elementary, middle, and high school levels. Jang et al. (2009) tested the SDT prediction that high school students in collectively oriented South Korea would benefit from classroom experiences of autonomy support and psychological need satisfaction. Across four studies, findings supported the theory's cross-cultural generalizability. Similarly, a series of three studies involving elementary and secondary school students and carried out by Roth and colleagues (2006) lent strong support to the relative autonomy continuum proposed by SDT. In 2009, Deci himself teamed up with colleagues Ma and Zhou to show that the SDT framework captured well the motivational orientation of children attending rural Chinese schools (Zhou, Ma, & Deci, 2009). Rudy and colleagues (2007) distinguished between controlled and autonomous motivation (as suggested by SDT) as well as between individual and inclusive ("my family and I") motivation in three separate studies involving Chinese Canadian, European Canadian, and Singaporean students. Overall, in these investigations, Chinese Canadian and Singaporean students felt less relative autonomy (both inclusive and individual) than did European Canadian students. Individual relative autonomy was associated with psychological well-being for all three groups, while inclusive relative autonomy was associated with psychological well-being only for Chinese Canadian and Singaporean study participants. And in two separate studies of Chinese and Chinese Canadian university students, Walker (2009, 2010) combined an examination of culture, self-construal (see Triandis, 1995) and SDT. Overall, both autonomy-based and competence-based intrinsic motivation were found to facilitate performance, with autonomy's facilitative effects most prominent during engagement in leisure activities and competence's facilitative effects most apparent during engagement in nonleisure activities.

Perhaps not surprisingly, many of the investigations applying the SDT framework to student populations have focused on the relation between motivation and school achievement, some even attempting to predict achievement over time. Most activities associated with the learning process involving teachers, parents, and students tend to rely on extrinsic rather than intrinsic motivation (Hennessey, 2015b). But could this system be backfiring? The high school years have been repeatedly shown to usher in a sharp drop in student motivation for learning (Wormington et al., 2012). Both intrinsic and extrinsic motivation decline at the transition to high school, to levels significantly lower than those shown by elementary grade children or college students (Martin, 2009). In their especially comprehensive paper published in 2012, Wormington and colleagues explored what happens when a high schooler is simultaneously driven by motives at both the autonomous and the controlled ends of the continuum. Cluster analysis of the motivational profiles of 1,066 students revealed four primary motivational patterns and led to the suggestion that controlled forms of extrinsic motivation need not be associated with maladaptive outcomes at the high school level when coupled with high levels of intrinsic motivation.

While these and other study results like them are informative, generally speaking, the outcomes of investigations applying the SDT perspective to issues of academic motivation and school achievement have been somewhat mixed. Taylor and colleagues (2014) set out to clarify the situation by conducting a large scale meta-analysis coupled with controlled longitudinal studies designed to explore the relations between specific types of motivation and school achievement. The meta-analysis (Study 1) underscored the potentially important role of intrinsic motivation in predicting academic achievement, while three empirical studies involving high school and college students in Canada and Sweden revealed that intrinsic motivation was the only motivational orientation to be consistently associated with academic achievement over a one-year time frame.

Supplementing this literature are a number of SDT-based studies specifically linking creative performance with motivational orientation. Liu and colleagues (2013) set out to examine the relation between autonomous-controlled motivation and creative thinking in a Chinese high school student sample. Results showed that autonomous motivation positively predicted creative thinking and this relation was moderated by parental involvement/autonomy support. For both junior and senior high school students, autonomous motivation was strongly related to creative thinking when there was high maternal involvement. The moderating role of paternal involvement, however, differed between junior and senior high school students with a three-way interaction effect.

Peng and colleagues (2013) offered data in support of a theoretical model arguing that classroom goal structures can shape students' different types of self-determined motivation and then go on to influence demonstrated creativity. In this study, Taiwanese junior high school students were most positively impacted by a mastery-approach goal structure that was found to lead to the highest levels of autonomous motivation. And, in an investigation of Chinese hotel workers, Hon (2012) reported data in support of both the Intrinsic Motivation Principle of Creativity and SDT, showing that a sense of autonomous motivation among employees played a significant role in predicting their creativity. Evaluations of the effects of two types of rewards (performance-contingent vs. task-contingent) have, in fact, shown that performance-contingent rewards need not undermine intrinsic task motivation and qualitative aspects of performance (Houlfort et al., 2002; Vansteenkiste & Deci, 2003). However, a study of college students in Sweden yielded somewhat complex and puzzling findings (Selart et al., 2008). Results of this investigation provided little support for the negative effects of performance-contingent rewards on motivational components. Yet participants in the task-contingent reward group and the control group did, in fact, achieve higher rated creativity than participants in the performance-contingent reward group.

Can SDT Explain It All, Or Are There Two Different Types of Intrinsic Motivation?

Given the extensive literature demonstrating the negative impact of expected reward on motivational orientation and qualitative aspects of performance, including creativity, the grading process is an area of continued theoretical controversy. In many respects, the grading system commonly employed across a variety of academic contexts is a ubiquitous real-world example of the use of extrinsic constraints to motivate behavior. Study results as to the efficacy of the grading system are mixed. Importantly, the receipt of an "A" on a report card is a distinctly different kind of reward than the opportunity to play with an instant camera (the reward offered in an early foundational study conducted by Amabile et al., 1986). The bulk of the theoretical and empirical work on the effects of reward cited earlier in this chapter, from Lepper, Greene and Nisbett's (1973) seminal study to more contemporary and nuanced investigations, focused on so-called task-contingent rewards – rewards promised and delivered to those who complete an activity without regard to the quality of their performance. This type of reward contingency has repeatedly been found to undermine intrinsic task interest and creative performance. But a grade on a report card is performance-contingent. Moreover, the receipt of an "A," or other performance-contingent reward, signals to the recipient that they have been deemed competent, maybe even gifted.

Proponents of what is termed General Interest Theory (GIT) (e.g., Eisenberger, Pierce, & Cameron, 1999; Jovanovic & Matejecic, 2014) argue that the receipt of a high grade or other performance-contingent reward for an initially interesting task is most likely to increase subsequent task intrinsic motivation if that reward is informational and serves to satisfy the need for competence (Cameron, Banko, & Pierce, 2001; Cameron et al., 2005; Eisenberger & Aselage, 2009). Yet advocates of SDT might contend that the pressure to obtain the reward of a high grade will undermine a student's need for autonomy, thereby decreasing intrinsic task motivation.

Overall, empirical studies involving situations in which the receipt of reward is contingent on quality of task performance have yielded mixed results. Performance-contingent rewards have been variously found to have either no appreciable impact (see Deci, Koestner, & Ryan, 1999) or even a positive impact on task interest and qualitative aspects of performance (Cameron & Pierce, 1994; Eisenberger, 2003; Eisenberger & Cameron, 1998; Eisenberger, Pierce, & Cameron, 1999). Could it be that the construct termed intrinsic motivation is better conceptualized as two (or more) distinctly different types of motivation – one focused on more immediate reactions to the task that is accomplished and the other focused on more long-term, continuing task motivation and willingness to persist once the initial task is ended (see Cameron et al., 2005; Elliot et al., 2000; Ryan, Koestner, & Deci, 1991)?

Pulfrey, Darnon, and Butera (2013), in fact, demonstrated the usefulness of this distinction in an investigation of the impact of grades on middle school students' intrinsic motivation. Cooper and Jayatilaka (2006) also underscored the need for theorists to consider a third type of motivation beyond the dichotomous intrinsic/extrinsic distinction, but their findings call for a consideration of what they term "obligation motivation." And Forgeard and Mecklenburg (2013), as well as Grant and Berry (2011) and Auger and Woodman (2016), proposed that creative behavior is often driven by an almost bidirectional, "prosocial motivation" based on whether a creator's intended beneficiary of their work is the self or another. Additionally, yet another group of investigators (e.g., Gilson & Madjar, 2011) found that intrinsic motivation is associated mainly with the production of radical ideas, while extrinsic motivation is linked more closely with the generation of ideas that are solution-driven and developed on the basis of concrete practices.

Muddying the conceptual waters even further are some especially complex findings emerging from studies focused on organizational creativity and the performance of employees charged with making innovations in product design and marketing. Intrinsic motivation can have both positive and negative outcomes in the workplace (for a review, see Grant and Shin, 2012). In one study, Burroughs and colleagues (2011) employed a 1 (Reward/No Reward) × 2 (Training/No Training) experimental design to examine the creative behavior of product design engineers. The reward manipulation consisted of the promise of three cash prizes to be delivered to the participants producing the most creative designs, and creativity training came in the form of targeted creative idea production (customer-focused visualization) instruction. They found a significant main effect of extrinsic reward on creativity, with designs produced under the expectation of reward rated as more creative than designs produced by the no-reward group. Importantly, however, this result was primarily driven by a significant interaction effect. Designs created when both training and extrinsic rewards were provided were judged to be significantly more creative than products developed under any of the other three experimental conditions. In the absence of training, the expectation of reward undermined creativity, although not to a significant extent.

Moving beyond an investigation of the impact of cash prizes, Markova and Ford (2011) demonstrated in another empirical study that nonmonetary rewards such as achievement recognition in newsletters, certificates for dinner for two, or tickets to a sporting event were an even stronger predictor of intrinsic motivation than were monetary incentives, serving to augment workers' intrinsic motivation, which in turn was related to enhanced performance and innovation. In a case study of a medium-sized company in the fashion industry, Busco and colleagues (2012) also found that managerial control, operationalized as both formal control involving the imposition of extrinsic constraints like reward and informal (social) control, need not kill creativity. Yet these authors cautioned that a "purposeful imbalance" must be maintained whereby both forms of control are managed so as to meet the concurrent need for ongoing creative design and efficient production practices.

One potentially important but relatively intangible aspect of the workplace environment that may contribute to this optimal environmental imbalance comes in the form of employees' perceptions of organizational justice. Research carried out by Hannam and Narayan (2015) also underscored the influential role played by perceptions of fairness in the workplace. They proposed that intrinsically motivated workers may perceive their environment more favorably than do individuals who are not interested in the tasks placed before them. More specifically, high levels of intrinsic motivation may lead employees to view the rewards offered (distributive justice), decision-making procedures used (procedural justice), and interpersonal treatment in their work environment (interpersonal justice) as more fair, due to the positive affect associated with intrinsic motivation. In this paper, laboratory-based data were presented to show that intrinsically motivated study participants did, in fact, view their environment as fairer than participants who were relatively uninterested in the experimental task. Moreover, perceptions of distributive and interpersonal justice were found to significantly mediate the relation between intrinsic motivation and creativity. Finally, survey data collected by Sacchetti and Tortia (2013) from over 4,000 Italian employees focused on satisfaction with creativity also served to underscore the importance of inclusive, fair processes and relationships in the workplace.

How are researchers and theorists to make sense of these various research outcomes? In a meta-analysis of studies investigating motivational mechanisms of employee creativity, Liu and colleagues (2016) underscored the need for a more fine-grained examination of motivation and creativity. Research findings reported by Yoon and colleagues (2015) typify the complexities of this relation. Their investigation examined the effects of tangible and intangible creativity-contingent rewards on employee creativity. In seemingly direct opposition to SDT or Intrinsic Motivation Principle predictions, tangible rewards for creativity were negatively related to extrinsic task motivation, whereas employee creativity was positively related to extrinsic motivation but not intrinsic motivation. In an attempt to frame their own study findings regarding creativity in the workplace, Yoon and colleagues (2015) made the point that investigations carried out in a real-world business setting, outside the highly controlled and often artificial laboratory environment, are subject to a whole host of influences, many of which go unrecognized by researchers and study participants alike. In fact, real-world business settings may be even more complex than classroom environments. Individual differences in workers' perceptions of their corporate culture and the degree of fairness exhibited there are but two of the factors that may serve to mediate or moderate the impact of rewards and other extrinsic constraints on motivational orientation and creative performance. At issue here may be the affective response of employees to their workplace situation.

The Role of Affect

The management of knowledge workers necessitates the building of a community of employees who have satisfying "inner work lives" marked by predominantly positive emotions, a favorable view of their company, their work, and their colleagues, and strong intrinsic motivation. These are the conclusions taken from a large and especially comprehensive longitudinal research program carried out in a variety of corporate settings (Amabile & Kramer, 2011). These data and others like them consistently show a strong relation between positive affect, intrinsic motivation, and creativity (see Baas, De Dreu, & Nijstad, 2008; Binnewies & Wörnlein, 2011; Isen, 1999). The undermining of intrinsic interest and the potential for creative breakthroughs may result as much from emotion or affect as it does from thoughts or cognitive analysis (see Hennessey, 2010). It is no accident that contemporary views of intrinsic motivation frequently include an affective component (e.g., Isen & Reeve, 2005; Izard, 1977). In fact, the influential work of Csikszentmihalyi and colleagues (Csikszentmihalyi, 1990, 1997; Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005; Nakamura & Csikszentmihalyi, 2003) has brought to light the elation that can result from deep task involvement often termed "flow" or "optimal experience"; and Izard (1991) has argued that, like motivation, emotions (and moods) can also function as both traits and states.

Recent explorations of the potential link between affect and creative performance have revealed that, under certain circumstances, negative affect can sometimes lead to *increases* in creativity. Just as studies of the interplay between intrinsic and extrinsic motivation have become far more nuanced, so too have investigations into the role played by affect begun to take a variety of directions. George and Zhou (George, 2011; George & Zhou, 2007) developed a "dual-tuning" model illustrating how positive and negative moods can interact in supportive settings to influence employee creativity. Building on this perspective, Bledow, Rosing, and Frese (2013) reported data showing what they termed an "affective shift" where a highly creative outcome results when an individual experiences an episode of negative affect followed by a decrease in negative affect and an increase in positive affect. Ceci and Kumar (2016) also highlighted a positive relation between negative affect and creativity. They found that while the creative capacity of college students was not significantly correlated with happiness, it was correlated significantly with scores on both positive and negative affect scales as well as with their absolute sum (for an in-depth look at creativity and mood, see Baas, Chapter 12, this volume).

The Role of Culture: A Final Overarching Consideration

Throughout this chapter exploring the intersection between motivation and creativity, a number of the empirical investigations reviewed, perhaps most especially investigations of the business world, have focused on study participants living, learning, and working in non-Western environments. Yet, curiously, only occasionally have theorists and researchers addressed the possibility that the relation between motivational orientation and creativity in one cultural context may be distinctly different from the relation in another. While some researchers have talked of "supportive motivational milieus," corporate or classroom "climates," or the complex social systems found within large organizations, until recently at least, few investigators have asked how the culture into which we are born impacts our creative development and performance. As explained by Csikszentmihalyi (1999), the creative act is as much a product of social and cultural influences as it is cognitive or psychological. Creativity must be seen and studied as a highly contextualized phenomenon. In fact, most everything we think we understand about creativity and the creative process is socioculturally dependent.

One psychological area of study that has been shown to be directly tied to both motivational orientation and cultural influence focuses on individual differences in self-construal. There are a number of significant differences between Eastern and Western perspectives on the self, and nowhere are these differences more striking than in cross-cultural comparisons of assumptions about control. In the East, emphasis tends to be placed on forces of control imposed by the environment wherein the individual is expected to adapt. Asians are thought to exercise what Ng (2001) terms “secondary control,” shaping their internal needs and desires in order to maximize the goodness of fit with existing reality. In the West, people are expected to rise above externally imposed constraints and even to alter their environment so as to better meet their own needs. In this cultural context, it is the individual who needs to feel primary control. As summarized by Ng (2001), Asian societies tend to place more value on extrinsic motivation, while Western societies value intrinsic motivation. A thorough delineation of the social and cultural context in which creativity flourishes (or fails to flourish) is essential to any investigation of the psychology of creativity. Researchers must determine how study participants view their situation – their status and their role in the creative process. Do they feel comfortable exploring their creative potential, and do they approach experimental tasks or projects at school and in the workplace with a strong and primarily individualistic sense of purpose? Or are they instead willing to “take a back seat” and to defer to the other members of the group? Are they looking for consensus? Are they driven by a fundamental need to feel autonomous and in control of their situation or are they content to look within themselves for evidence of that control? And, finally, do they feel capable of and excited about coming up with a creative idea or approach to a problem, or has their lack of experience with such open-ended situations left them uncertain and unwilling to explore the possibilities?

These are just some of the questions, some of the considerations, that must be addressed by investigators and theorists exploring the motivation–creativity connection across cultures. The impact of culture cannot be overstated, especially perhaps when it comes to the individual’s interactions with others. It is quite likely that classrooms and workplaces spread across the globe are characterized by distinctly different sets of social-cognitive dynamics – cultural and subcultural differences in self-construal as well as important differences in the relationships between students and their teachers or employees and their managers which, in turn, might make for distinctly different relations between the imposition of extrinsic constraints, task motivation, and creative performance. A small but growing group of researchers is now pursuing these issues. Hennessey (2015a) offered a systems perspective in an attempt to make sense of seemingly contradictory findings gathered in schools in Saudi Arabia and the United States. Chiu and Kwan (2010) also proposed a systems or process model of creativity that explores the role of culture at each stage of knowledge creation, providing data to show that culture can affect creative outcomes through its effects on a variety of social and psychological processes. In fact, this paper authored by Chiu and Kwan was just one of many appearing in a 2010 special issue of the journal *Management and Organizational Review* devoted to the role of culture in the creative process. In this volume, De Dreu (2010) explored the possibility that culture may impact the psychological processes through which original yet useful ideas and insights are achieved. Erez and Nouri (2010) linked the need for assimilation vs. differentiation to the collectivistic vs. individualistic tendencies of various cultural groups and argued that it is differentiation needs that activate the motivation to be unique and to generate original ideas. Zhou & Su (2010) suggested that certain leadership styles may impact employees' intrinsic motivation and subsequent creativity very differently in some cultures than in others. And Morris and Leung (2010) offered the possibility that intrinsic motivation is tied to the opportunity to make individual choices for Westerners, while for Easterners it can come from having choices made by a legitimate and respected in-group leader.

In sum, cultural norms and values must be incorporated into any and all research and theorizing on motivation and creativity. For decades, investigators who focused on the interface between motivation and creativity concentrated on Western, often American, workplaces and classrooms; and findings from study to study were remarkably consistent. The imposition of extrinsic constraints such as the promise of a reward or the expectation or evaluation was thought to universally undermine intrinsic motivation and creativity. Hydraulic models proposing that as extrinsic motivation increases intrinsic motivation (and creativity) is bound to decrease served the research community well. But, in recent years, investigators have come to discover considerable variability across individuals as well as variability in motivational orientation and creative performance tied to differences in cultural contexts (see, for example, Iyengar & DeVoe, 2003). Researchers and theoreticians must be ever vigilant to keep cultural biases, most especially Western biases, and simplistic assumptions from affecting their work (see also Lubart, Glăveanu, de Vries, Camargo, & Storme, Chapter 20, this volume, and Niu, Chapter 21, this volume). Similarly, schools and companies setting out to stimulate creativity and innovation must guard against the temptation to look for a quick fix in the form of a blanket application of research findings to their own particular context. Studies carried out in one nation may have little, if anything, to say about how best to structure the workplace or classroom environment in another part of the world. Factors that support intrinsic motivation and creativity in one culture may have no important effect, or even a negative effect, on the creative performance of individuals or groups in another culture. And even persons who are all living and learning in the same cultural context are likely to exhibit important and complex individual differences. The research and applied, practical challenges are many.

Yes, motivation and creativity are complicated and there remains a lot to be learned. But the proliferation of recent research reviewed here, studies and models cutting across cultures and contexts and accommodating individual differences, does much to bring us closer to an in-depth understanding of ways in which motivational orientation impacts creative performance. It would appear that there is more than one

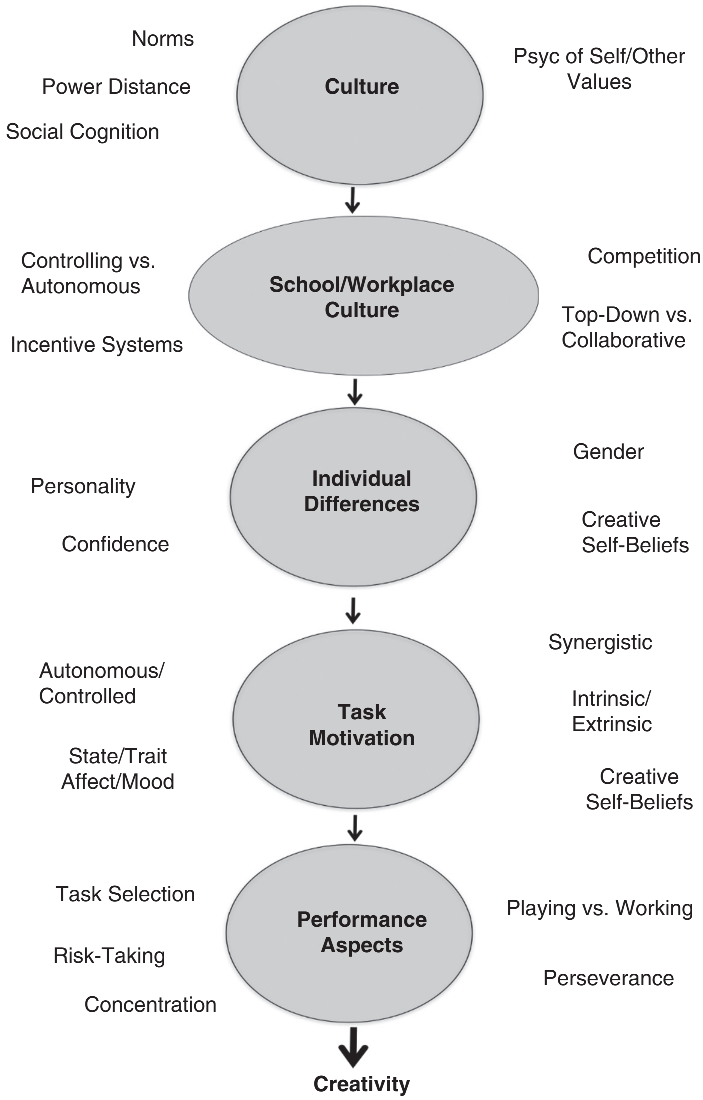

Figure 18.1 *Interrelated forces operating at multiple levels to impact motivation and creativity*

motivational path to creativity, and cultural norms may have much to do with which path is chosen. Long gone are the days when theorists can be satisfied with a one-size-fits-all conceptualization. Instead, researchers must work to develop an empirically based systems model of the creativity–motivation connection. In 2010, my colleague Teresa Amabile and I made a call for investigators to recognize that creativity arises from a complex web of interrelated forces operating at multiple levels that can only be modeled and understood via multidisciplinary investigation (Hennessey & Amabile, 2010). As summarized in Figure 18.1, this review suggests many potentially important components to be explored.

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19 Creative Self-Beliefs

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"Our beliefs guide our desires and shape our actions" – Charles Sanders Peirce (1877, p. 4)

Does it matter what people think about their own creativity? Is it important whether they believe they can think and act in creative ways? Do beliefs offer anything more to performance than a reflection of prior performance? In short, do creative self-beliefs matter? Creativity researchers, working over the past two decades, have attempted to address these and related questions.

Indeed, research on creative self-beliefs represents a rapidly growing line of inquiry in the field.[1] Scholars have published numerous papers and book chapters devoted to antecedents, correlates, and consequences of creative self-beliefs (e.g., Beghetto, 2006; Jaussi, Randel, & Dionne, 2007; Tierney & Farmer, 2002, 2011), including meta-analytical summaries (e.g., Karwowski & Lebuda, 2016; Liu et al., 2016) and even a recent edited volume devoted to the topic (Karwowski & Kaufman, 2017).

Given the proliferation of scholarly activity on this topic, it is important for creativity researchers to take stock of some of the foundational issues and questions surrounding creative self-beliefs as well as promising new directions for this line of inquiry. The purpose of this chapter is to provide a conceptual overview of creative self-beliefs and discuss how creativity researchers might continue to clarify, develop, and contribute to this topic.

The chapter opens with an overview of the nature of creative self-beliefs, including basic assumptions, conceptual distinctions, and needed directions for work in this area. This is followed by a discussion of the need for researchers to take a more integrative approach to theorizing and empirically examining creative self-beliefs in relation to creative action. The chapter closes with a brief summary and suggestions for future work on creative self-beliefs.

[1] Consider the following example. We searched in Google Scholar for "creative self-efficacy" (one of the most frequently studied creative self-beliefs in the literature) for the past two decades (i.e., "1997–2017") as compared with nearly a century prior to the past two decades (i.e., "1900–1996"). As of this writing, the past two decades yielded 3,670 results, whereas the entire database prior to the past two decades yielded only 14 results.

What Is the Creative Self?

Defining the creative self is not an easy task. Difficulties stem from a variety of meanings that can be ascribed to the term "self." Although it is beyond the scope of this chapter to review all the ways that the self can be conceptualized, we highlight some variations (adapted from Leary & Tangney, 2012), which are relevant for understanding creative self-beliefs.

The term *self* is often colloquially used in reference to all the core factors that make a *person* unique. Indeed, dictionaries tend to define the self as the essence of one's being. This colloquial sense of the term differs from how creativity scholars typically define the creative self. Creativity researchers tend to view the creative self as part of a person's broader identity (see Karwowski & Kaufman, 2017), rather than as the essence of a person.

The self has also been conceptualized as a proxy for *personality* traits (Leary & Tangney, 2012). This perspective dates back to humanistic psychology (e.g., Maslow, 1954). Creativity researchers have demonstrated an empirical link between creative-self variables and personality factors (Hughes, Furnham, & Batey, 2013; Karwowski et al., 2013; Kaufman et al., 2009), especially *openness to experience* and *plasticity*. Moreover, results of a recent meta-analysis indicate that personality factors account for approximately 40 percent of the variance among creative self-beliefs (for a meta-analysis, see Karwowski & Lebuda, 2016).

Although personality factors seem to play a role in shaping the creative self, creativity researchers tend to view personality factors (which focus more on immutable and biologically determined traits: DeYoung, 2010; Eysenck, 1967) as related to but conceptually distinct from the more sociodynamic and malleable beliefs that constitute the creative self (e.g., Bandura, 1991, 1997; Beghetto & Karwowski, 2017; Glăveanu, 2017).

Viewed from this perspective, the term *self* refers to beliefs that people hold about themselves. These beliefs have an agentic aspect to them that helps determine whether people will act on their environment (Bandura, 1997; Sternberg & Lubart, 1995), informs how they deal with historical and political pressures (Lebuda, 2016), and serves as an internal standard that people use when making autonomous decisions (Bandura, 1997; Baumeister & Vohs, 2012; Vohs & Baumeister, 2011).

In sum, perspectives on the creative self have been influenced by various historical, psychological, and sociocultural traditions. In recent years, agentic perspectives of the creative self and various concomitant self-beliefs have grown in popularity. It is this perspective that we explore in the remainder of this chapter. In what follows, we provide a conceptual overview of the various types of creative self-beliefs studied by creativity researchers and highlight key conceptual similarities and differences among those beliefs.

Creative Self-Beliefs: A Closer Look

Creative self-beliefs serve as a conceptual umbrella in creativity studies, spanning across a wide family of interrelated yet conceptually distinct categories

(Beghetto & Karwowski, 2017; Karwowski & Barbot, 2016; Karwowski & Lebuda, 2017). These beliefs form a complex system of interrelated beliefs that are nested within each other and differ in their stability, temporal characteristics (orientation toward the past, presence, or future), and specificity (for a discussion, see Beghetto & Karwowski, 2017). Table 19.1 provides an overview.

As illustrated in Table 19.1, creative self-beliefs can be organized into three broad types: *creative confidence* beliefs, which include creative self-efficacy (Beghetto, 2006; Tierney & Farmer, 2002) and creative self-concept (Beghetto & Karwowski, 2017; Karwowski, 2016); *creative self-awareness beliefs*, which include creative metacognition (CMC) (Kaufman & Beghetto, 2013) and creative mindsets (CM) (Hass, Katz-Buonincontro, & Reiter-Palmon, 2016; Karwowski, 2014); and *creative self-image beliefs*, which include beliefs about one's creative identity (Jaussi et al., 2007; Karwowski et al., 2013). Each of these broader categories and associated self-beliefs are also discussed in the sections that follow.

Creative confidence beliefs. Creative confidence refers to the belief in one's ability to think or act creatively in and across particular performance domains (Karwowski & Beghetto, 2018). Creative confidence beliefs serve as the driving engine of agentic action. More specifically, these beliefs influence task engagement, effort, persistence, and performance on creative tasks and endeavors.

Creative confidence beliefs can be further decomposed into *creative self-efficacy* and *creative self-concept.* Creative self-efficacy beliefs refer to a person's perceived confidence to creatively perform a given task, in a specific context, at a particular level of performance (e.g., "I can come up with at least three creative solutions to this particular problem"). Creative self-efficacy beliefs are highly malleable, future-oriented, and influenced by a range of sociocognitive and environmental factors, including physiological state, features of the physical environment, prior performance, vicarious experiences, and social persuasion (Bandura, 1997, 2012).

Creative self-concept is related to creative self-efficacy but refers to a more stable, holistic, and retrospective appraisal of one's confidence to perform creatively in and across domains (Beghetto & Karwowski, 2017). One way to think of the relationship between these two self-confidence beliefs is that self-efficacy serves as a precursor to self-concept (Bong & Skaalvik, 2003). This is not to say that creative self-concept is simply a crystalized or aggregate form of self-efficacy, but rather that efficacious experiences can, in part, shape one's self-concept.

In some cases, efficacy and self-concept beliefs may appear nearly identical (e.g., when a person has limited prior experience with a particular task). In other cases, these beliefs may appear distinct (e.g., a person's efficacy is low for creatively solving a particular problem, whereas general creative self-concept for problem-solving is high). In yet other cases, the relationship may be reciprocal (e.g., people with a strong creative self-concept in a domain may enjoy a boost in creative self-efficacy when attempting to perform creatively on a particular task in that domain).

Table 19.1 *Creative self-beliefs: categories, specific types, dimensions, and representative works*

Category	Specific Types	Dimensions
Creative Confidence *Beliefs in one's ability to think or act creatively in and across particular performance domains.*	**Creative Self-Efficacy** *Perceived confidence to creatively perform a given task, in a specific context, at a particular level.*	**Future orientation** *(prospective judgments),* **specific** *(focused on specific task and situational features), &* **dynamic** *(highly malleable).*
	Creative Self-Concept *Holistic cognitive and affective judgments of creative ability in and across particular domains.*	**Past orientation** *(based on retrospective judgments),* **general** *(more holistic appraisals within and across tasks and domains), &* **stable** *(changes more gradually, over time).*
Creative Self-Awareness *Beliefs about one's creative strengths and limitations and beliefs about the nature of one's creative abilities.*	**Creative Metacognition** *A combination of self-knowledge (i.e., belief about one's creative strengths and weaknesses) and contextual knowledge (i.e., beliefs about when, why, and how to be creative).*	**Present orientation** *(in situ judgments);* **moderately specific** *(influenced by present and past self-beliefs and perceptions); &* **moderately stable** *(somewhat stable, but influenced by specific task features).*
	Creative Mindset *Beliefs about the nature of creativity itself (e.g., is creative competence fixed, incremental, or both).*	**Present orientation** *(based on current beliefs about creativity);* **moderately specific** *(influenced by present and past self-beliefs and perceptions); &* **moderately stable** *(somewhat stable, but influenced by specific task features).*

Table 19.1 (*cont.*)

Category	Specific Types	Dimensions
Creative Self-Image *Creative self-image beliefs pertain to how people perceive creative activities, aspirations, and abilities as part of their sense of self.*	**Perceived Value of Creativity** *Belief about the value, merit, or worth of creativity in relation to one's broader sense of self.*	**Past orientation** *(based on retrospective judgments of the value that creativity has to one's life);* **general** *(more holistic appraisals within and across tasks and domains), &* **stable** *(changes more gradually, over time).*

Although sociocognitive and environmental factors influence both efficacy and self-concept beliefs, these influences tend to accrue over time for self-concept beliefs, whereas situational factors can have a more immediate influence on efficacy beliefs (Bong & Skaalvik, 2003). In addition to being more stable, creative self-concept is also multifaceted (Bong & Clark, 1999). More specifically, creative self-concept beliefs include both cognitive (e.g., "I have always been good at coming up with creative solutions to social problems") and affective appraisals (e.g., "I enjoy coming up with creative solutions to social problems").

One of the most important (and often neglected) distinctions in the field is the temporal and task dimensions of these beliefs (Beghetto & Karwowski, 2017). Indeed, when it comes to designing studies to tap creative self-efficacy beliefs, the temporal and task dimensions should be taken into consideration. More specifically, creative self-efficacy beliefs likely are most salient once participants have been presented with a specific performance task but prior to engaging with that task.

As Bandura (2012) has explained, efficacy beliefs vary not only across domains but also across situational conditions; they do not "manifest uniformly across tasks and contexts in the likeness of a general trait" (p. 13). Self-concept, on the other hand, has more trait-like characteristics and thereby can be assessed within and across performance situations and domains (Bong & Skaalvik, 2003).

Moreover, efficacy beliefs are most salient in situations with clear performance targets ("I am confident that I can come up with at least five original ideas for solving this problem" – efficacy belief) and less salient in ambiguous performance situations ("I am good at coming up with original ideas" – self-concept belief). Ambiguity with respect to performance requirements is one conditional factor that can influence efficacy beliefs and may be one of the explanatory factors of the appearance of overconfidence and underconfidence in relation to actual performance (Bandura, 2012; but see Kruger & Dunning, 1999). When designing measures to assess efficacy beliefs, specificity of performance targets is a key consideration (otherwise, such measures likely will tap into more general self-concept beliefs).

Much of the prior work exploring creative confidence beliefs has tended to blur the conceptual and methodological distinction between creative self-efficacy and creative self-concept (Beghetto & Karwowski, 2017). The vast majority of the work on creative confidence has endeavored to explore creative self-efficacy. The types of methods and measures used, however, likely have tapped more into self-concept beliefs than efficacy beliefs.

Indeed, researchers (Beghetto, 2006; Karwowski, 2011, 2012; Tierney & Farmer, 2002; Farmer & Tierney, 2017) have tended to measure creative confidence beliefs, specifically creative self-efficacy, using more general, retrospective, and global items (e.g., "I am good at coming up with new ideas"). This is even the case when using domain-specific items (e.g., "I am good at coming up with new ideas when solving math problems"). Consequently, such measures likely have tapped into the more global features of creative confidence (akin to creative self-concept) rather than the more performance specific beliefs of creative self-efficacy.

This is not to say that the previous work, over the past two decades, should be dismissed. Instead, we are simply highlighting the importance of situating this work in a more specific conceptual context of creative confidence beliefs and suggesting that researchers aim to clarify the distinctions between efficacy and self-concept moving forward. Bandura (2006) provides specific guidelines and examples for how researchers can design measures to ensure that they are assessing people's efficacy beliefs (rather than more general confidence beliefs).

Future work that endeavors to more clearly distinguish between creative efficacy and creative self-concept beliefs is needed to help clarify and empirically examine how these two types of confidence beliefs develop, work together, and what specific role they play in creative performance.

Creative self-awareness beliefs. Creative self-awareness refers to beliefs about one's creative strengths and limitations and beliefs about the nature of one's creative abilities. Creative awareness beliefs work in conjunction with creative confidence beliefs in shaping agentic action. More specifically, these beliefs inform whether people think it is possible to be successful and improve with effort as well as determine whether to engage with performance tasks, regulate creative effort, and recalibrate their perceived competence following task performance.

As with creative confidence beliefs, creative awareness beliefs can be further decomposed into more specific beliefs, including *creative metacognition* (CMC) and *creative mindset* (CM). CMC refers to a combination of creative self-knowledge (i.e., beliefs about one's creative strengths and weaknesses) and contextual knowledge (i.e., beliefs about when, why, and how to be creative) (Kaufman & Beghetto, 2013).

CMC represents a form of creative self-awareness because it refers to a combination of beliefs about one's perception of creative strengths and limitations in light of a particular performance task. Consequently, issues of accuracy and regulation of these beliefs are of particular importance when attempting to assess CMC (Beghetto & Karwowski, 2017).

CMC beliefs are most salient prior to and during task engagement and inform self and situational appraisals (e.g., "I am confident I can solve this particular problem creatively") and help regulate creative behavior (e.g., "This problem is more challenging than I thought") (Beghetto & Karwowski, 2017). CMC beliefs also come into play following task engagement and serve as a means for adjusting or recalibrating confidence beliefs (e.g., "I'm not as good at creatively solving this kind of problem as I thought"). In this way, CMC beliefs are influenced by and, in turn, influence creative confidence beliefs.

CMC beliefs tend to be activated prior to engaging with a task and during task engagement. They also play a role after task engagement in recalibrating confidence beliefs in light of performance. Creative confidence can therefore be thought of as directly informing CMC appraisals (at least with respect to confidence prior to performance, sustaining effort during performance, and recalibration of confidence beliefs following performance).

Consequently, there are at least two facets of CMC that creativity researchers can assess: *metacognitive accuracy* (e.g., creative confidence aligns with creative performance) and *metacognitive regulation* (e.g., putting forth more or less effort as the task demands, including disengaging with the task; recalibrating confidence beliefs in light of actual task performance) (Beghetto & Karwowski, 2017; Ivcevic & Nusbaum, 2017; Kaufman & Beghetto, 2013).

Empirical work exploring CMC is somewhat limited. Much of the work to date has focused on assessing the creative accuracy portion of CMC, but typically following task performance (Kaufman, Beghetto, & Watson, 2016; Pretz & McCollum, 2014; Study 1 in Pretz & Nelson, 2017). Pretz and McCollum (2014), for instance, compared the performance of more global creative confidence and more task-specific measures of creative performance. They found that global creative confidence was related to past creative achievement (consistent with what would be expected for self-concept) but not predictive of performance on specific tasks. In that same study, they found that self-judgments of creativity performance following completion of specific tasks were related to actual task performance and those self-judgments tended to differ across tasks (indicative of the domain specificity of self-ratings) (Baer, 2017; see also Kaufman et al., 2016).

We are aware of only one study that used a design, which assessed creative confidence prior to and immediately following task performance, which will allow for the exploration of metacognitive accuracy and metacognitive regulation (Karwowski, Han, & Beghetto, in press). At this point, research is needed that takes a more complete look at CMC, using designs that assess these beliefs prior to, during, and following task performance and analyze variance within and between individual performance. Such micro-longitudinal studies are necessary to develop a better understanding of how these beliefs operate in and across tasks.

CM refers to beliefs that people hold with respect to the nature of creativity. More specifically, CM beliefs inform whether people view creativity as fixed, malleable (Karwowski, 2014), or both (Karwowski, Royston, & Reiter-Palmon, 2018). CM represents a form of self-awareness belief because these beliefs pertain to perceptions about the nature of creativity (definite limits vs. indefinite potential) and one's perceived level of creative ability in light of those perceptions (e.g., "No amount of additional effort or feedback will make me a more creative writer" vs. "With effort, practice, and guidance I can learn how to write more creatively").

Empirical work exploring CM is also limited but growing. Mindsets are typically measured using scales describing individuals' perception of creativity as being stable (fixed mindset) or changeable (growth mindset) (Karwowski, 2014; Karwowski & Brzeski, 2017). People who hold a fixed creative mindset have been found to have lower creative confidence beliefs (Karwowski, 2014), report lower creative achievements (Puente-Diaz & Cavazos-Arroyo, 2017), demonstrate lower creative potential (as measured by performance on divergent thinking tasks), and tend to more quickly lose interest in creative thinking (O'Connor, Nemeth, & Akutsu, 2013).

People who hold a fixed mindset tend not to value creativity as much as those with a growth mindset (Pretz & Nelson, 2017) and tend to be less willing to pursue their creative aspiration following negative performance outcomes (Beghetto, 2014). On the other hand, a malleable (growth) creative mindset has been linked with creative personal identity, creative confidence (Hass et al., 2016; Karwowski, 2014; O'Connor et al., 2013; Pretz & Nelson, 2017). It was also positively correlated with effectiveness of creative problem-solving (Karwowski, 2014), insight and divergent thinking tasks (Karwowski & Beghetto, 2018), and adaptive behaviors related to creative task performance and failures (Puente-Diaz & Cavazos-Arroyo, 2017).

Subsequent research on CM likely would benefit from being situated in a more integrative model of creative self-beliefs to determine how specifically mindsets work in relation to creative confidence, creative self-awareness, and creative self-image beliefs. We provide an example of one such integrative framework in a later section of this chapter.

Creative self-image beliefs. Creative self-image beliefs pertain to how people perceive creative activities, aspirations, and abilities as part of their sense of self. Creative activity not only is time-consuming and effortful but also requires undivided devotion and withdrawal from even the closest interpersonal relationships (Gardner, 1993; Lebuda & Csikszentmihalyi, 2018). Sustained creative aspirations and activities can, therefore, be subsumed into one's personal sense of self (Beghetto & Dilley, 2016).

Creativity researchers have used various indicators of creative self-image beliefs, which have been viewed as proxies for the creative personal identity, including appreciation of creativity (Plucker & Makel, 2010) and perceived value of creativity (Karwowski & Beghetto, 2017). From a sociocognitive perspective, the importance of behaving creatively gets incorporated into a person's self-description (Jaussi, Randel, & Dionne, 2007). Indeed, people seem to be eager to engage in identity-congruent actions (Oyserman, 2007; Oyserman, Elmore, & Smith, 2012).

Consequently, people who consider creativity to be an important part of their identity likely will seek out opportunities to act in ways congruent with this self-image (see Freeman, 1993; Petkus, 1996; Steele, 1988). Likewise, unless people value creativity, they likely will not be willing to take the risks necessary to express it. Indeed, Karwowski and Beghetto (2018) found across three studies that creative self-image beliefs (in the form of valuing creativity) moderated the link between creative potential and creative behavior. More specifically, the results reported by Karwowski and Beghetto (2018) indicate that, even if people have creative potential and confidence in their potential, that potential will not be realized in the form of creative activities or accomplishments unless they also personally value creativity.

In this way, creative self-image beliefs can be thought of as providing an ambient reciprocal influence on creative confidence and self-awareness beliefs (Beghetto & Karwowski, 2017), as well as a conditional influence on creative behavior. As creative confidence and self-awareness strengthen, so does one's creative identity, which in turn further strengthens one's creative confidence and creative self-awareness. With respect to the conditional influence, unless people value creativity they likely will not engage in creative behaviors.

Creative Self-Beliefs: Toward an Integrative Approach

As we have discussed, interest in creative self-beliefs has grown steadily over the past two decades. This growing interest may, in part, be a reaction to the historically trait-based focus of research in the field. Indeed, creativity research historically has been focused on more static, individual traits (e.g., Feist & Barron, 2003; Getzels & Jackson, 1962; Guilford, 1950). Key work in this area has found robust cognitive and personality traits that are predictive of creativity (e.g., Benedek et al., 2012; Feist, 1998; Kim, 2008;

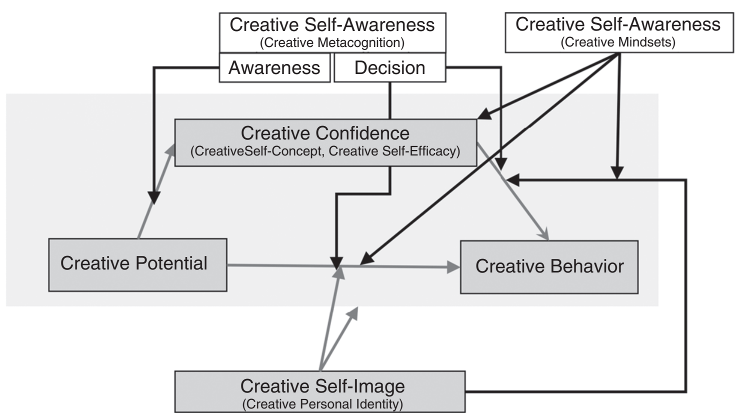

Figure 19.1 *Elaborated Creative Behavior as Agentic Action (E-CBAA) model* (after Karwowski & Beghetto, 2018)
Gray elements denote elements of the original CBAA model; the remaining elements' roles were hypothesized based on their characteristics and mechanisms played, as described in this chapter.

Silvia et al., 2009; Wolfradt, & Pretz, 2001) and has demonstrated that creative potential is linked with creative activity and accomplishments (Jauk, Benedek, & Neubauer, 2014; Kim, 2008; Plucker, 1999).

Additional perspectives are needed to provide insights into why high levels of creative potential do not always, or even that often, pay out in the form of creative achievement (see Winner, 2000). Taking an integrative approach to studying the role that creative self-beliefs may play in the link between creative potential and creative performance may shed much needed light on what factors support the movement from potential to performance.

There are a few recent examples of researchers taking a more integrative approach (e.g., Karwowski & Beghetto, 2018, see also Karwowski & Barbot, 2016). This line of work has endeavored to help explain variations in the relationship between potential and performance. Drawing on this work, we offer by way of example an elaborated version of the Elaborated Creative Behavior as Agentic Action (E-CBAA) model (originally presented in Karwowski & Beghetto, 2018). The elaborated model is displayed in Figure 19.1.

The operating assumption of this model is that creative outcomes emerge from an agentic process. Unless people value creativity and believe in their ability to produce creative outcomes, then it is unlikely that, even if someone has creative potential, they will realize that potential in the form of creative behaviors. This model builds on recent work (Karwowski & Beghetto, 2018; see also Karwowski & Barbot, 2016) and provides creativity researchers with a new way of conceptualizing and empirically testing the role that creative self-beliefs play in transforming creative potential into creative performance.

Creative Potential

The first element of the E-CBAA model is *creative potential*. Indicators of creative potential must fulfill at least two criteria: (1) serve as antecedents of creative activity and achievement and (2) remain relatively stable overtime. The first criterion helps to narrow the focus to factors that are conceptually related to but precursors of creative behavior. Divergent thinking would, for instance, be considered an antecedent of creative behavior and thereby serve as an indicator of creative potential (Plucker, 1999).

The second criterion excludes more volatile motivational states or self-beliefs themselves and, instead, focuses on more stable indicators of creative potential.[2]

[2] Obviously, in several specific cases it may be difficult to decide whether a certain psychological category should be included in the category of potential or not. For instance, intrinsic motivation (Amabile, Hennessey, & Grossman, 1986) may be analyzed as a motivational orientation (Amabile, et al., 1994) – relatively stable and therefore likely fulfilling the criteria we propose – but also as a state, which should not be included in this group. Similarly, we call against including creative self-beliefs in the category of potential, as it is acknowledged that they are changeable, dynamic, and task-oriented (Beghetto & Karwowski, 2017). Moreover, confidence beliefs (efficacy in particular) are not merely a reflector of prior performance but rather can influence behavior independent of prior performance (e.g., vicarious experiences, social persuasion) (Bandura, 1997, 2012). On the other hand, however,

Examples include prior performance (Chang, Wang, & Lee, 2016), cognitive abilities (Jauk et al., 2013; Karwowski et al., 2016; Silvia & Beaty, 2012), imaginary skills (Jankowska & Karwowski, 2015), insight-related abilities (Dietrich & Kanso, 2010), openness to experience (Puryear, Kettler, & Rinn, 2017), convergent thinking (Runco et al., 2010), and synthesizing abilities (Barbot, Lubart, & Besançon, 2016).

Taken together, these criteria help establish creative potential as a theoretically relevant antecedent to creative behavior and enable researchers to empirically test a wide range of relatively stable indicators of creative potential. Importantly, the criteria do not rule out the possibility of testing indicators of potential that have previously demonstrated variable, weak, or even null direct relationship with creative behavior.

Consider, for instance, moments of insight or the "aha!" experience, which have long been viewed as an antecedent to creative behavior (Mednick, 1962; Wallas, 1926; Weisberg, 1995, 2006). Prior empirical work, however, has failed to demonstrate a consistent link between performance on insight problems and creative behavior or achievement (Beaty, Nusbaum, & Silvia, 2014). There are various reasons why researchers have failed to find a consistent link, including everything from issues with how performance on insight problems has been measured and the possibility that there is no link. Performance on insight problems should not be ruled out just because prior work has failed to demonstrate a reliable relationship with creative behavior. Indeed, Karwowski and Beghetto (2018) provide evidence that there is an indirect link that is mediated and moderated by creative self-beliefs.

Creative Behavior

Creative behavior represents the second element of the E-CBAA model. Creative behavior is posited as the observable realization of creative potential. There are at least two criteria that should be taken into consideration when selecting indicators of creative behavior. First, the indicators should represent measurable outcomes (e.g., achievements, performances, behaviors, artifacts). Second, the measures should adhere to the generally agreed upon definition of creativity (e.g., representing some combination of novelty and meaningfulness).

There are various measures of creative behavior – including observations of students' activities in the classroom (e.g., Boysen, 2017; Gajda, Beghetto, & Karwowski, 2017), creativity activity or achievement checklists (Carson, Peterson, & Higgins, 2005; Jauk, Benedek, & Neubauer, 2014), and day-to-day measures of engaging in creative activities (Conner & Silvia, 2015). Of these various types of measures, perhaps the most popular among creativity researchers is self-reported activity or achievement checklists.

Creative activity scales measure a person's self-reported frequency of performing different creative activities, such as "painting an original picture," "giving a recital,"

some theoretical takes of the creative self-concept, which perceive it as stable and a more trait-like characteristic (e.g., Batey & Hughes, 2017), could be effectively included in that category.

or “writing a play” (see Dollinger, 2007; Hocevar, 1979). A large number of these measures have been used to date (for an overview and assessment of their quality, see Silvia et al., 2012), including the Creative Behavior Inventory (Dollinger, 2007; Hocevar, 1979), the Inventory of Creative Activity and Achievement (ICAA; Diedrich et al., 2018; Jauk et al., 2014) or the Biographical Inventory of Creative Behaviors (Batey, 2007).

Creative achievement checklists and scales are oriented toward observable and socially valued creative accomplishments (see Carson et al., 2005; Diedrich et al., 2018; Jauk et al., 2014). The most widely used example is the Creative Achievement Questionnaire (CAQ; Carson et al., 2005); an instrument assessing individuals' creative achievement in ten different domains. Creative activity scales and creative achievement checklists are examples of the kinds of measures that meet both criteria of creative behavior as specified by the E-CBAA model.

Creative Self-Beliefs

The third set of elements represented by the E-CBAA model is creative self-beliefs. As depicted in Figure 19.1, self-beliefs are posited as playing an intermediary role between the more primary indicators of creative potential and subsequent creative behavior. The various roles that each self-belief plays in the model are discussed in the sections that follow.

Mediating role of creative confidence beliefs. The E-CBAA model posits that creative confidence mediates the link between creative potential and creative behavior. This indirect effect was demonstrated in both cross-sectional (e.g., Chen, 2016; Choi, 2004) and longitudinal (Karwowski & Beghetto, 2018) studies. As higher potential is associated with previous successes and positive social feedback, these prior experiences can serve as building blocks for confidence (Bandura, 1997), which in turn impacts creative behavior.

In this way, creative potential works through creative confidence to influence creative activity and achievement. Previous studies have demonstrated that creative confidence partially mediates the link between indicators of creative potential and behavior (Choi, 2004; Karwowski & Beghetto, 2018). This makes sense, given that creative confidence is only one of many potential factors likely responsible for transforming creative potential into activity.

Moderating role of creative self-image beliefs. Perceiving creativity as a worthwhile endeavor and valuing creativity serves as a threshold for the link between creative potential and behavior. There are highly skilled individuals who may not value creativity much. The likelihood that they will engage in creative activity is low (Karwowski & Beghetto, 2018). Therefore, at least a moderate level of valuing creativity seems to be a necessary condition for effective transition from creative potential to creative activity.

Valuing creativity and perceiving it as an important element of the self not only moderates the relationship between potential and behavior but also moderates the links between creative confidence and behavior. Likewise, it is much less likely that someone confident in her or his ability will engage in creative action, if (s)he does not perceive creativity as important. Therefore, the perceived value of creativity plays a special role in the model.

Apart from moderating the link between potential and behavior, valuing creativity also moderates the indirect relationships of *potential → confidence → behavior*. It was empirically demonstrated (Karwowski & Beghetto, 2018) that the indirect effect between potential and behavior as mediated by confidence is significantly stronger among individuals who value creativity and is virtually missing among those who do not appreciate it. In other words, valuing creativity plays a crucial role in the E-CBAA model – without it, even the strongest level of creative confidence may not translate into creative behavior.

Moderated mediation of creative self-awareness beliefs. As illustrated in Figure 19.1, the self-awareness belief of CMC is posited as moderating the mediated *potential → confidence → behavior* relationship. There are at least two reasons for this assertion. First, metacognitive awareness helps ensure more accurate self-assessments of creative strengths and weaknesses (Kaufman & Beghetto, 2013). Given that more creative people are, on average, more confident (Runco, 1991; Silvia, 2008), the E-CBAA model posits that the mediating role creative confidence plays will be enhanced by individuals with higher levels of CMC.

Second, metacognition serves to regulate the decisions and actions of people. Put simply, more accomplished creators recognize that there is a right time and place for putting forth creative effort (Kaufman & Beghetto, 2013). Sometimes it is better to quit than to create and this is exactly the role CMC plays. This regulatory aspect of CMC moderates the confidence–behavior link. Indeed, a person may decide not to behave creatively for strategic reasons (even if that person has high potential, high creative confidence, values creativity, and has a creative growth mindset).

Direct and indirect influences of creative self-awareness beliefs. Creative self-awareness beliefs, in the form of mindsets, are posited as influencing the links between creative potential, creative behavior, and creative self-beliefs. Mindsets can be thought of as informing creative confidence beliefs and prior empirical works have demonstrated a link between growth mindset and stronger creative confidence beliefs (Hass et al., 2016; Karwowski, 2014; Karwowski et al., 2018). Moreover, links between mindsets and potential or behavior (achievement) are much weaker and less systematic (Karwowski et al., 2018).

Consequently, the E-CBAA model asserts that creative self-awareness in the form of mindsets would have the strongest influence on creative confidence beliefs. More specifically, perceiving creativity as malleable would positively influence creative confidence beliefs, whereas associating creativity with a stable and unchangeable characteristic would reduce creative confidence.

Moreover, people who believe that creative ability is fixed and unchangeable likely will not engage in creative activity as they will see very limited chances of success in doing so. Consequently, fixed mindset is posited as reducing the links between potential and behavior. In some cases, mindsets may play a limited role (e.g., in the case of relatively easy tasks) and in other cases play a more influential role (e.g., when people are faced with complex tasks and the risk of failure is salient).

Taken together, the E-CBAA model provides an example of how creativity researchers can take a more integrative approach when conceptualizing the relationship among creative self-beliefs and the role they play in creative behavior. The model is but one example of an empirically testable model that can help clarify the multifaceted and conditional role that creativity self-beliefs play in creative thought and action. The testing, refinement, and further development of this and similar models likely will help ensure that the burgeoning work on self-beliefs makes a meaningful contribution to the field and our growing understanding of creative phenomena.

Discussion

In this chapter, we focused on three categories of creativity-related beliefs: creative confidence beliefs (i.e., creative self-efficacy and creative self-concept), creative self-awareness beliefs (i.e., CMC and CM), and creative self-image beliefs (creative personal identity). We endeavored to clarify the nature of creative self-beliefs and demonstrate how creativity researchers can work to advance knowledge in the field about the role these beliefs play in creative thought and action.

In what follows, we briefly summarize a few key themes and make suggestions for future work in this area.

On the Dynamics of Creative Self-Beliefs

Creative self-beliefs are not epiphenomena of personality, prior performance, or other individual differences characteristics. They correlate with them and likely develop under their influence, yet they are independent and dynamic constructs that play an intermediary role between creative potential and performance. Consequently, researchers need to take a more integrative and dynamic approach when studying such beliefs. Doing so will require epistemological and methodological changes. Epistemologically, creative self-beliefs should be theorized as "between" constructs, situated between traits and states, closer to motivational orientations than personality traits. They develop thanks to an individual's activity, the modeling of significant others, previous successes and failures, and also cultural conditions and peer influences.

Their dynamism is primarily related to situation and task specificity. Individuals may value creativity in general and think about themselves as about (generally) creative or not so creative. In reality, however, while acting individuals take a task-specific perspective, they continuously assess their own potential in relation to the task at hand. Researchers may want to aggregate such self-estimates, yet it is much more informative to analyze the specific facets of self-beliefs. Future studies require designs and measures that take into account the dynamic features of creative self-beliefs in an ecologically valid way.

On the Measurement of Creative Self-Beliefs

Previous studies on creative self-beliefs relied heavily on self-reported scales that measure domain-general self-beliefs or the more domain-specific creative self-concept. A more dynamic approach is needed to complement these general measures with scales that are tailored to specific tasks and situations. Instead of asking participants whether they are creative or not, researchers may want to ask them to estimate the likelihood that they're able to deal with a task at hand (see, e.g., Bandura, 2006).

When such assessments are provided before and after solving a problem or producing something creative, not only creative self-efficacy but also calibration of CMC might be measured more effectively. Studies of creative self-beliefs may also benefit from more dynamic and naturalistic designs, as recently demonstrated Karwowski et al., (2017). They could include ecological momentary assessment (Silvia et al., 2014) but also thinking-aloud protocols, observational studies on individuals solving tasks with posttask retrospective interviews, or even eye-tracking studies that show how attention and mind-wandering during a task relate to their beliefs (see e.g., Janowska et al., 2018).

On the Influences on Creative Self-Beliefs

One of the main premises that make self-belief constructs so relevant and interesting for creativity researchers is that self-beliefs are considered malleable and influenced by internal (personality, hobbies, previous successes) and external (culture, parents, teachers, peers, training) influences. Although previous studies summarized here and elsewhere (Karwowski & Barbot, 2016; Karwowski & Lebuda, 2017; Karwowski et al., 2015) indeed make it plausible that such influences are robust, future studies are needed to estimate the relative weight of different elements on creative self-beliefs.

Strong designs that go beyond simple correlational and cross-sectional studies and are based on experimental and longitudinal investigations are necessary to better establish crucial predictors and the level of change in creative self-beliefs. Micro-longitudinal studies with intensive measures of different tasks and processes of calibration of creative self-beliefs seem to be useful here as well. Similarly, thorough interventions that simultaneously develop creative abilities and creative self-beliefs (e.g., Mathisen & Bronnick, 2009; Tang & Werner, 2017) are needed to better understand the possibilities of their enhancement.

There are several lingering questions that arise out of this line of work: What is the role of parents, new technologies, the media, or cultural blending? How can we build strong yet accurate creative confidence? How do we make creativity more valued, without making it overly ideologized (Hanchett Hanson, 2015)? These are key questions waiting for future researchers to tackle.

On the Mechanisms of Creative Self-Beliefs

The final point relates to the mechanisms different creative self-beliefs play – mechanisms that may allow researchers to understand the relationship and movement between mini-c, little-c, and Pro-c (Kaufman & Beghetto, 2009) or a transition from creative potential to creative behavior and achievement. In this chapter, we also highlighted an example of a recent integrative model (Karwowski & Beghetto, 2018), which posits that creative confidence mediates the link between potential and activity, whereas valuing creativity moderates the direct link between potential and behavior as well as the indirect link of potential–confidence–behavior.

This model assumes that creativity is an agentic process and agentic decision. There is no creativity without valuing it and likely very little of it when someone does not believe in her or his creative skills. What we proposed in this chapter is a somewhat speculative elaboration of this model by incorporating two additional self-beliefs categories: CMC and CM. This model, therefore, goes beyond what was recently proposed (Karwowski & Beghetto, 2018; see also Karwowski & Barbot, 2016), yet it requires intensive theoretical and empirical work to be considered complete. New and alternative versions of integrative models are needed to better understand the role creative self-beliefs play in creative action. Doing so may add important new insights into how creative potential develops into creative performance.

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Environmental Differences in Creativity

20 Cultural Perspectives on Creativity

Todd Lubart, Vlad P. Glăveanu, Herie de Vries, Ana Camargo, and Martin Storme

Creativity is a contextually embedded phenomenon. It involves a person or group of people who operate within a context. This context (with its physical and social facets) has many levels, ranging from family, school, work/organizational settings to local community, regional, national, or transnational ones. All of these contextual levels contribute to the expression of culture. Culture, as a social environment, can be defined as "an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and attitudes toward life" (Geertz, 1973, p. 89). In the GLOBE international research program, House and Javidan (2004, p. 15) defined culture as "shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives and are transmitted across age generations."

In this chapter, culture will be examined as a multidimensional construct, just like creativity. Moreover, we start from the premise that the meaning of creativity and that of culture are intrinsically bound to each other (see Glăveanu, 2014). Creativity as a process uses "culturally-impregnated materials" (ideas, signs, objects, values, etc.) to create new and meaningful artifacts that contribute to culture itself (both the macro-culture of entire groups or nations and the micro-culture of local actors and interactions).

If we equate culture mainly with the nation – as in some cross-cultural research – we risk missing this complexity. And what, in the end, would national culture be like? For example, the French culture can be operationalized, for the current work, as the composite traditions, beliefs, values, and preferred ways of behaving in contemporary France. Of course, French culture is not confined to within the borders of modern France. It can be found to varying degrees in many parts of the world. Evolving for thousands of years ago, it involves a way of seeing the world, including a shared lifestyle and language. It is part of European culture, which together with some other cultural regions can be viewed as part of the "Western" world. Needless to say, contemporary French culture is somewhat different from its historical versions (such as French culture in the time of Louis XIV). Modern French culture is also influenced by its current geographical, economic, and political situation (France is currently a republic with representative government, and part of the European Union, rather than an isolated monarchy.) Finally, it is worth noting that French culture is not a homogeneous entity. Indeed, some cultural patterns in southern France are quite different from those in northern, western, or eastern France. Parisians, among others, claim to have a specific subculture. This example illustrates some of the complexities involved in capturing the "culture" variable in order to study its impact on creativity. The same observations could be made concerning other cultural settings, such as the United States, which we may refer to as "American culture," although many regional and other subcultures exist. Thus, there are many layers of culture, apart from the national level; these include the regional, ethnic, religious, and linguistic levels, the gender and generational levels, the class level, and, with respect to organizations, the departmental, division, and corporate levels.

Culture is a pervasive, omnipresent part of human living conditions (Valsiner, 2014). It is so connected with everyday behavioral patterns that we tend to take it for granted. Often, we do not even realize the impact of culture. To take a hypothetical case, if a person lives in a world in which all objects are round, the person may not even realize that this feature of the environment influences how they live. Of course, a brief trip to another planet where all objects are square may offer some insights, perhaps producing "culture shock" when the usual ways of acting in a round world are employed in a square world. Given the variations within and between cultural contexts, an enhanced understanding of creativity may be gained by examining in-depth, creative expression in a specific cultural setting as well as comparing and contrasting creativity in different cultures. This chapter does not seek to provide a comprehensive review of all relevant studies on the topic. Rather, the goal is to raise key issues, highlight major trends, and provide illustrations of research findings. In this way, it offers a complementary view to previous syntheses on creativity and culture (see Lubart, 1990, 1999; Ludwig, 1992; Niu & Sternberg, 2002; Rudowicz, 2003, Westwood & Low, 2003; Glăveanu, 2016).

In this chapter, two main cultural perspectives on creativity will be examined. First, the sociocultural psychology of creativity and its basic premises will be introduced and discussed. This approach is based on a view of interdependence between person and culture, and studies creative action in its cultural context. Does "creativity," for instance, mean the same thing in different cultural settings? Existing research based on people's conceptions of creativity, including implicit and explicit definitions of creativity, descriptions of creative people, and evaluations of creative productions, will be highlighted. Second, cross-cultural studies make comparisons between the expression of creativity in two or more contexts, focusing on dimensions such as individualism/collectivism, on which societies tend to vary. Are these cultural dimensions related to differences in creativity? Third, and finally, there is increasing interest in the impact of exposure to multiple cultures and the use of cultural tools – including modern technologies – as sources of creativity. Research on multicultural experiences and creativity and technology will be reviewed at the end of the chapter.

The Sociocultural Approach to Creativity

The basic premise within a sociocultural approach is that creative processes are not exclusively individual and intra-psychological, but rather distributed across people, objects, places, and institutions. Creative action is, in this perspective, intrinsically cultural, given the fact that it is mediated (or made possible) through the use of signs (e.g., language) and tools (e.g., technology). Creativity takes place, therefore, "in between" people and the cultural environment rather than "inside the head." This view builds on the early works of Lev Vygotsky (1930/1998), who discussed creativity as a social activity; John Dewey (1934), who explored it as material and symbolic action; and Mikhail Bakhtin (1929/1984), who pointed to the dialogical nature of the creative process. These strands of scholarship, however, did not make an impact on the psychology of creativity when this branch emerged in the mid-twentieth century. This is because the concerns that occupied researchers after 1950 (see Guilford, 1950) had to do with the relation between creativity and intelligence, on the one hand, or personality, on the other (Barron & Harrington, 1981). Only gradually, from the 1970s and 1980s onward, did social concerns enter this field of study, mainly through the systemic thinking of Csikszentmihalyi (1988) and Gruber (2005), the historiometric analyses of Simonton (1975), and the social psychological approach of Amabile (1982). However, for as much as these new theories considered creativity as a contextual process, they did not provide an explicit understanding of culture. It is only in recent years that cultural and sociocultural psychologists started to focus on the topic of creativity (e.g., Glăveanu, Gillespie, & Valsiner, 2015) and developed frameworks that recognize its simultaneously psychological and cultural nature.

An example of a sociocultural framework of creativity is the Five A's (see Glăveanu, 2013, 2015), which were intended to "rewrite" the classical Four P's (person, process, product, and press; Rhodes, 1961) in a cultural key. The Five A's include the actor(s) doing the creating, the audience(s) being engaged or addressed, the action(s) being performed, the artifact(s) being produced, and the affordances (i.e., the potential for action "afforded" by the material properties of objects) being used in the process. Where exactly is culture in this model? In line with the sociocultural view of the interdependence between culture and mind, there is no distinct element called "culture." Instead, culture is considered to shape precisely the ways in which the five "elements" interact in order to produce creative outcomes. The particular organization of the actors, audiences, actions, artifacts, and affordances reflects the cultural beliefs, values, and norms specific for a certain group, situation, or moment in time. For example, the creative actions of a painter will depend on the specific audiences he or she is in dialogue with and the material means at his or her disposal (affordances). Equally, the work of a scientist, for instance, is an act of communication directed at different audiences (e.g., peers, reviewers, inventors), generating new and meaningful conceptual or material artifacts and building on the affordances of technology and of previous scientific discoveries. It is important to note that, in this paradigm, culture is not studied only at the national level and in terms of shared beliefs and values. The Five A's are organized in ways that promote (or hinder) creativity at different cultural levels: from societal to interpersonal. This is why a sociocultural approach to creativity supports considering it as largely domain-specific (Kaufman & Baer, 2004).

Moreover, this approach focuses our attention on the relationships and interactions established between the Five A's, rather than the analysis of each element taken separately. It also considers the cultural system creators are embedded within as evolving over time (see also Gruber, 2005). Last but not least, it focuses our attention not only on creative actions and the ways in which they might vary across cultural contexts (something discussed in the cross-cultural section) but also on creativity beliefs or the more or less implicit conceptions of creativity specific for certain cultural groups or settings (as we will discuss). In fact, it considers the relationship between beliefs and practices as co-evolving, given the fact that what people believe about creativity has a direct impact on what they do and thus reflects the broader culture of which they are a part.

Conceptions of Creativity in the Cultural Context

The conception of creativity includes its defining features as well as associated characteristics. For example, in psychology, Western researchers' definitions of creativity tend to focus on a capacity to produce work (ideas or productions of all kinds) that is both novel/original and adaptive or useful given the task or situational parameters. According to this conception, central features are productivity, originality, and adaptiveness. It is worth examining whether these same defining features hold across all cultural settings, both national and local. Needless to say, the investigation needs to be conducted in the most unbiased way possible, so that researchers based in a Western approach do not see everything through their own perspective. In this respect, it was noted several times in Kaufman and Sternberg's (2006) *International Handbook of Creativity* that research on creativity in various parts of the world has often been dominated by Western paradigms.

Several methods allow conceptions of creativity to be examined. First, it is possible to ask people in different cultural settings to define creativity in their own culturally appropriate way. Second, people can nominate examples of "creativity" in their cultural context and the common features can be examined. Third, people can indicate the individual or social variables that characterize creative people or creative accomplishments. Finally, people may be asked to judge a set of work and their evaluations of creativity can provide insight into the criteria that they use implicitly.

One goal of research on conceptions of creativity is to define the concept. A second goal, as mentioned earlier, is to identify characteristics associated with creativity within and between cultural settings. These include, for example, the fields of endeavor in which creativity is valued in a certain culture, the categories of people who are expected to be creative, and the way that creative activities are organized.

Defining Features

Research evidence suggests that there may be some universal components of creativity. The most obvious one is the notion of novelty or originality. However, novelty is itself context-dependent. What is novel in one society may not be novel in another. Furthermore, the degree of novelty is relevant. As an extreme case, some authors have argued that a vast number of sentences uttered in everyday conversations are novel combinations of words. In this view, nearly everyone engages in some creative activity every day. However, for others, this kind of novelty is not sufficient and would be disregarded. Thus, it is possible to distinguish the issue of what is novel (content) from how much novelty has been expressed (degree). The degree of novelty leads to an important definitional issue concerning the fundamental nature of the novelty. Is the conceptual model one of a break with the past, a radical, categorically new, and different idea? Or, rather, is the model one of progressive improvement, modification, and adaptation (see Puccio & Chimento, 2001)? In this case, the cutoff for deciding that an idea or other form of production is creative will be less strict. It has been suggested that a high level of novelty, with a conceptual break, may be the underlying view in some cultures, in particular Western ones, and the more gradual concept of continuing levels of novelty, working off of an existing idea, may characterize other cultures, perhaps Eastern ones. For example, Li (1997) compared Chinese inkbrush painting and modern Western painting. Chinese inkbrush painting was viewed as a "vertical" domain, in which some basic elements are essential in each work and certain other aspects can be modified (such as using humor concerning a theme). In contrast, modern Western painting is a "horizontal" domain, with novelty allowed, supposedly, on all aspects. Thus, novelty can occur "in all directions" in modern Western painting but only in certain directions in Chinese inkbrush paintings. Different processes of creating may be associated with these kinds of novelty. Thus, there seems to be a general reference to novelty across cultural definitions of creativity but the meaning of this novelty, and the way to achieve it, may vary substantially.

The second main definitional component of creativity that seems to be cross-culturally recognized is adaptive value. The term "value" is used here to cover the notions of usefulness, constraint satisfaction, adaptiveness, appropriateness, effectiveness, and relevance within the context in which the novelty is generated. It is clear that, across various domains of endeavor, the relative weight of novelty vs. adaptive value can vary. For example, in the artistic field, novelty is perhaps more highly valued than adaptiveness, whereas, in engineering, the trend may be inverted. Thus, to the extent that a cultural group or society values creativity in some sectors of activity more than others, the definition of creativity may reflect this strategic choice. Beyond this domain-related variation in the importance of adaptive value, variations can occur in the importance placed generally on usefulness. If utilitarianism is highly valued in a cultural context, the adaptiveness component of creativity will have a relative importance with respect to the novelty component (see, for example, Paletz & Peng, 2008).

Finally, the notion of adaptive value has another facet, which is the societal utility of the creative act. This trend appears most clearly in studies of creativity in Asian and African settings; creativity involves novelty that contributes positively to society (Niu & Kaufman, 2005; Mpofu et al., 2006; see also Niu, Chapter 21, this volume). Some debate on novel thinking and productions, such as inventions for evil purposes (the dark side of creativity; Cropley et al., 2010), may not necessarily be classified as creative acts in all cultures because they lack moral validity. For example, in Kenya, creative storytelling, according to Gacheru and colleagues (1999), should be both imaginative and provide an ethical message.

A few studies conducted across national cultures have examined agreement on creativity ratings of productions, such as drawings, evaluated by judges from different cultures, in particular, the United States and China (Chen et al., 2002; Niu & Sternberg, 2001; Rostan, Pariser, & Gruber, 2002). For example, Niu and Sternberg (2001) had Chinese and American graduate students in psychology rate collage and drawing productions made by Chinese and American college students. High levels of agreement were observed between Chinese and American judges. Chen and colleagues (2002) had American and Chinese college students make drawings based on geometric figures (triangle, rectangle, circle). These drawings were evaluated by American and Chinese undergraduate judges, who had not produced drawings and were blind to the origin of each drawing. The overall correlation between the judges from different cultures was 0.97, indicating a nearly perfect level of inter-judge agreement on the relative creativity of the productions. Indeed, it can be argued that these studies optimized the conditions for cross-cultural agreement because the tasks used relatively neutral stimuli, familiar in both cultures; moreover, judges were from relatively similar groups (university students) and were blind to the cultural origin of each production.

Product vs. Process Orientation

The outcome of a creative act is a production, which can be evaluated as more or less novel, original, and adaptive. The creative act, or creative process, refers to the sequence of events, including mental events that lead to the production. Some cultures, particularly modern Western cultures, focus on the production itself, with relatively less attention paid to the way that the creator achieved the outcome. When the process is considered, it is typically viewed as a linear sequence of events that moves the individual from a known starting point to a new place in the field, which is ideally as far as possible from the starting point. This view can be contrasted with an Eastern perspective, in which the key to creativity is the process more than the result. The creative process is cyclical, nonlinear, and enlightenment-oriented. It involves connecting to a larger reality, such as reconfiguring or rediscovering existing elements. In this way, respecting traditions is not alien to creating because the creative act involves finding new interpretations of existing elements and giving new breath to old ideas and practices. In this line, Westwood and Low (2003) cited the examples of creativity from a Hindu perspective, in which traditional truths are revealed in a new way, and in classic Chinese visual art, in which a well-known topic represented with a certain style is explored in a new way.

Gender Differences

As Ludwig (1992) noted, various gender-related differences can be observed for creativity as we look across cultures. In certain traditional societies, men may show their creativity in woodcraft, sculpture, and medicinal/healing practices, whereas women may express their creativity in basket weaving or making clothing, embroidery, rugs, or pottery (see, for example, Oral, 2006; Shostak, 1993). In some cultures, one gender group may be allowed access to fields involving creative work, with the other gender group denied access. Kim (2007) argued that Asian cultures based on Confucianism have long fostered inequality between men and women, with a woman traditionally being expected to show high levels of obedience, which is not conducive to creative work. Of course, creative work is not inherently gender-typed. Gender differences seem often to be related to social status, and, as different kinds of work in society vary in social status, creativity becomes gender-related. Recent trends suggest that the gender-related organization of creativity may be decreasing given the numerous changes in modern societies.

Individual or Collective Forms

In some cultural contexts, the individual creator is the focus of attention, whereas, in other cultures, creativity is mainly a collective act, often situated at the group level (Lubart, 1999). For example, a contrast can be made in the musical domain between a focus on creative composition being driven by individual composers or by musical groups. In traditional Balinese society, for example, Colligan (1983) observed that musical creativity is an essentially collective task accomplished by musical groups rather than by individual musicians, as in jazz. Sawyer (2006) described another example of habitual collective (dyadic) creativity in traditional societies, in which a shaman, based on a vision from a possession state, would work with a carver to realize a spiritual mask for ceremonial use. The position that a culture adopts on the individualistic nature of creativity is hypothesized to be related to the individualism/collectivism dimension of cultural variation, which will be described in more detail in the section “Culture Influences the Amount of Creativity.”

Domains

Several authors have observed that some cultures channel creativity into certain domains more than others (Lubart, 1990, 1999, Ludwig, 1992). Creativity may, for example, be recognized, valued, and promoted in the visual arts or technical inventions more than in religious or political spheres (Mpofu et al., 2006). As culture is often intertwined with religion; it has been noted that Islamic societies appear to foster artistic creativity in particular in nonrepresentational styles (such as geometric designs, decorative works, and calligraphy) as well as in verbal creativity in domains such as poetry, literary compositions, storytelling, and folk songs (Khaleefa et al., 1996; Ludwig, 1992; Mpofu et al. 2006; Oral, 2006). Other reports indicate that, in Turkey, scientific and technological creativity are highly valued and that, in Latin America, there is emphasis on creativity in business and advertising (Rudowicz, 2003).

In line with the sociocultural approach, the domains of culture should not be studied only at a national or supranational level but also at mezzo and micro levels. For example, a study of different professional cultures (Glăveanu & Lubart, 2018) pointed to the fact that creative work in art, science, and design is shaped by cultural interactions, expectations, and resources specific for each domain. Moreover, interviews with established creators from each one of these professional cultures revealed distinct types of normativity occupying center stage: norms imposed by the person in the case of art, by the social field in design, and by the subject itself in science. It would be interesting, in the future, to combine the two levels of analysis and examine the same professional domain in two or more different national cultures in order to reach a more complex view of the similarities and differences that govern creative actions in their cultural context. In this respect, a cross-cultural study showed that the process in one domain of creativity differs across cultural contexts. Güss and colleagues (2017) compared artists in Russia, Cuba, and Germany and, based on interviews, found that different steps of the creative process varied between these cultures. For example, emotional frustration was a typical part of the creative process in Germany and Russia but not in Cuba. The cognitive and motivational aspects of the creative process also differed: Cuban artists saw themselves typically as working within and at the center of society, whereas, for German and Russian artists, this was rare and isolation from society was the norm.

Big-C, Little-c

The distinction between eminent cases of creativity, Big-C creativity, and everyday acts of creativity, little-c creativity, can be examined across cultures. In some cultural settings, everyone can be creative. In others, it is an exclusive ability, reserved for a few exceptional people. It is interesting to note that, in the Polish language, the word "twórczość" refers to eminent creativity marked by distinguished achievements, whereas "kreatywność" refers to everyday creativity, conceived as a personal trait (Necka, Grohman, & Slabosz, 2006).

Undoubtedly, a range of creativity may be recognized in nearly every culture, even if the prototype of a creative person or group varies. It seems that numerous Western societies recognize everyday creativity but highlight and glorify the eminent cases of creativity, such as Albert Einstein, Marie Curie, Johann Sebastian Bach, Michelangelo, and Sylvia Plath. Montuori and Purser (1995) raised the possibility of the "Lone Genius Myth"; cultures that focus on eminent cases of creativity tend to highlight the individual characteristics of these special people, reducing the perceived contribution of their environment. This tendency was hypothesized to be related to a culture's position on the individualism/collectivism dimension.

In contrast, according to some reports in other cultures, everyone is naturally creative in all activities of life, such that the question itself of nominating creative people is odd and often meets with no response. For example, the !Kung San are a tribal group living in the Kalahari Desert, who engage in creative activities such as bead-weaving, storytelling, and music performance; when Shostak (1993) asked who were the most creative people, respondents would often list everyone engaged in the activity. Mpofu and colleagues (2006) reported on a study with people from North Africa and sub-Saharan Africa, representing twenty-eight linguistic groups. They found that the concept of creativity was often expressed as a commonplace ability intertwined with resourcefulness, intelligence, wisdom, talent, originality, and inventiveness. In their sample, more than two-thirds of sub-Saharan and North Africans described themselves as involved in creative activities in their daily life. At the extreme end of little-c creativity, the possibility of creativity at the personal level, in creative acts of self-development that yield no tangible production, can be mentioned. This personal creativity, a form of self-actualization or individual self-development, is valued in some cultures more than others (see recent work on implicit theories: Karwowski & Kaufman, 2017; Kaufman & Beghetto, 2013).

The Cross-Cultural Approach to Creativity

Cross-cultural research describes variations of human behaviors, such as creativity, and relates these to the cultural contexts in which they appear. This represents a quest to find similarities and differences between cultures as well as interactions between cultural and behavioral phenomena (Berry et al., 2002). It starts from different premises, however, than those of sociocultural-oriented colleagues (Cole, 1996; Shweder, 1990).

Interestingly, it is possible to argue that the evolution of cross-cultural comparisons in the research domain itself is marked by how humans related to each other over time. Human beings have observed and tried to explain each other's behavior maybe for as long as they have existed. One reason was to understand an enemy in case of war (e.g., Herodotos, 460–359 BC; Hartog 1988). Later, curiosity and discovery of unknown cultures drove research (e.g., Mead, 1935). At first, most civilizations saw themselves at the center of the universe. This ethnocentric perspective resulted in absolutism (human phenomena are thought to be the same in every culture) and lasted until the eighteenth century. Foreign cultures were described and compared with "modern civilization" and were always viewed as less developed or civilized compared with one's own culture. Most likely, trade activities and meeting people from diverse backgrounds through increased travel contributed to the appearance of cultural relativism (human behavior is patterned but comparisons between cultures are rare and seldom made out of fear of ethnocentrism) from the end of the eighteenth century onward. During the nineteenth century, there were, however, still many racial theories, also influenced by Darwin's late nineteenth-century theory of evolution.

During the late nineteenth century, cultural relativism gained ground through an appreciation for other cultures. Finally, after World War II, a new perspective of universalism (phenomena are universal but culturally sensitive measurement is needed) impacted definitions of culture. A differentiation was made between emic (specific to a culture) and etic (shared by most cultures) features. From the second half of the twentieth century, the field of cross-cultural psychology developed.

Cultural values emerged as an important topic based on anthropologists' observations (e.g., Mead [1901–1978]) that every society, in order to function, needs to solve (1) the problems of power, (2) the relation of the individual and the collective, (3) gender roles, and (4) conflicts. The fact that cultural values differ shows that societies have unique ways to solve these problems. The learned values are transmitted horizontally (peers) and vertically (parents), in direct and indirect ways (Berry et al., 2002). Minkov and Hofstede (2012, 2014, 2014) note that the idea that subcultures matter for values has little empirical support, finding that 299 in-country regions, covering twenty-eight countries in East and Southeast Asia, sub-Saharan Africa, Latin America, and the Anglo world, were clustered strongly according to national lines on basic cultural values. Thus, the study of cultural differences at the national level seems particularly relevant for creativity.

In addition to the traditional concern of cross-cultural research with the collective level, group and individual levels of analysis are increasingly seen as important as well (van de Vijvert, van Hemert, & Poortinga, 2015). There is also greater attention to methodological issues when comparing cultures, including sampling (Minkov, Bond, & Blagoev, 2015), response biases and styles (Smith, 2004, He & Van de Vijver, 2013), the use of Likert scales or forced and free choice surveys (Heine et al., 2002), isomorphism related to levels of analysis (Van de Vijver & Poortinga, 2002), the suitability of an instrument or a specific cultural context (Cheung, Van de Vijver, & Leong, 2011), and appropriate statistical analysis (Van de Vijver, 2015). In this rich context of recent work, the cultural dimensions that impact the "amount" and "direction" of creativity will be reviewed in the following section.

Culture Influences the Amount of Creativity

The issue of whether one culture fosters creativity more than another has often been raised. This question concerns both the quantity of creative production in a given culture and the quality or greatness of the productions. Simonton (1999), using the historiometric approach, has greatly contributed to comparisons of creativity within and across cultural centers during long historical periods. Political fragmentation, turmoil and war, ideological diversity, and economic circumstances, for example, have been found to impact creativity. The current issue – comparing contemporary cultures in terms of creative production – has been attempted; typically, samples from two different cultures, such as students from United States and from China, complete the same experimental creative thinking task and their productions are compared. These productions may be responses to divergent thinking tests, drawings, collages, or other kinds of work. There are some important methodological issues, such as the appropriateness of the "creativity" task in each culture as a valid measure of creativity.

Presuming that the creativity measure is equally valid (which is difficult to certify), several studies have shown that one cultural group outperforms another (such as American vs. Chinese student comparisons, Ng, 2001). The next step is to investigate why these differences were observed. In some cases, there may be several variables confounded in the "culture" variable. For example, it is important that the two contrasting cultural groups do not differ on age, socioeconomic status, education level, access to technology, and other variables. If these potential confounds are controlled, the remaining differences observed stem, it is argued, from cultural characteristics.

Some studies comparing creative performance in Westerners (notably people from the United States) with Easterners (Asians in Japan, Hong Kong, Taiwan, and Singapore) have found results favoring samples from the United States (for examples of studies using divergent thinking tests, see Saeki, Fan, & Van Dusen, 2001 comparing American and Asian samples; see also Kharkhurin & Samadpour Motalleebi, 2008). Niu and Sternberg (2001) compared artistic creativity in American (Yale University) and Chinese (Peking University) students using collage-making and alien-drawing tasks. The productions were evaluated by American and Chinese graduate students in psychology. The results indicated that the American students received higher scores on creativity than Chinese students, according to both American and Chinese judges (who were blind to the cultural origin of each drawing). Needless to say, the findings are not always in favor of US samples. In studies showing an advantage for a Chinese sample, the argument that the task taps a specific domain enhanced by a particular kind of education in the culture showing good results is typically evoked, to avoid countering the logic of the main cultural dimension argument (Niu & Sternberg, 2002, 2003).

In terms of the psychological bases of cultural effects, a few main dimensions have guided cross-cultural studies in past decades (Hofstede, 1980; Schwartz, 1994, 1999; Triandis, 1994). For example, using Schwartz's framework, employee creativity in Israel and India related to conformity (negative) and achievement (positive) values (Cohen & Erlich, 2015). The dimensions proposed by Hofstede (1980, 2011) in his landmark study of people working at IBM across the world are among the most well-known and researched: individualism/collectivism, power distance, masculinity/femininity, uncertainty avoidance/uncertainty acceptance, long-term/short-term orientation, and indulgence/restraint. Recently, the GLOBE study of cultural dimensions as relevant to professional contexts and leadership in organizations was conducted. In the study, House and his colleagues (2000) investigated, across sixty-two societies, the dimensions of Assertiveness, Future Orientation (planning, investing in the future, delaying gratification), Gender Egalitarianism, Human Orientation (fairness, altruism), Institutional Collectivism (encouraging the collective distribution of resources and action), In-Group Collectivism (pride, loyalty, cohesiveness of the group), Performance Orientation, Power Distance, and Uncertainty Avoidance. Several of these dimensions are in line with Hofstede's work, whereas others suggest new avenues that seem relevant for cross-cultural comparisons. The GLOBE study focused on leadership, so there is a large potential for future research on creativity based on these dimensions.

It is worth noting that cultures, studied at the societal levels, can be described by profiles of scores on these GLOBE dimensions. When examined together, the nine dimensions across sixty-two societies allow cultural clusters to be identified. There are ten clusters: Anglo cultures (e.g., Australia, the United Kingdom, the United States), Latin Europe (e.g., France, Portugal, Spain, Italy), Nordic Europe (e.g., Finland, Sweden), Germanic Europe (e.g., Germany, the Netherlands), Southern Asia (e.g., India, Indonesia, Philippines), Eastern Europe (e.g., Greece, Russia), Latin America (e.g., Argentina, Colombia, Mexico), sub-Saharan Africa (Nigeria, Zimbabwe), the Middle East/Arab world (e.g., Egypt, Morocco, Qatar), and Confucian Asia (China, South Korea, Japan). These clusters could serve as a basis for future investigations on creativity. When using these clusters, caution is needed when interpreting findings. According to some authors, the comprehensive GLOBE study measured the cross-cultural practices of individuals and how a society should be, rather than personal values (Minkov & Blagoev, 2011; Smith, 2004). It concerns rather ideologies (related to the use of "as-if" questions in surveys) as well as national auto-stereotypes concerning practices (McCrae et al., 2008, Minkov & Blagoev, 2011). As a result, the cultural dimensions of the GLOBE study relate only weakly with Hofstede's cultural dimensions.

Work related to creativity has centered on individualism/collectivism, uncertainty avoidance, and power distance (Hofstede, 2001; Rank et al., 2004). Individualism/collectivism characterizes the strength and cohesion of bonds between people, with people looking after themselves in individualist societies and looking after the larger societal unit to which they belong in collectivist societies. Power distance refers to the extent to which power and authority are expected and accepted to be distributed unequally in a society. Uncertainty avoidance concerns the extent to which people feel uncomfortable or threatened by unknown, uncertain situations.

In general, with collectivism, high levels of uncertainty avoidance and high power distance (hierarchical structure) are negatively related to national levels of inventiveness (Hofstede, 2001). Shane (1992, 1993) examined national rates of innovation in thirty-three countries, based on per capita number of patents, and found an advantage for societies with low uncertainty avoidance, low power distance, and high individualism. An acceptance of uncertainty (low uncertainty avoidance) may foster tolerance for risk and change. Individualism is associated with autonomy, independence (defining oneself as unique from the group), and freedom. The meta-analysis conducted by Taras, Kirkman, and Steel (2010) on the literature on the relationships between Hofstede's dimensions and indicators of innovation confirms Shane's findings. They (2010) found that innovation is strongly negatively correlated to uncertainty avoidance ($r = -0.41$) and positively to individualism ($r = 0.65$).

Rinne, Steel, and Fairweather (2012) used the Global Innovation Index (GII) to reanalyze the relation of innovation with the same value dimensions from Shane and colleagues (1995). They found a strong negative relation with power distance, a strong positive relation with individualism, and no correlation with uncertainty avoidance. Ng (2003) provides empirical evidence for a model in which cultural individualism/collectivism influences self-construal as independent or interdependent on others, and this self-concept in turn influences creativity and conformity tendencies. Lack of power, characteristic of nonhierarchical societies, fosters enhanced interactions and communication between people at different status levels, such as superiors and subordinates. Finally, hierarchical societies do not tend to embrace change because of the potential redistribution of power that might go against vested interests.

Thus, the classic argument is that cultures showing the creativity-compatible profile on certain dimensions (individualism, etc.) will favor the development and expression of creativity. People from these cultures should show higher performance on laboratory creativity tasks, more creative productions (e.g., more patents for inventions), and greater levels of creativity (e.g., Nobel Prize winners). It is worth noting, however, the effects of cultural dimensions on creativity beyond the question of cultural compatibility. Phases of creative and innovative processes may relate differentially to these cultural dimensions. For example, low power distance, individualism, and low uncertainty avoidance may foster idea generation but hinder idea implementation. Hofstede (1991, 2001) suggested collecting ideas in certain cultural contexts (e.g., weak uncertainty avoidance, with tolerance for deviant ideas and unpredictable situations) and refining them in others (strong uncertainty avoidance, sense of detail and precision).

Some recent studies have started to examine additional value dimensions of Hofstede. For example, Everdingen and Maars (2003) investigated the adoption of innovation in different cultural contexts, finding that countries with a high level of uncertainty avoidance and a low level of long-term orientation, such as Mediterranean countries, were found to be slower when adopting innovations compared with northern European countries. Shane, Venkataraman, and MacMillan (1995) examined national culture and preferences for innovation-championing strategies in thirty countries, with 1,228 professionals from four different industries. Innovation champions are those who promote the new ideas and help to overcome resistance to these ideas in organizational contexts. In this study, innovation was defined as any idea that is new to an organization (administrative, technological, product, process, etc.). Questionnaires were used to measure the perceived effectiveness of various innovation championing strategies. The results show that high uncertainty avoidance is related to preferences for idea champions to work within existing organizational rules and procedures to promote the ideas. For high power distance contexts, effective innovation champions focus on gaining the approval of important authority figures, whereas in low power distance contexts, innovation champions can seek to build a broad base of people who see value in an innovation. Finally, collectivism was associated with the strategy of getting people from different organizational departments to see the benefits of an innovation and thereby build consensus for the new idea.

Another potential effect of cultural variability on dimensions such as uncertainty avoidance or individualism is the impact on the role of creativity-related personality traits at the individual level. For example, in a culture that shows high uncertainty avoidance as a general societal characteristic, a natural variability between individuals, in terms of tolerance of ambiguity and risk-taking, personality traits considered important for creativity and related to uncertainty avoidance, exists. It is reasonable to hypothesize that individual differences in tolerance for ambiguity or risk-taking will have an enhanced importance in this cultural context because the baseline cultural contribution is low. In contrast, in a culture that shows low uncertainty avoidance, individual differences in ambiguity tolerance and risk-taking will have relatively less importance in predicting differences in people's creative output. Every individual benefits from the cultural context, and other variables that distinguish individuals will become the discriminating factors. The same line of argument can be developed concerning individualism/collectivism. This dimension is related to individual differences in individuality, self-expression, and conformity. Thus, in a highly individualist cultural setting, the relative importance of individual differences on conformity will be low compared with other variables relevant to creativity (such as ambiguity tolerance). In contrast, in a collectivist culture, given the baseline, individual differences in conformity will play a relatively important role in determining people's creative output.

A recent study indicates that cultural values may relate dynamically to creative potential. Team members working virtually together were primed with a collectivist reference, which decreased their perceptions of diversity, and increased creativity and team members' satisfaction (Ye & Robert, 2017). The tension between the individual and the group is rarely researched in cross-cultural research on creativity. As Walton (2014) describes, the individual needs the group to identify with him- or herself but also needs to deviate from the group in order to be creative. This dynamic becomes perhaps even more complex when cultural contexts change. A study on students in diverse cultural contexts showed that, for Asian students in multicultural cities – for example, London and the greater region of Luxembourg – those who scored highest for openness were the least creative in a foreign environment (de Vries, Kirsch, & Furnham, 2014). A possible explanation is that, in line with Hofstede's theory (Hofstede & McCrae, 2004), students from the collectivist Asian societies engage in fewer social interactions with the new environment than those from an individualistic society (see also Chen et al., 2016).

As mentioned earlier in the section, cultural differences can be observed between countries and within different cultures within a country. Recently, Harrington and Gelfand (2014) analyzed the difference in terms of tightness/looseness across all states in the United States and the effects on different variables, including creativity (assessed via the number of utility patents per capita). The level of tightness/looseness refers to the degree to which social norms are endorsed. In their study, tight states (showing a strong respect for social norms as well as rules and the strict punishment of deviant behavior) were less creative than loose states (displaying a greater flexibility toward the enforcement of social norms and rules and a higher tolerance for deviant behavior).

Chua, Roth, and Lemoine (2015) investigated the dynamic impact of cultural tightness of creators and audience on the tendency of creators to engage and succeed in creativity tasks. To examine this question, the authors used the data from a crowdsourcing platform, on which companies propose creative contests to generate ideas for marketing purposes. Individuals from all over the world can participate in contests that are proposed by companies from all over the world. With the data from this platform, it is possible to assess the cultural characteristics of the countries of the company that start the contest, the individuals who choose to engage in the contest, and the individuals who win the contest. Chua, Roth, and Lemoine (2015) found that creativity engagement and success depend on the cultural tightness of the countries of the creator, the countries of the receptor, and on the cultural distance between the creator's and the receptor's countries. More specifically, individuals from tight cultures are less likely to engage and succeed in creative tasks that are foreign and culturally distant. Chua, Roth, and Lemoine (2015) show also that the greater the distance between the countries, the stronger the negative impact of cultural tightness; in addition, in countries with a tight culture, foreign entrants are less likely to encounter creative success. For immediate benefits, it seems that countries with tight cultures should therefore look for creative potential in their own population as their audience is more likely to find ideas of such persons more creative.

The relationship between work culture and creativity is receiving more and more attention. At the individual level, studies show that transformational leadership – which is a leadership style focusing on intrinsically motivating followers, as opposed to transactional leadership, which focuses more on extrinsic rewards – is positively associated with followers' creativity (Gong et al., 2009). A culture of trust seems also to be important for creativity in organizations. Alge and colleagues (2006) showed that information privacy – that is, the perception that employees have of their personal information in the organization – positively predicts creativity. This is because employees who feel that they have control over their personal information are empowered and therefore more creative (Alge et al., 2006). At the level of teams, Rosing, Frese, and Bausch (2011) showed that transformational leadership is especially important in the early phases of the creative process – when ideas are generated – whereas transactional leadership is beneficial at later phases – when ideas are implemented. At the level of the organization, it seems that decentralized structures lead to greater innovation (Jung et al., 2008). More generally, a climate supportive of innovation is associated with greater innovation (Jung et al., 2008).

Cultural Issues: Multiculturalism and Technology

In the end, both sociocultural and cross-cultural approaches make distinct contributions to our understanding of creativity as a contextual, situated phenomenon. Sociocultural research considers culture as an integral part of creativity (and, inversely, creativity as the "engine" of cultural growth and development) and pays particular attention to how the meaning of creativity and its practice are co-constructed in local cultural settings. Cross-cultural investigations consider the influence of culture on creative production through its impact on value orientations and their clustering at national and supranational levels. Both point to the importance of integrating multiple cultural elements within creative acts and, as such, they are interested by how multicultural experiences might shape creativity. It is not only language, for instance, that differs across cultural contexts but also the tools available for creators to do their work. The rise of new technologies, an essential part of today's global culture, is of particular concern for creativity researchers from both approaches.

Multicultural Experiences

A line of research has been developing in recent decades concerning the influence of exposure to several cultures. This work concerns effects of short-term stays in a foreign culture as well as long-term exposure in a multicultural society, living near to contrasting cultural centers, or living in a bilingual or multilingual context. Multicultural experiences may involve time spent living abroad, interactions with people from diverse nationalities, ethnic groups, exposure to foreign languages, immigration experiences, and exposure to other cultures via educational experiences. In general, the basic hypothesis is that exposure to multiple cultures and/or multiple languages is beneficial for creativity. This exposure enhances knowledge and provides contrasts with typical modes of thought and action that help people overcome their cultural habits. Multicultural experiences may foster openness to new ideas. Leung and colleagues (2008) suggested that multicultural experience can provide exposure and knowledge concerning diverse ideas, allow multiple interpretations of the same object, "destabilize" routine knowledge structures, promote a tendency to seek information from unfamiliar sources, and foster syntheses of diverse ideas.

The earliest studies focused on potential advantages of bilingualism for creativity, generally using divergent thinking tests. Convergent thinking tests have also shown a bilingual advantage in tasks requiring inhibition of competing information and strong top-down control (Hommel et al., 2011). The hypothesis that language influences thought and that exposure to more than one linguistic system will open up possibilities to view the world alternatively has been proposed. Findings tend to show higher divergent thinking performance for bilinguals compared with monolinguals (see Ricciardelli, 1992; Simonton, 2008). In a recent example of this kind of research using a divergent thinking test and a structured imagination test, Kharkhurin (2009) compared Farsi–English bilinguals living in the United Arab Emirates and Farsi monolinguals living in Iran. Bilingualism was related to higher originality scores for the divergent thinking test and the tendency to break away from standard category properties in the structured-imagination task. Kharkhurin (2008), in another study, compared Russian–English bilingual immigrants and English monolingual native speakers using a series of divergent thinking tasks and found that bilinguals showed enhanced performance compared with monolinguals, with effects of age of bilingual acquisition and exposure time to the new culture. Of course, these studies illustrate a few of the potential complications with studies of bilingual populations: bilinguals may live in a completely different cultural context than monolinguals; they may be part of a subculture within a larger cultural context; and they may be immigrants who integrated a new cultural context. Furthermore, they may be part of a minority group. Studies that have used a bicultural population have shown that the degree to which an individual identifies to both cultures has an effect on creativity. Biculturals who identified as biculturally blended (biculturals that identify with two cultures in equal measure) experienced greater creative originality in a divergent thinking task compared with those that identified more with one culture over the other (Saad et al., 2013). These parameters yield a number of potential confounds (such as minority status), leading the "pure" effect of bilingualism to be hard to isolate. Additionally, there are different perspectives concerning the degrees and types of bilingualism, such as additive or subtractive bilingualism, and high- and low-proficiency bilingualism (Hommel et al., 2011; Lambert, 1981).

Using bilingual participants can be tricky; the language of testing affects participants' fluency and originality scores on divergent thinking tasks (Kharkhurin & Altarriba, 2016) and, when comparing similar bilingual populations, it is important to keep the sociocultural contexts of the different study populations in mind (Kharkhurin, 2010). Once confounds associated with bilingualism are taken into account, to the extent that they can be controlled, bilingualism is hypothesized to facilitate creativity due to the specific "double coding" of concepts in memory, with each language providing nuances on the same concept. The alternative lexical coding schemes can facilitate associations and conceptual blends. Another facilitative effect of bilingualism is enhanced mental flexibility, which perhaps develops as bilinguals need to move from one language to another in their daily life (for a review of this literature, see Simonton, 2008). Supporting this idea, Soveri, Rodriguez-Fornells, and Laine (2011) found that, among early bilinguals, higher rates of everyday language switches were positively associated with performance in a set-shifting task, which is considered as an important contributor to creative cognition (Dijksterhuis & Meurs, 2006). Karkhurin and Wei (2015) showed that the extent to which bilinguals switch languages in daily life is positively related to the number and originality of ideas found in verbal and graphical divergent thinking tasks. The effect of habitual language switching on creativity switching is magnified when bilinguals are required to switch languages during a divergent thinking task (Storme et al., 2017).

In addition to effects of exposure to multiple languages, research on societies' geopolitical situation, generally using historiometric data on creative output of societies over centuries, has shown that societies located near contrasting cultural centers or at the crossroads of cultural exchange tend to show higher creative output (Simonton, 1984). Data also show that societies characterized by political fragmentation (such as multiple political entities comprising the society, multiple political parties) tend to have higher rates of creative activity (Simonton, 1984, 1999). Therivel (1995) contrasted societies with unified power (one party, "insular" societies) with those having a division of power. A historical ethno-psychological approach suggests that exposure to multiple sources of power is beneficial, allowing an expanded worldview and less conformity pressure.

Some recent studies have focused directly on multicultural exposure. Leung and colleagues (2008) reported on a series of studies that indicate that exposure to multiple cultures can be beneficial for creativity. For example, in one experimental study, people who saw, simultaneously, stimuli from two cultures (American and Chinese) wrote more creative stories than those exposed to stimuli from only one culture. These same participants, tested one week later, showed a continuing effect of the multicultural experience on a different, creative-analogy generation task. In other studies, positive links were found between creative idea generation, using tasks such as generating unconventional gift ideas, and a questionnaire of multicultural life experiences. Godart and colleagues (2015) have shown that executives' foreign work experiences were predictive of the level of innovation of firms. They found that it is especially the depth of the experience – that is the amount of time that an individual spent in foreign countries – that is the most predictive of firms' creativity.

In a series of studies, Maddux, Adam, and Galinsky (2010), explored further the effects of multicultural experiences on creativity, focusing on the benefits of multicultural experiences and functional cultural learning given the accessibility of these concepts in the mind to facilitate their activation. Participants who recalled multicultural experiences before completing a creativity task were more creative than those who recalled within culture experiences. In a different study, participants who reflected on the reasons behind the existence of cultural differences, known as functional cultural learning, were also more creative (compared with a group that considered reasons explaining within-cultural differences). Two perspectives on why multicultural experiences and creativity are related can be distinguished. The first one – the spreading activation perspective (Mednick, 1962) – assumes that multicultural experiences lead to an expansion of connections in semantic networks that leads in turn to unconventional associations and greater originality in divergent thinking. The second perspective emphasizes the effect of multicultural experiences on cognitive functioning and conflict resolution skills (e.g., Leung & Chiu, 2010). According to this perspective, being exposed to multiple cultures fosters the ability to combine and integrate competing perspectives on the same object – an ability referred to as "integrative complexity" (Suedfeld, Tetlock, & Streufert, 1992), which is positively associated with creativity (e.g., Tadmor, Tetlock, & Peng, 2009). Empirical research supports this reasoning. For example, in a more recent study, Çelik, Storme, and Forthmann (2016) found a positive relationship between the amount of value conflict – that is the extent to which a social environment is characterized by disputes and debates between individuals about core values – in an individual's environment and his/her level of divergent thinking in highly diverse environments. This finding suggests that multicultural experiences benefit creativity when individuals engage actively in cultural confrontation.

Most research on multicultural experience concerns adult populations. In children, there is little research to date on identity, migration, and acculturation processes relating to creativity. In a recent study, instead of the general positive correlation of multicultural experience and creativity, a contrasting result was found. Children's scientific creativity was impacted negatively if their parents or they themselves were born in another country than the one where they were going to school (de Vries & Lubart, 2017). Specifically, the originality and convergence of concepts of scientific creativity were significantly negatively related to the number of family members who were born in a foreign country. A study concerning young adolescents in Taiwan from mono- and bicultural families, on the other hand, found that children from bicultural families (children's mothers born in Taiwan) scored higher on divergent thinking in fluency, originality, and flexibility on a Chinese version of the Torrance test (Wu et al., 1999). According to the authors, there were, however, multiple factors involved, such as socioeconomic differences between the groups and interactive effects involving culture and personality (extraversion trait), illustrating the need for greater understanding of the way that multiculturalism impacts creativity during childhood.

Technological Culture and Its Impact on Creativity

It is clear that over the past few decades, advances in technology and science have greatly altered the world in which we live. Only thirty years ago, floppy disks, boom boxes, and visits to physical libraries and corporate meetings were all common practice. Today, having access to minuscule and large capacity micro SD cards, vast amounts of real-time information, virtual teams and meetings, and online libraries increase the realm of possibilities and, in a way, this has become a new culture in itself. Yet the effects of technology on creativity have only just begun to be studied in fields including education and business. Enterprise mobile applications such as cellphones, tablets and laptops, apps, and other role-based applications have been found to increase perceived job performance, which in turn increases perceived job creativity among employees, managers, and senior executives (Chung, Lee, & Choi, 2015). The way online teams collaborate and, more specifically, the different characteristics of their communication (frequency, decentralization, reactivity) influence the teams' creativity – notably, their idea generation and product outcomes (Gaggioli et al., 2015; Karakaya & Demirkan, 2015).

Recent work has reflected on the current and future impact that technology has on creativity (Burkhardt & Lubart, 2010; Sporton, 2015; Zagalo & Branco, 2015). For example, word-processing programs compared with handwritten composition of literary texts may dramatically influence the literary creative process; repeated exposure to games may influence thinking by training certain skills (such as visual tracking ability and speed) and providing a value system within the game that is a cultural model for longer-term motivations (see Green & Kaufman, 2015). Lubart (2005) outlined several ways in which computers may impact creators' work, ranging from providing support (e.g., a helper that reminds people to take a break, check work for banality) to computers as full-fledged partners in the creative process, generating new content that a person may integrate or rework.

The point here is the cultural impact of technological tools on the traditional human creative process. In this regard, virtual reality environments offer a new cultural space in which people act and eventually "create." Multiple-user virtual environments (MUVE), such as Second Life,[1] provide rich virtual environments in which people

[1] See www.secondlife.com

represented by their avatars interact. In some recent work, the impact of these MUVE on creative performance has been studied, showing effects of the "physical" characteristics of these workspaces and the characteristics of the avatars, which may allow individuals to "escape" their traditional culturally determined roles and patterns of behavior (Guegan, Nelson, & Lubart, 2017; Ward & Sonneborn, 2009).

Conclusion

Culture is omnipresent and for this very reason its impact is often underestimated. Culture provides the bedrock, the deep psychological structure, in which all human activity occurs. For complex activities with social facets, such as creativity, the importance of understanding the influence of culture is particularly important. Culture influences both the production of "creative" work and its' reception, recognition, and diffusion. Culture influences the who, what, and why of creativity; it influences the way that creativity is expressed and the degree to which it is expressed. In this chapter, findings from two different approaches (sociocultural and cross-cultural) and several cultural contexts were cited as illustrations of the different ways in which culture shapes creativity. First, it was argued that culture influences the definition and conceptual boundaries of creativity, although there is some evidence for similarities across cultures on key components of creativity. Second, research on basic cultural dimensions on which societies vary was overviewed and the implications for creativity were explored. Third, the impact of exposure to several cultures, of multiculturalism, and of the use of technology, an emblematic cultural tool, was discussed, with research suggesting a positive impact on creativity, given the right circumstances.

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21 Eastern–Western Views of Creativity

Weihua Niu

Creativity is an original impetus for human civilization, without which we might still live in a primitive society. The concept of creativity exists in some early documents and has multiple philosophical roots (Niu & Sternberg, 2006). A systems-view of creativity, that is, when creativity is understood as an interaction among creative individuals, creative products, and the environment, has gained much popularity in the creativity literature. Based on this systems-view, a generally acceptable definition of creativity is a person's ability to create something that is judged by a group of experts in a specific domain as both *new* and *appropriate* (Lubart & Sternberg, 1998). This definition suggests that creativity is not a general cognitive ability that applies to individuals in different societies, as people used to believe (Guilford, 1950); rather, it is bonded by time, domain, and culture (Albert & Runco, 1999; Baer & Kaufman, 2005; Niu & Kaufman, 2013; Niu & Sternberg, 2002; Rudowicz & Yue, 2000; Lubart, 1999).

After examining the literature on concepts of creativity across different cultures, especially those from the West (such as European and North American countries) and the East (such as Asian cultures), Niu and Sternberg (2002) concluded that people from the East hold similar yet somewhat different conceptions of creativity to Western people. Some core characteristics of creativity are shared by people from both the West and the East, which include being original, imaginative, intelligent, and independent. The difference lies in the different worldviews held by the two cultures, namely individualism vs. collectivism. Whereas the Western conception places greater emphasis on personal characteristics of a creator at the present time, the Eastern understanding places a greater emphasis on the social contribution of a creative individual and more value on the linkage between current and past in the development of creative products.

A decade later, Niu and Kaufman (2013) performed a closer scrutiny of people's conceptions of creativity in two of the most studied populations – American and Chinese. They highlighted five notable differences between the two conceptions of creativity: (1) although both novelty and appropriateness are critical in judging a *creative product* in both cultures, Chinese culture places greater emphasis on appropriateness whereas American culture places greater emphasis on novelty; (2) Chinese culture also places more emphasis on the role of environmental influence on creativity whereas American culture places more emphasis on characteristics of a *creative person*; (3) in viewing the *creative process*, the Chinese hold a more malleable view of creativity than do the Americans, and are more likely to take a proactive approach to influence individuals' creativity through direct education; (4) when *promoting creativity*, the Chinese are more likely to use a top-down approach (e.g., from the level of implementing governmental and social policies to promote creativity), whereas the Americans are more likely to employ a bottom-up approach (e.g., by creating an environment to protect or promote individuals' intrinsic motivation). Lastly, (5), although there is a well-established literature linking intrinsic motivation and creativity (most done in the United States), the Chinese's top-down approach to creative education suggests that extrinsic motivation is perceived as valuable in promoting creativity in Chinese societies (Niu & Liu, 2009; Niu, Zhou, & Zhou, 2017).

Going beyond just American and Chinese cultures, this chapter further examines the cultural relevance of creativity, comparing and contrasting those from the West (primarily European and North American cultures) and the East (mostly Asian cultures). It focuses on two bodies of literature, including both explicit theories and implicit theories, to provide an updated picture of the Western vs. Eastern views of creativity.

Explicit Theories of Creativity

Explicit theories refer to theories explicitly proposed by psychologists to examine the concept of creativity. Most explicit theories of creativity come from English-speaking countries such as the United States, based on studies of people from the West (Glăveanu & Karwowski, 2013). The word for *creativity* comes from the Genesis story: God created the world from nothing (creato ex nihilo). Is the meaning the same across cultures? Here I focus on the examination of explicit theories coming from two Eastern cultures – Chinese and Indian – to illustrate how each of these two Eastern cultures defines and understands creativity in a way that is different from that found in the West.

Chinese Culture

Chinese culture represents one important ancient civilization. The influence of its cultural heritage goes beyond China, to neighboring countries such as Japan, Korea, and many Southeast Asian countries. It is important to note that the modern term for *creativity* in Chinese, *chuangzaoli* or *chuangzaoxing*, comes from a modern Japanese word "kozosei," which was translated from the modern English word "creativity" and has existed in the Chinese language only for a century. It is therefore not a surprise that the dictionary definition for creativity is identical in both Chinese and English. However, on carefully examining the historical and classical Chinese philosophical documents, Niu and Sternberg (2006) concluded that the concept of creativity has existed in Chinese for at least 2,300 years. It appeared in the *Book of Changes* (or *Yijing* 易经), using different terminologies, such as *dao* (the way 道), *tian* (the heaven 天), *tai-yi* (the Great One 太一), *taiji* (the Great Ultimate 太极), and *yin-yang* (阴阳) (Berthrong, 1998; Niu & Sternberg, 2006).

Through examining both Confucian and Taoist philosophical documents and research literature on contemporary Chinese views of creativity, Niu (2015) proposed the usage of a new concept, called "contextual creativity or co-creativity" (or creatio in situ). Co-creativity was proposed in contrast to the Western conception of creativity that is rooted in the biblical idea of God's creation (or called creatio ex nihilo). Four unique characteristics of Chinese co-creativity were illustrated in comparison to the Western concept of creativity: (1) although both creatio in situ and creatio ex nihilo share the same meaning for "creation of the world," Chinese co-creativity recognizes the significant role human beings play in the creation of the world and human civilization, and emphasizes that every human being has the potential to be creative; (2) whereas the Western notion of creativity lies in the power of the creator, Chinese co-creativity attributes creative process as a result of the interaction between the creator and the environment – therefore creativity is always contextual and interactive in the Chinese context; (3) although novelty is important for the Chinese conception of creativity, appropriateness, defined as fitting to the changing context, is viewed as more important in the Chinese conception of creativity; (4) creativity is also viewed as domain-specific. Again, everyone has the potential to be creative in the domain of their own choice, which can range from an everyday field such as culinary arts to more prestigious and scholarly disciplines such as literature.

When viewing how creativity is nurtured, two major schools of thoughts, Taoism and Confucianism, offer two different approaches. According to the Chinese Taoist tradition, the creative process is viewed as releasing people's free will from any old knowledge, to allow the inner self to connect to the original stage of the universe. Such a process can be achieved through meditation, which is similar to the stage of mindfulness. In contrast, Confucianism views creative education as purposeful activities. Through self-cultivation and learning from others, people seek to achieve excellence and perfection in any field of their choice, resulting in the kind of achievement that makes a significant contribution. Even though Taoism and Confucianism offer entirely different approaches to nurture creativity, it is apparent that Chinese culture fosters an incremental mindset of creativity, viewing creativity as something people can develop throughout their lives.

Indian Culture

Indian culture represents another important worldview from the East. Rooted in Hindu philosophy, especially the Samkhya school of philosophy, the Indian view of creativity stresses the process of making connections between a person and the primordial realm, or perfect knowledge through the practice of yoga and meditation, which is called the process of self-actualization, self-fulfillment, and self-realization (Raina, 2002, 2004; Raina & Srivastava, 2000). The Indian word for creativity is *pracibha*, or intuitive creative power, meaning a flash of light, a revelation, a supra-rational or a beyond rational appreciation, grasping truth directly, and leading to the realization of new meanings (*navonavonmesasalini pratibha*) and the creation of something that had no prior existence (*apurvastunirmanksama prajna*). The goal of engaging in the creative process is to seek joy, to reach the highest standards in every phase of life, to discover the best of oneself, or to reach extraordinary achievement in any field of human endeavor, driven solely by strong and powerful inner urges without external prodding (Misra, Srivastava, & Misra, 2006; Rina, 1996).

Using constructivist qualitative inquiry, Sen and Sharma (2011) conducted semi-structured interviews with 250 children and 121 adults to investigate how Indian children and adults of different professions (including teachers, eminent creators, and crafts persons) understand the word "creativity" and related Hindi terms for creativity, such as *rachnatamakata*, *srijanatamakata*, *srijan karna*, and *rachna karna*.

They found that contemporary Indians hold multiple perspectives on creativity. The first perspective sees creativity as the intuitive creative power, or *pratibha*. Consistent with the Indian philosophical tradition, here creativity is perceived as an instinct or a quality preexistent in the person, a god's gift derived from Sanskrit, or the imprints left on the subconscious mind by experience from this or previous lives, which then color one's nature, response, and states of mind. Importantly, intuitive creative power is perceived to exist only in particular domains, usually in arts and sports (Mackey, 2015). Beyond the domain of arts and sports, when describing creativity, Indian people tend to focus more on the creative process rather than on creative products or on a creator, and perceive creativity as (1) a product of thinking or cognitive processes (the cognitive self); (2) an emotional and experiential state that accompanies the thinking of new ideas and learning of new skills (the emotional and experiential self); (3) both cognitive and emotional involvement in the creative activities (the holistic self); and, lastly, (4) the physical act of creation (doing something or bringing something into physical existence (the physical self).

There are some unique features of the Indian conception of creativity. Compared with the Western conception, the Indian notion of creativity places a greater emphasis on a person's involvement and investment of the self in the creative process, rather than merely bringing a product into being. Experiencing a sense of agency in the creative process can be cognitive, emotional, experiential, holistic, or physical. Because of the emphasis of a sense of agency, the level of newness and ownership of creative products is less emphasized in Indian culture compared with Western cultures. When approached as a process, the objective assessment of a product's novelty gives way to the subjective meaning context. Creativity is also viewed as a process of self-expression, self-extension, self-fulfillment, and self-actualization in Indian culture. This self-based conception makes the primary goal of creativity to discover and realize one's potential. Lastly, creativity is seen as an active learning process in the Indian context. The physical act of creation overrules originality and ownership of thought.

Taken together, explicit theories from the East provide unique perspectives on the concept of creativity that differ from what Western scholars have proposed. Having multiple philosophical roots, namely Confucianism, Taoism, and Hinduism, creativity is understood in multiple perspectives, which include (1) the creative process as a collaborative interaction between the creative individual and the context within which the individual lives – therefore creativity is viewed as contextual; (2) everyone has the potential to be creative, and the primary goal of engaging in creative activities is to discover and realize one's potential; (3) there is a greater emphasis on engaging in creative activities than on bringing out something new – as a consequence, the novelty of creative products is less important than actively engaging in creative activities or seeking appropriateness within the context; (4) creativity is viewed as excellence and can be achieved via purposeful learning and practicing; and (5) there is a greater emphasis on the linkage between old and new; therefore, creativity in the East is more evolutionary than revolutionary.

Implicit Theories of Creativity

Do any of the explicit theories of creativity reflect contemporary views of creativity from the East? A useful approach to examine the influence of cultural influence on people's conception is through studies on implicit theories of creativity. Implicit theories are the underlying beliefs of individuals (often ordinary people) regarding their everyday understanding to certain phenomena, which allow laypeople's views to be integrated into scientific discourse (Glăveanu & Karwowski, 2013). The studying of implicit theories of creativity began in the 1980s, using the seminal approach proposed by Sternberg and his colleagues when they investigated implicit theories of intelligence (Sternberg et al., 1981). It was soon adopted to study implicit theories of creativity (Runco, 1984; Runco & Bahleda, 1986; Sternberg, 1985) and has been widely used globally in studying the concept of creativity of people from different ages, profession, and cultures (e.g., Chan & Chan, 1999; Lee et al., 2015; Lim & Plucker, 2001; Paletz & Peng, 2008; Panda & Yadava, 2005; Rudowicz & Hui, 1997).

Results from the earliest studies on implicit theories of creativity (primarily using American samples) commonly link creativity to characteristics of an ideally creative person such as being intelligent, open-minded, imaginative, energetic, active, motivated, willing to take a stand, inquisitive, curious, adventurous, ambitious, confident, determined, enthusiastic, free-spirited, nonconformist, individualistic, assertive, daring, and artistic, as well as having good aesthetic taste and having a sense of humor (Runco, 1984; Runco & Bahleda, 1986; Sternberg, 1985). An environment with choices, the acceptance of ideas, the boosting of confidence, and the stimulus of intrinsic motivation are believed to be conducive to the development of creativity (Fleith, 2000; Westby & Dawson, 1995).

Beyond American samples, implicit theories from other Western cultures demonstrate that personal traits most often associated with creativity are also markers of individualism, such as being free-spirited, nonconformity, questioning social norms, love of solitude, ability to express oneself and create one's own style, confidence, decisiveness, and individualism (Drewsen, Kirstine, & Maaloe, 2014; Glück, Ernst, & Unger, 2002; Nemerzitski, 2017; Nowacki, 2013). A study on Finnish teachers' implicit views of creativity revealed that both individual and social factors are important. These include (1) finding new solutions, (2) hard work, (3) using old knowledge in new ways, (4) humor and imagination, and (5) being flexible in social situations (Saarilahti, Cramond, & Sieppi, 2012).

A special issue on creativity research from Eastern and Central Europe (Glăveanu & Karwowski, 2013) that includes scholars from Poland (Szen-Ziemiańska, 2013), Romania (Hojbotă, 2013), and Serbia (Pavlović, Maksić, & Bodroža, 2013) provided a picture of people's perceptions on creativity from Eastern and Central European countries. Findings confirm that Eastern and Central Europeans share the same conception of creativity as that held by Western Europeans and Americans.

Overall, implicit theories of the West emphasize the importance of individual traits in creativity. Cultural differences among various parts of Europe and the Americas are minor and nonessential.

Studies from the East, particularly Asian cultures (such as China, Japan, Korea, and India), have painted a different picture. Results from Chinese people's implicit theories of creativity have demonstrated that although they share some core personal characteristics with Westerners, such as being intelligent, imaginative, and independent, a few characteristics, such as having a sense of humor and having aesthetic taste, are missing in Chinese samples (Chan & Chan, 1999). Chinese participants reported unique characteristics in describing creativity, such as holding some ethical standards such as honesty, being responsible, self-discipline, selflessness, and making a significant contribution to society (Rudowicz, 2003; Rudowicz & Hui, 1997, 1998; Rudowicz & Yue 2000; Yue, 2003, 2004; Yue & Rudowicz, 2002).

Similar to findings from Chinese societies, studies from India revealed a greater emphasis on relational, social, and interpersonal aspects rather than personal, cognitive, analytical, and utilitarian aspects of creativity among a sample of Indian college students (Panda & Yadava 2005). Creativity in Indian culture is also viewed as domain-specific (Misra et al., 2006) and as seeking connection between inner and outer existence. Being able to reinterpret traditional ideas in the domain of music and literature, making original contributions, and being able to synthesize and integrate are perceived as chief characteristics of creativity in the domain of sciences (Sen & Sharma, 2011). Overall, compared with the Western notion of creativity, the Indian conception of creativity emphasizes affective, social, and intuitive elements, and places greater value on intuition, insight, introspection, the ability to look inwards, open-mindedness, and creating a relationship between external surroundings and internal processes (Bhargava & Chakrabarty, 1996; Kapur, Subramanyam & Shah, 1997; Majumdar, 1996; Sen & Sharma, 2011; Tripathi, 1993).

Results from Korea also demonstrated the importance of social aspects in creativity as well as other cultural variations (Choi et al., 2011; Kim & Plucker 2001; Lee et al., 2015). For example, using in-depth interviews, Choi and colleagues (2011) found that Koreans' conceptions of creativity emphasized solid bases of basic knowledge, the ability to connect domains from experience in various fields, challenge, shared values, teamwork, and social contributions. They also found that a permissive, loving parenting style with fewer rules imposed on children, psychological support from teachers, and horizontal relationships in organizations were effective in promoting creativity. Kim and Plucker (2001) reported that although Koreans have a similar conception of creativity to Westerners, they tend to associate creativity with some negative personality traits such as deviance, suggesting that being creative may not be socially desirable in the Korean cultural context.

Direct studies of Japanese implicit theories of creativity are sparse. Muneyoshi and Kagawa (2004) reported a study examining Japanese laypeople's conceptions of creativity and found that creativity is associated with being new, with art, and with intuition. The Japanese also tend to value creativity in traditional arts (Ramos, 2005). Given the fact that the Japanese have created some of the most innovative products in the world (Anderson, Potočnik, & Zhou, 2001), more studies are needed to examine the Japanese conception of creativity.

Interestingly, there are some cross-cultural studies that directly compare implicit theories of people from East and Southeast Asia and the United States. For example, Ramos (2005) studied implicit theories of creativity between Americans and three main groups of ethnic Singaporeans (Chinese, Malays, and Indians). They asked participants to rate the importance of creativity in two types of peoples, innovators (those who break the rules and create their own rules) and adaptors (those who follow the rules), as well as their perception of creative individuals. The results showed that both Americans and Singaporeans listed thinking out of the box and being new, innovative, and unusual as being important to creativity. Creativity was also perceived to be associated with Kirton's (1976) innovators' cognitive style, rather than the adaptors' cognitive style. Cultural variation existed only in the top categories, in which Americans and Malay Singaporeans tend to associate creativity with the arts or with being artistic, whereas Chinese and Indian Singaporeans tend to emphasize being new, innovative, and thinking out of the box in defining creativity. This lack of emphasis on being artistic or having aesthetic taste in Chinese people was consistent with other studies of the Chinese conception of creativity (e.g., Rudowicz & Yue, 2000). Overall, the study concluded that, although a more collectivist-oriented culture, Singaporeans share similar conceptions of creativity to Americans in which seeking innovation and breakthrough are highly valued. They attribute this lack of cultural variation in people's implicit theories of creativity to Singapore's national desire for improving its citizens' creativity and to learn from the West for the continued growth of its economy.

Tang, Baer, and Kaufman (2014) carried out a study comparing American and Chinese students' implicit theories of creativity in computer sciences. They proposed that since creativity is domain-specific, personality traits of creative individuals vary across different domains; therefore, laypeople's implicit theories of creativity should also be studied within each specific domain. Using the same list of adjectives characterizing creative computer scientists that was generated from a pilot study, they found the same four primary factors emerged from both American and Chinese samples to describe creativity in computer sciences: (1) smart/effective, (2) outgoing, (3) thinking originally, and (4) unsociable. Cultural differences are exhibited in the relative importance of each of the four factors in the conception of creativity: whereas American participants rated being smart/effective and outgoing more important than their Chinese counterparts, Chinese participants rated having creative thinking as being more important in evaluating creative computer scientists than their American counterparts. They speculated that this cultural difference could reflect a strong desire to catch up within Chinese laypeople's view of creative thinking. No cultural differences were observed on the factor of “unsociable,” which was inconsistent with findings from another study in which creativity was rated as relatively undesirable for the Chinese (Chan & Chan, 1999). Tang and colleagues concluded that, at least in the domain of computer sciences, people from both cultures hold similar implicit theories of creativity. They believe that cultural influences on implicit theories are more complex than explicit theories have suggested.

Paletz and Peng (2008) studied the relative importance of appropriateness and novelty in conceptions of creativity among Chinese, Japanese, and American participants. They found that novelty is important across all three cultures. However, contrary to a common belief, appropriateness was deemed as more important to the Americans and the Japanese for their evaluations of creativity and more desirable for creative products than for the Chinese.

In another study, Paletz, Peng, and Li (2011) asked American, Chinese, and Japanese college students to generate words and phrases associated with creative acts and behaviors of individuals. The entire list was coded as either external (that is, needing to involve others, such as social interaction, sports, and cooperation), internal (that is, can be done individually, such as thinking and designing), neither external nor internal, or both. The results demonstrated that both Chinese and Japanese students showed preference for the external, whereas Americans showed a preference for the internal, direct evidence that Asians place a greater emphasis on social aspects than their American counterparts.

Conclusions

Lubart and Sternberg (1998) proposed that culture could influence people's conceptions of creativity. Since the beginning of the twenty-first century, a growing body of literature has been developed to verify this claim. From the above literature review, one may conclude that people across cultures define creativity similarly, all viewing creativity as having both newness and appropriateness as core features. Nevertheless, people from the West (e.g., American and European countries) and the East (e.g., Asian countries) have some critical differences in their conceptions of creativity that are deeply influenced by their worldviews, especially along the lines of individualism and collectivism (Trandis, 1975, 1977) or independent-self and interdependent-self perspectives (Markus & Kitayama, 1991). Here are highlights of these differences.

Individual vs. Social

Western notions focus more on individual characteristics of creative individuals, such as having certain personality traits and cognitive styles, whereas Eastern notions focus more on social aspects of creative acts or products, such as teamwork and having support from others (evidence from Korea), interaction between the creator and his or her environment (evidence from China), as well as having significant contributions to the society (evidence from China, Korea, and India). The social aspect of creativity is unique in the conceptions from most Asian countries, such as China, India, Japan, and South Korea. In other words, compared with people from the West, people from the East value the social contribution of creators more than their individual characteristics. This is perhaps the most salient departure between the two conceptions, and it is also consistent with the worldviews, one being individualist in nature and the other collectivist.

General vs. Contextual

Creativity was viewed as a general cognitive ability – divergent thinking – in the West (Guilford, 1950) and only recently has been viewed as domain-specific (Baer, 2008; Baer & Kaufman, 2005; Sternberg & Lubart, 1999). On the contrary, as illustrated in this chapter, rooted in their perspectives and philosophical traditions, creativity has been continuously viewed as contextual and domain-specific in Chinese and Indian cultures. Evidence from studying people's implicit theories also supports the idea that creative artists and scientists are viewed as having different traits and styles from the Eastern perspective and should be dealt with differently.

Novelty vs. Appropriateness

Both cultures view novelty and appropriateness as defining features for creativity, but do people view them equally in judging creativity? The literature has provided an inconclusive answer to this question. Studies from the explicit theories confirm a general stereotype that Westerners place more emphasis on novelty and Easterners place more value on appropriateness – although appropriateness is a relative term and people from different cultures may perceive appropriateness differently. However, such a belief was not supported by an empirical study (Paletz & Peng, 2008) on implicit theories of people from both Eastern and Western countries. More studies are needed to further examine cultural differences in the novelty-appropriateness dimension of creativity conception.

Revolution vs. Evolution

Whereas Westerners often view creativity as a breakthrough between new and past products (a revolution or radical), Easterners often view the importance of linkage between past and new (an evolution or incremental) (Gardner, 1989, 1996).

The Role of Intrinsic vs. Extrinsic Motivation

Western theories have emphasized the importance of intrinsic motivation for creativity. According to Amabile's (1996) componential theory, people's creativity is driven by intrinsic motivation (see also Hennessey, Chapter 18, this volume); any external constraints such as rewards, deadlines, observation, peer critiquing, and even explicit coaching would diminish people's intrinsic motivation and have a negative consequence on people's creativity. However, the theory has yet to be fully examined in Chinese culture, especially in its relationship with the other domain-specific aspects of creativity. In an examination of Chinese mathematical classrooms, Niu and Zhou (2010) have asserted that Chinese teachers' training model and its system of promotion encourage teachers to learn from the collective wisdom of their peers with regard to creative teaching strategies. More specifically, the system of exercising a "model lesson," a type of cognitive apprenticeship in which inexperienced teachers observe well-crafted and executed classes taught by experienced teachers, makes Chinese classroom teaching a performance art, and it is both socially and economically desirable for novice teachers to learn and exercise to become an artist in teaching mathematics. Peer observation, especially open observation by a group of other teachers, peer critique, and competition in classroom teaching are all external incentives; however, they are used widely in Chinese teaching training systems and are deemed as effective ways for achieving creative teaching.

Lab experiments examining motivation and creativity in the Chinese context have also shown mixed results. Generally, intrinsic motivation seems to help student creativity, although extrinsic motivation is not seen as a negative. For example, in one study, Niu and Liu (2009) found that the creativity of Chinese students actually increases when they were explicitly told the goal of the creativity exercise and the means to attain creativity. Chinese participants are also more affected by special instructions that explicitly encourage them to be creative, perhaps because of the need for "permission" to be creative (Niu & Sternberg, 2002).

Cultural variation in intrinsic motivation was also studied extensively in other research. For example, Iyengar and Lepper (1999) found that although personal choice is typically connected to an increased level of intrinsic motivation, greater persistence, better performance, and higher satisfaction, having personal choice seems to enhance motivation more for Americans than for Asians. When the choices were made by trusted authority figures or peers, rather than themselves, Asian American children were more intrinsically motivated than Anglo-American children. Iyengar argued that compared with Anglo-American cultures, Asian American culture values group identity more. Having the choice made by relevant in-group members provides a greater opportunity to promote harmony and to fulfill the goal of belonging to the group.

This may relate to Chinese educational practices, where competition among students is encouraged and practiced on a regular basis. External incentives, pressure, or encouragement from others, especially from an authoritative figure, may serve as effective motivators for Chinese students in tasks that require creative thinking. More studies are needed in this area to further examine this notion.

This difference in viewing the past and the new significantly affects how creativity is nurtured in the two cultural contexts. In the West, there is a greater emphasis on protecting the intrinsic motivation of individuals; therefore, creative education takes a bottom-up approach – that is, it provides individuals freedom and a less constrained environment to allow people to self-explore. In contrast, creativity from the Eastern perspective is something one can gain and enhance through effortful learning from others and mindful exercise; therefore, creative education tends to be top-down, often through national policy (as in the case of China, Korea, Singapore, and Taiwan). This also explains why Asians tend to view providing people with basic knowledge and skills training as critical for creative education (Niu, Zhou, & Zhou, in press).

Overall, cultural differences in people's conception of creativity do exist. As creativity is becoming more and more important in our lives, understanding Western vs. Eastern views of creativity can not only enhance our understanding of the nature of creativity but also provide useful guidance on how to promote creativity in today's increasingly diverse cultural contexts.

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22 Creativity's Role in Society

Dean Keith Simonton

In 1970, I started graduate school in Social Psychology, a program housed not in the Department of Psychology but rather in Harvard University's somewhat distinctive Department of Social Relations. The latter department split off from the former in 1946, and thus was just two years older than I was at the time. Eminent psychologists Gordon Allport and E. G. Boring had in fact published an article on the separation in the very first volume of the *American Psychologist* (Allport & Boring, 1946). Social Relations was then founded as a truly interdisciplinary department that included social and clinical psychology along with sociology and social anthropology, where clinical incorporated personality psychology and social anthropology encompassed cultural anthropology. Unfortunately, by the time I arrived, the bold experiment was falling apart for a diverse set of reasons (Nichols, 1998). Indeed, when I received my 1975 PhD in Social Psychology the program was already part of an integrated Department of Psychology and Social Relations (sans sociology and anthropology). The latter integration, however, only lasted from 1972 to 1986, when "Social Relations" was dropped from the departmental name. Psychology was just psychology, the singular individual its subject matter.

Why do I open a chapter in a creativity handbook with this esoteric piece of academic history? Because the experience made me appreciate very early in my intellectual development that creativity is not just a psychological phenomenon. It is a social and cultural phenomenon besides. Exposed to the thinking of sociologists and anthropologists as well as psychologists, I was obliged to view creativity from both psychological and sociocultural perspectives. The interdisciplinary breadth of these perspectives is clearly evident in the most important journal article to come out of my doctoral dissertation (Simonton, 1975; chap. 3 from Simonton, 1974). My treatment of creativity was heavily influenced by psychologists, sociologists, and cultural anthropologists (as well as a few economists, historians, and philosophers thrown in for good measure). It was a doctoral dissertation that could only have germinated in the old Department of Social Relations in which I began my graduate training.

That broad interdisciplinary perspective on creativity stayed with me for more than four decades. More immediately, that viewpoint informs this chapter. Here I want to focus on creativity not at the individual level (cf. Simonton, Chapter 31, this volume) but rather on creativity manifested in larger cultural and social units. In particular, this chapter will concentrate on creative cultures, cities, nations, and civilizations. In each case, creativity plays a major role in defining the culture, city, nation, or civilization. At the same time, the specific culture, city, nation, or civilization largely determines the nature of creativity exhibited in the society.

Cultures

Creativity is a universal human characteristic. And yet, almost all creativity researchers study participants who are just plain WEIRD (aka children and adults from *Western*, *educated*, *industrialized*, *rich*, and *democratic* societies; Henrich, Heine, & Norenzayan, 2010). Even when research is carried out with participants who do not fall exactly into this group, almost always those persons come from very Westernized countries, such as the economic powers in East Asia. Given that Western civilization is becoming ever more globalized, the number of distinct cultures is rapidly declining, producing a pervasive cultural homogenization. One sad manifestation of this increased homogeneity is the rapid extinction of the world's languages and the corresponding rise of English as the dominant second-language.

One solution to this problem is to conduct cross-cultural research on traditional cultures all over the globe, using the extensive ethnographic record stored in Yale's Human Relations Area Files.[1] Such databases provide unique information insofar as almost all cultures are now extinct or have so seriously assimilated modern civilization that they no longer represent independent cases. In any event, this massive archival record contains data about a diversity of cultural traits, many of which concern various forms of creativity. These data can be either used alone or combined with newly collected data based on additional sources. For example, the cultural context can be correlated with folk song style to show, among other findings, that norms regarding sexual behavior correlate with the manner of singing (Lomax, 1968). However, I would like to focus on how cross-cultural research sheds light on the social evolution of creativity. The very nature of creativity exhibits considerable cross-cultural variation.

Societal Complexity and Creativity

This research begins with the evolutionary conjecture that cultures can be ordered according to complexity by employing objective criteria. The cultural anthropologists conducting these inquiries are not engaged in ethnocentric rankings of "savage" versus "civilized" cultures that always seem to place European cultures at the top. Instead, they are taking a large inventory of important cultural traits and subjecting them to rigorous statistical analyses (Marcus, 2008; Peregrine, Ember, & Ember, 2004). For our purposes, the best example is probably the seminal work of Carneiro (1970). Adopting the working hypothesis that "simplicity precedes complexity," this researcher conjectured that increased complexity would take the form of an accumulation of specific economic, social, political, religious, legal, military,

[1] For Yale's Human Relations Area Files, see http://hraf.yale.edu/

technological, and artistic traits. Rather than showing up randomly, such traits will appear in a certain order, some earlier and others later in the evolution of culture, according to a definite logic. For instance, special religious practitioners, such as a shaman, must appear before temples will emerge, and temples in turn must appear before a temple can exact tithes. Carneiro therefore applied statistical tests to determine whether the traits can be arranged in an ordinal scale. Specifically, he conducted this scale analysis on 100 world cultures assessed on 354 different traits. The traits concerned the categories of subsistence, economics, social organization and stratification, political organization, law and judicial process, settlements, architecture, warfare, religion, tools, utensils, ceramics and art, textiles, metalworking, watercraft and navigation, and various other knowledge and practices. The statistical results revealed that approximately 90 percent of these traits defined a reliable evolutionary scale.

Carneiro's (1970) scale thus delineates the cultural conditions that are most likely to support creative activity. That result follows from the fact that the scaled cultural traits often have an obvious relation with creativity, such as craft specialization, craft production for exchange, full-time craft specialists, monumental stone architecture, full-time painters or sculptors, and full-time architects or engineers. Not only do these traits regard instances of cultural creativity but they also form an evolutionary sequence, a sequence representing the emergence of professional artists from artisans. Moreover, these creativity traits display an ordinal link with other cultural traits. A society must reach a certain level of economic and political complexity before full-time painters, sculptors, architects, or engineers can appear. Hence, the scaling of these traits informs us about the level of societal complexity that is required before creative activity can maximize in specific domains. Certainly, creative genius can only appear when a culture attains the highest degree of complexity observed in Carneiro's scalings. Examples include New Kingdom Egypt, the Roman Empire, the Assyrian Empire, the Aztecs, China under the Han Dynasty, the Incas, the Vikings, and the Ashanti.

It is significant that the evolutionary development of a culture also has an impact on the qualitative features of the creative activity. For example, creativity in music, dance, and the visual arts becomes increasingly more complex as the society develops (e.g., Dressler & Robbins, 1975; Lomax & Arensberg, 1971). Only a portion of this increased complexity can be attributed to internal forces within a particular art form, such as a drive toward increased originality (cf. Martindale, 1990). Complex cultures tend toward complex creativity. Perhaps that's why whenever a trend toward creative simplicity occurs in a complex society – such as the Minimalist movement that peaked in the 1960s – its duration is relatively short and its influence limited. A monochrome painting like Yves Klein's 1962 *IKB 191* has nowhere to go. What do you do? Just paint one after another until the entire painter's color palette is exhausted?

Societal Complexity and Primary Process

The empirical findings reported in the previous section must be interpreted with care. Increases in cultural complexity should not be taken as certain proof of evolutionary progress. Complex cultures are not "better" than simple cultures, just "different." Creativity is just channeled into different forms of expression. Because everyone reading this chapter has been fully socialized into modern Western culture, there is a natural tendency to let ethnocentrism interfere with the appreciation that cultures can still display considerable creativity even if they have produced not a single creative genius. This necessary understanding is illustrated by an important cross-cultural study carried out by Colin Martindale (1976).

Also a late product of Harvard's Department of Social Relations, Martindale's own doctoral dissertation introduced a computer content-analytical technique for scoring textual materials for primary-process imagery (Martindale, 1975; later called primordial cognition: Martindale, 1990, 1994). In particular, the coding scheme identifies words strongly associated with basic drives, general and specific sensations, defensive symbolization, regressive cognition, and Icarian imagery. Although this method was initially applied to literary material, especially French and English poetry, Martindale (1976) also exploited the technique to gauge the primary-process imagery in the folktales of forty-five preliterate cultures. These same cultures were also assessed regarding their level of societal complexity. Much as Carneiro (1970) had done, complexity was gauged according to such cultural traits as the number of craft specialties, technology, subsistence level, social stratification, economic institutionalization, political complexity, religious level, and demographic level. Significantly, the quantity of primary process in the folktales was *negatively* associated with the magnitude of societal complexity.

The original goal of Martindale's (1976) cross-cultural study was to test theories of the so-called primitive mentality as advanced by Ernst Cassirer (1925/1955) and Lucien Lévy-Bruhl (1978). Primary process was accordingly adopted as a measure of "dedifferentiated" or "prelogical" thought. Even so, a far less ethnocentric interpretation is also possible. Both theoretical and empirical research suggests a positive connection between creativity and primary-process thinking (Martindale, 2007; Martindale & Dailey, 1996; Ochse, 1989; Simonton, 1989; Suler, 1980). This connection then casts a different light on Carneiro's (1970) conclusion that as a society evolves toward enhanced complexity, creative activities become more the exclusive province of a minority of full-time creators. Hence, with respect to creativity, social evolution has both positives and negatives. While an elite emerges with the status of creative genius, the average individual becomes uncreative. This shift echoes what anthropologists often point out: Our conceptions of creative genius are not cross-cultural universals. In societies lower in complexity, virtually the entire community engages in creativity (Brenneis, 1990; Dissanayake, 1992). Almost everybody tell stores, paints and carves, sings and dances. Creativity is communal. Therefore, if creativity is calculated on a per capita basis, then social evolution entails a *decline* in creativity!

Cities

One of the major cultural traits associated with societal complexity is the degree of urbanization (Murdock & Provost, 1973). Temporary settlements turn into permanent settlements, which in turn grow in size to become villages and then cities. According to Carneiro's (1970) scaling, (1) craft specializations do not appear until communities attain a size of 100 or more occupants, (2) political or religious leaders will not hire artisans to glorify their rule until towns emerge with 2,000 or more occupants, and (3) full-time sculptors, painters, architects, and engineers do not become conspicuous until cities contain 10,000 or more citizens.

Cities can then become the locus of creative achievements that would not be possible in a town or village. This connection is illustrated in Weiner's (2016) book *The Geography of Genius* in which he narrates the creative explosions seen in Athens, Hangzhou, Florence, Edinburgh, Calcutta, Vienna, and the Silicon Valley. In the case of Athens, its Golden Age did not burst out until it had a population of about 90,000 freeborn persons (Galton, 1869). In philosophy alone the florescence included Socrates, Plato, and Aristotle in quick succession.

The reasons for the creative ascendency of certain cities are far too numerous to discuss in detail here. Whole chapters and books have been written about the subject (Andersson, Andersson, & Mellander, 2011; Florida, Chapter 29, this volume). So may it suffice to make some brief comments (cf. Simonton, 2011).

To the extent that the abilities and dispositions associated with creativity are normally distributed in the population, then as a city grows in size it will possess an ever-larger number of denizens who represent the extreme upper tail of the distribution. For example, a village of only 1,000 people can have only ten persons in the top 1 percent in intelligence. But a city with 100,000 will have 1,000 such individuals, plus a sizable number at even more elitist percentiles. What makes this distributional effect especially critical is that creativity most often requires the convergence of several individual-difference variables, many of which are only weakly correlated if at all (e.g., Feist, 1998). As a consequence, an even larger city would be necessary to obtain creators at the upper tail on several participatory factors. For instance, suppose that creative achievement also demands appreciable persistence and determination (Cox, 1926; Galton, 1869). To simplify the math, let us assume that this motivational factor is orthogonal to intelligence; then if an individual must be in the top 1 percent on both, a city having 100,000 will only have ten eligible souls – only a very tiny proportion of the overall population.

Of course, these creators do not have to be native-born but instead may have arrived from elsewhere once a city becomes known for activity in a particular creative domain. Well-known examples include the numerous twentieth-century artists and writers who gravitated to Paris and later New York City (Hellmanzik, 2014). I grew up in a Californian city – Los Angeles – which appropriated to itself the title "Creative Capital of the World." In fact, a very large proportion of Angelinos are employed in the "creative industries," especially entertainment, but many of the creators and talents who fill those ranks were born elsewhere, immigrating to LA to become "rich and famous." Even if most don't make it, the talent scouts and agents have the luxury of selecting the best of the best.

Importantly, the tremendous influx doesn't just increase the per capita representation of first-rate creators. The concentration of such creative personalities facilitates the formation of social networks and other dynamic interactions that are also highly supportive of outstanding creativity (Hellmanzik, 2014; Simonton, 1984a, 1992b). For instance, creative artists can meet at sidewalk cafés, attend showings of their respective work, and form academies and conservatories for the training of the next generation of artists. Although the advent of the internet has enhanced the capacity to engage in such stimulating exchanges at a distance, it may still take some time before cities cease to have this facilitative role.

Nations

In some periods of history, cities, or rather city-states, form the primary societal unit. In the Golden Age of Greece there was no Greek nation, just as the Italian Renaissance took place hundreds of years before a nation called Italy appeared. With the rise of nationalism, however, the city was gradually replaced by the nation as the unit of societal creativity. In other words, instead of talking about the comparative creativity of single cities we should discuss the relative creativity of whole nations, each most often consisting of multiple cities.[2] The very first scientist to investigate cross-national differences in creativity was Alphonse de Candolle (1873). Curiously, Candolle had specifically conducted his investigation to counter Francis Galton's (1869) *Hereditary Genius*, which argued that national contrasts in creative output were attributable to racial differences. By comparison, Candolle hypothesized that cross-national variation could be ascribed to various political, economic, educational, ideological, and geographic differences.

To conduct this inquiry, he wisely adopted a much less ambitious strategy than Galton did. First, Candolle confined attention to European civilization since the Renaissance. In addition, Candolle chose to concentrate on a single form of creativity, namely exceptional scientific achievement. A key advantage of this choice was that it helps avoid potential ethnocentrism. The contributions of scientists are evaluated by far more objective standards than are the contributions of artists (Simonton, 2009). Data and logic actually matter. Nor was this his sole methodological precaution. Because societal creativity tends to increase with population size, as noted for both cultures and cities, he decided to introduce a critical methodological control. Rather than look at a nation's total output of notable scientists, he focused on per capita output (cf. Lehman, 1947; Murray, 2014). But another methodological device was especially striking. To remove any residual nationalistic biases that might confound his calculation of cross-national contributions to science, he only counted scientists as eminent if they had received a decided international reputation, a status that could only be attained by receiving honors in a nation outside their own. Accordingly, a French scientist who had earned election to the Académie des sciences in France but not to any foreign academy would not be considered eminent! When this precaution is combined with the control for population size, Candolle found that his own nation, France, did not perform as well as Switzerland, a much

[2] See, e.g., the Global Creativity Index at http://martinprosperity.org/media/Global-Creativity-Index-2015.pdf

smaller country. Indeed, the per capita output of eminent Swiss scientists is about five times greater than that of eminent French scientists. Interestingly, although French-born (albeit to a Swiss father), Candolle acquired an international reputation, receiving honors in both Sweden and Great Britain; he ended his career as professor at the University of Geneva in Switzerland.

By combining these corrected cross-national assessments with other characteristics of various European nations, Candolle (1873) was able to discern the conditions that support outstanding scientific creativity. For example, nations with higher activity were more prone to possess a large group of individuals who did not have to preoccupy themselves with manual labor. That is, such nations enjoy a large percentage of persons with both the leisure and the desire to engage in cultural and intellectual pursuits. This engagement was reinforced by a cultural value placed on real-world knowledge rather than spiritual concerns. In particular, the general lay public should have a favorable attitude toward science rather than being anti-scientific. One crucial manifestation of this cultural value should be the abundance of institutions conducive to scientific activity, such as observatories, laboratories, libraries, and collections. There should also be many families who have a long tradition of supporting the involvement of members in intellectual activities. This condition is descriptive not only of Candolle's own situation but also that of Galton. Indeed, the family lineages that the latter assiduously collected in 1869 can just as well be taken as evidence for the importance of nurture rather than nature (cf. Galton, 1874).

Candolle (1873) identified other national characteristics associated with scientific achievement, such as freedom from persecution for the expression of new ideas, openness to the immigration of foreign intellects, an exceptional educational system that provides support for both students and teachers, proximity to other scientifically active nations, and a climate that is generally moderate rather than extremely cold or hot. Especially fascinating was Candolle's observation that certain languages were most conducive to scientific creativity, namely English, French, and German. These three had become the international languages of science to such a degree that scientific contributions published in other important languages, such as Italian or Russian, would often not become fully disseminated until translated into one of these three languages. Based on demographic trends, Candolle went one step farther to argue that one specific language would become the dominant language of science, namely English. I think it ironic that Candolle's important work is often overlooked because it has never been translated from French into English!

Needless to say, research on national differences in scientific creativity have advanced considerably since Candolle's (1873) pioneering effort (Szabo, 1985). For example, although he examined how cross-national variation changed across historical time, his data did not cover a sufficient period of time to identify how the centers of scientific creativity have switched from one nation to another. A century later, Yuasa (1974) showed that science was dominated by various nations in the following order: Italy, 1540–1610; Great Britain, 1660–1730; France, 1770–1830; Germany, 1810–1920; and the United States, 1920 on (cf. Kroeber, 1944, p. 170).

Even so, Candolle's inquiry still provides a classic illustration of how and why creativity can vary across national systems.

Civilizations

Candolle (1873) may have been among the first to challenge Galton's (1869) genetic determinism but he certainly was not the last. Of special importance was the attack launched by Alfred Kroeber, the eminent cultural anthropologist. Kroeber earned his PhD under Franz Boas, a German anthropologist whose criticism of racist ideas earned him such notoriety that the Nazi's decided to burn his books and even rescind his PhD. Like his mentor, but unlike Galton, Kroeber maintained that any differences separating human groups were merely the reflection of cultural contrasts. Accordingly, race must be replaced by ethnicity as an explanation. Culture's causal primacy also operated in the specific sphere of creative genius. To make his case, Kroeber offered two main arguments. The first concerned independent discovery and invention, the second configurations of culture growth.

Independent Discovery and Invention

When I was a first-year graduate student, I had an uncomfortable interaction with a sociologist at some departmental get-together. After first asking which graduate program I had just entered, he then asked what I was interested in studying. I responded "creativity." He immediately advised me that I had picked the wrong discipline. Creativity was not the proper topic for a psychologist, not even for a social psychologist. Instead, the subject more properly belongs to sociology and cultural anthropology, the very disciplines that were leaving the interdisciplinary department. When I inquired why, he said that the sociocultural nature of creativity was emphatically proven by the well-documented phenomenon where two or more scientists or inventors independently come up with exactly the same discovery or invention. At the time, I was only vaguely familiar with this phenomenon and even less familiar with the research that sociologists and social anthropologists had done on the topic. That would soon change.

In fact, Kroeber (1917) was among the first social scientists to draw major inferences about creative genius from the phenomenon of independent discovery and invention, or what the sociologist Robert Merton (1961) later called *multiples* (see also Lamb & Easton, 1984). Kroeber offered numerous classic instances, such as the creation of calculus by Newton and Leibnitz, the conception of the theory of evolution by natural selection by Darwin and Wallace, and the invention of the telephone by Bell and Gray. Kroeber was particularly taken by the fact that many multiples are not just independent but also simultaneous, or nearly so. Thus, Bell and Gray both sought patent protection for their respective telephones on the *same day*. Seemingly, such events could have only one explanation: The creative products of so-called genius are actually the deterministic outcomes of the larger sociocultural milieu. At a particular moment in the history of any civilization certain discoveries or inventions become absolutely inevitable (see also Ogburn & Thomas, 1922). Hence, if Newton had not invented the calculus, Leibniz would have, and if either Newton or Leibniz had died in the crib, then somebody else, perhaps someone completely unknown to us today, might have gotten credit for the invention. The civilization is the creative agent, not the individual creator, who is a mere pawn.

Naturally, this sociocultural reductionism did not sit well with someone who thought that creativity was at least partially psychological. I was not going to switch graduate programs from psychology to either sociology or cultural anthropology. Consequently, this conversation inspired me to begin a systematic empirical and theoretical inquiry into the etiology of the multiples phenomenon, an inquiry that lasted more than forty years (e.g., Simonton, 1979, 1987, 2010). It should come as no surprise that I discovered that sociologists and cultural anthropologists had severely overstated the case for their deterministic sociocultural reductionism. In the first place, probabilistic models do a much better job predicting the nitty-gritty details of the phenomenon (Simonton, 2010). For example, such models successfully predict that the distribution of multiple grades – the number of independent inventors or scientists – should be described by a Poisson distribution. The latter distribution best fits events with extremely low probabilities; it is inherently incompatible with any deterministic process. In addition, the individual contributor does play a significant role. For instance, it turns out that the independent contributions identified as a single multiple are often extremely different from each other. Leibniz's calculus was not a duplicate of Newton's, the contrasts sufficiently striking that the history of mathematics would have differed had one or the other died young. Indeed, such cross-creator contrasts become even more pronounced in artistic domains where multiples almost never happen (Price, 1986). Beethoven's Fifth Symphony, Michelangelo's Sistine Chapel frescoes, and Cervantes' *Don Quixote* were created only once and could only be created once.

This is not to say that my research program was designed to throw out the baby with the bathwater. The goal was certainly not to replace a sociocultural reductionism with a psychological reductionism. Instead, my more modest aim was to identify their relative spheres of explanation. If I ever ran into that sociologist again, I would simply admit the two main contributions of the sociocultural system. First, the latter provides the necessary (but not sufficient) basis for any given discovery or invention. Galileo could not have made his astronomical discoveries had the telescope not yet been first invented (Simonton, 2012b). Second, the sociocultural conditions can determine how many creative individuals focus on a particular problem, thus increasing the probability not only of a solution but also of how many come up with the same discovery or invention. To illustrate, after Galileo first shocked the world with his initial discoveries regarding lunar mountains and Jovian moons, he quickly found himself surrounded by competitors armed with the newfangled telescopes, so that sunspots were a multiple discovery rather than his alone (Simonton, 2012b). Yet, note, it was Galileo himself who altered those sociocultural conditions. If he had not been so quick to publish his initial results, he might have avoided sharing credit. Genius shapes the Zeitgeist.

Configurations of Culture Growth

More than a quarter-century after his 1917 observations regarding multiples, Kroeber (1944) provided a second objection to Galton's (1869) biological determinism: Creative genius is not distributed across historical time in a manner consistent with genetic theory. Instead creativity tends to cluster into "configurations of culture growth" far more conspicuous than could be explained by changes in the population's gene pool, which must be too slow to produce such effects. To be specific, creative activity in civilizations tends to concentrate in "Golden Ages" interspersed with "Dark Ages," albeit sometimes the former period might be followed by a "Silver Age" of less pronounced creative activity (see also Simonton, 2018; Sorokin & Merton, 1935; Spiller, 1929). This clustering of creative genius has been replicated multiple times across the world's major civilizations for which there exists sufficient historical data (Simonton & Ting, 2010).

Besides providing extensive cross-civilization documentation for these configurations, Kroeber (1944) ventured to provide an explanation. Quoting an ancient Roman historian who had made the same observations with respect to Greek civilization, Kroeber argued that each generation builds on the creative contribution of their predecessors. That cumulative effort leads to a creative peak that may endure for some generations but then that peak is followed by decline as the initial "cultural pattern" that inspired the florescence becomes "exhausted." Unfortunately, unlike Carneiro (1970), Kroeber was not a quantitative cultural anthropologist and so he did not subject his conjecture to a statistical test. In response to this oversight, my 1974 doctoral dissertation was partly dedicated to converting his explanation into a testable hypothesis. To be specific, his idea was translated into the concept of role-model availability and then formalized in terms of generational time-series analysis (Simonton, 1984b). In simple terms, after first tabulating creators into consecutive twenty-year generations according to when they reached their acme or floruit (viz. their fortieth year of life; cf. Simonton, 1997a), the analysis would test the hypothesis that the number of creators in generation g is a positive function of the number of creators in generation $g - 1$ and perhaps $g - 2$. If a positive function existed, then the series displayed autoregression (whether first- or second-order). In any event, autoregressive generational time series appeared not only for Western civilization (Simonton, 1975) but also for other civilizations (Murray, 2003), such as China and Japan (Simonton, 1988, 1992b; Simonton & Ting, 2010).

To be sure, the rise and fall of creative activity is not the sole function of such role-modeling effects. My doctoral dissertation looked at other factors as well, such as the prevailing political conditions (Simonton, 1975; see also Murray, 2003; Simonton & Ting, 2010). Subsequent research has scrutinized other relevant factors, such as the impact of ideology and multiculturalism (Simonton, 1992a, 1997b). By now it has become evident that the coming and going of Golden Ages cannot be attributed to role-model availability alone. So many diverse factors operate that it is no wonder that such great periods of creative florescence stand out in the history of civilization. Such epochal moments are rare and brief. Although Plato's famed Academy endured intermittently for centuries in an increasingly provincial Athens, it was largely staffed by philosophical epigones, such as the obscure Philo of Larissa.

Before wrapping up this chapter, I should note that Kroeber (1944) was interested in the *quantitative* fluctuations in creative genius across the history of a given civilization. In contrast, others have been more intrigued by the *qualitative* changes in a civilization's history. A prime example is Pitirim Sorokin, Kroeber's contemporary, but a sociologist (and, indeed, the first professor of sociology at Harvard). While Kroeber was working on his 1944 *Configurations of Culture Growth*, Sorokin (1937–1941) was publishing his four-volume *Social and Cultural Dynamics*. Sorokin not only collected huge amounts of quantitative data but used those data to test a fascinating theory of sociocultural change. He put forward the idea that a given civilization at any specified time can be characterized by particular "cultural mentality." This mentality can be considered the "modal personality" of the civilization and involves a system of beliefs, values, and worldview. In Sorokin's theory, three mentalities were especially crucial: the Sensate, the Ideational, and the Idealistic. Impelled by a dialectic process, the prominence of these mentalities would change over time according to the following sequence: Ideational → Idealistic → Sensate. Because Sensate could transform into Ideational – such as happened when the late Roman Empire converted to Christianity – the result was a cyclical theory of history.

I need not go into detail about either the mentalities or the theory here. It should suffice to say that because Sorokin (1937–1941) actually published his raw data in his magnum opus, those data have been subject to secondary data analyses by subsequent researchers (e.g., Klingemann, Mohler, & Weber, 1982). These analyses have produced some valuable results about qualitative changes in creativity within civilizations. For example, the prevailing culture mentality influences the form that creativity is most likely to take. Thus, the Sensate mentality – which is founded on sensory experience and thus favors empiricism, materialism, determinism, individualism, and related beliefs – is positively associated with creative achievements in science and with highly realistic and even sensual art (Simonton, 1976a). At the same time, the various beliefs defining the three main mentalities are strongly influenced by certain political circumstances. For instance, civil disturbances tend to polarize the stance thinkers take on the defining philosophical positions (Simonton, 1976c). Hence, the number of thinkers will increase who represent contrary positions, such as both rationalism and empiricism and both indeterminism and determinism. These instances and others establish that the belief systems that come and go in intellectual history have both causes and effects – contrary to the Marxist view that such ideas are mere epiphenomena.

Discussion

We have just seen how creativity is more than a psychological phenomenon. Besides speaking of creative individuals, it is also meaningful to speak of creative cultures, cities, nations, and civilizations. That much admitted, the reality of these collective entities does not compromise in any way the central role played by the individual creator's psychology. As a graduate student interested in studying creativity, I had good reason for remaining a psychologist rather than switching over to sociology or cultural anthropology. To understand why, consider the following individual-level phenomena: creative productivity, creative personality, and creative development.

Creative Productivity

Within any given cohort of creators who are active at a given time and place, there remain impressive cross-sectional variation in creativity that cannot possibly be explicated according to sociocultural conditions. A case in point is the substantial individual differences in creative productivity (Simonton, 1991a, 1991b, 1997a). Beyond any doubt, not all creators born under identical milieus are equally productive across their life spans. Indeed, only a small proportion of the creators will produce enough to count as genuine creative geniuses (Albert, 1975). Because the sociocultural circumstances are effectively held constant, this variation must have a personal source, such as the personality and developmental factors to be discussed shortly under sections "Creative Personality" and "Creative Development." Moreover, the larger the number of creative individuals who are active in a given historical time and geographical location, the more extreme is the variation in productivity exhibited by those creators (Price, 1986; Simonton, 1988). A Golden Age is like a large pyramid, with big-name creators represented by big blocks at the apex and a very large number of more obscure figures forming a broad base of small bricks, whereas a Dark Age consists of a small pile of pebbles, the top pebble only slightly larger than the rest. Leonardo da Vinci, Michelangelo, and Raphael rubbed shoulders with numerous lesser artists who, nonetheless, collectively defined the Italian Renaissance. To drive in the point, Giorgio Vasari's 1550 *Lives of the Most Excellent Painters, Sculptors, and Architects, from Cimabue to Our Times* provides biographies – of highly variable length – for nearly 300 Italian artists. Most art lovers will likely claim familiarity with no more than two dozen at best (see Ginsburgh & Weyers, 2006).

Closely related to the preceding is another crucial fact regarding creative productivity: Besides variation across individuals, we also must recognize the importance of within-individual longitudinal changes (Jones, Reedy, & Weinberg, 2014; Kozbelt, 2014; McKay & Kaufman, 2014). Except for "one-hit wonders" whose creative productivity begins and ends with a single work (see, e.g., Kozbelt, 2008), most highly creative individuals will have their contributions distributed over the course of a long career (e.g., Simonton, 1977b). Typically, output is described by a single-peaked age curve (Simonton, 2012a). Moreover, their first high-impact product will appear in their mid to late twenties, their single best work around age forty, and their last high-impact product a little after age fifty (Raskin, 1936; Simonton, 1991a, 1991b). To be sure, the precise details of the career trajectory will vary according to several factors, such as cross-sectional variation in output, the nature of the discipline, and whether the creator is an early or late bloomer (Simonton, 1997a). Yet the crucial point is that the longitudinal changes in creative output are largely driven by endogenous forces connected with the individual's career age (Simonton, 2012a). Even if truly dramatic exogenous factors, such as outright war, might influence the career course, these influences are usually small and transient (e.g., Borowiecki, 2014; Cerulo, 1984; Simonton, 1977a). In short, the sociocultural system most often plays a very minimal role in shaping a creator's career trajectory.

Creative Personality

For the sociocultural system to dominate the individuals who make up that system, it would be expected that those individuals would display personality traits most appropriate for conforming to social roles and cultural norms. Such persons should be highly conventional conformists whose interests and values tightly match the mainstream or majority culture. When such persons train for a specific domain, the same conforming conventionality should be apparent. Their knowledge and skills should be closely constrained to a narrowly defined domain-specific expertise.

Yet what I have just described is essentially the exact antithesis of the creative personality. Not only are highly creative people far more likely to be unconventional nonconformists who value their autonomy but they also exhibit broad interests and experiential openness that go well beyond the demands of any domain-specific expertise (Carson, 2014; McCrae & Greenberg, 2014). In extreme instances, and especially in the arts, this disposition can even incline them toward subclinical levels of psychopathology and thus far more deviant from cultural norms than the average person on the street (Simonton, 2014). Moreover, the greater the creative genius, the more conspicuous is this tendency to "defy the crowd" (Sternberg & Lubart, 1995). This pronounced tendency is clearly apparent in the lives of great thinkers, for example (Simonton, 1976b). Such intellects advocate extreme positions and unusual ideational combinations that are out of sync with the prevailing intellectual Zeitgeist of their day. It is only the lesser thinkers who show any willingness to conform to an already well-established school of thought rather than found a new school entirely of their own (see also Simonton, 2000b).

Creative Development

The development of highly creative persons echoes what has just been said about the personality of highly creative persons. If the sociocultural system is to so intimately shape the individual creator, making him or her but a causal epiphenomenon, then creative development must be seriously confined by that system. Creative individuals should grow up in highly conventional families, with mainstream or majority-culture parents, and have their socialization similarly constrained by the educational system, as manifested in the individual's academic performance and domain-specific training. The result is a person highly representative of both the society and the domain – the perfect embodiment of the time and place.

But, again, the opposite is the case. Instead, creative development is highly dependent on "diversifying experiences that help weaken the constraints imposed by conventional socialization" (Simonton, 2000a, p. 153). Such diversifying experiences can involve any combination of the following: (1) parents who depart from the dominant culture with respect to ethnicity, religion, geographic origins, and/or socioeconomic background; (2) disruptive events in childhood or adolescence, such as orphanhood or economic instabilities; (3) stigmatizing features that make the young person feel different from peers, such as cognitive or physical disabilities; and (4) unusual events or encounters in education and training, such as poor performance, distinctive teachers and mentors, or changes in career goals (Damian & Simonton, 2014, 2015). Of special interest are the positive repercussions of bilingualism and multiculturalism, which, by their very nature, set the individual on a divergent developmental path, allowing the person to see the world from at least two sociocultural perspectives rather than just one (Leung et al., 2008; Simonton, 2008). It is no accident that a significant proportion of highly creative persons are either immigrants or the children of immigrants (Damian & Simonton, 2014). Interestingly, although the original research on diversifying experiences was correlational, recent laboratory experiments have been able to simulate their impact on creativity (e.g., Ritter et al., 2012; Saad et al., 2013; Vohs, Redden, & Rahinel, 2013). Creativity is enhanced when people are jarred out of normal, everyday thinking.

Conclusion

Although the research on my doctoral dissertation began more than forty years ago, and despite the occasional contributions of other researchers in the interim, considerably more empirical inquiry is necessary before we can fully comprehend creativity at the societal level. Unhappily, current trends in psychology and other relevant domains are not moving in the right direction for such investigations to continue. Most notably, psychology's present infatuation with the neurosciences has pulled the discipline further away from studying the larger sociocultural forces that have such a critical place in creativity. Perhaps an adventurous group of psychologists, sociologists, and cultural anthropologists need to form a new interdisciplinary program that can encourage future graduate students to launch research programs like I did so very long ago. In the meantime, it has at least been established that creativity can occur not just in persons but also in cultures, cities, nations, and civilizations. The latter phenomena do not invalidate personal creativity as a psychological phenomenon but rather demonstrate creativity's supreme importance beyond the individual creator. Creativity has a major role in society.

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23 The Physical Environment and Creativity

A Theoretical Framework

Jan Dul

The physical environment has long been neglected as a creativity-contributing factor. After the recognition that human behavior can be strongly influenced by context (e.g., Chapanis, Garner, & Morgan, 1948), context researchers and practitioners in creativity have almost exclusively focused on the role of the *social* context. In the well-known Four P model of creativity (Person, Process, Press, and Product), Rhodes (1961) defined Press as "the relationship between humans and their environment" (p. 308) and referred to the environment as the social environment. Examples of characteristics of the social environment that may influence creativity are trust, support, and challenge. Integrated models, theoretical frameworks, and taxonomies that capture a variety of creativity-supporting environmental characteristics are predominantly about the social environment. Hunter, Bedell, and Mumford (2007) evaluated forty-five models and found that only one model also included characteristics of the physical environment. This single model (Alencar & Bruno-Faria, 1997) distinguishes between creativity-stimulating characteristics (e.g., space) and creativity-inhibiting characteristics (e.g., noise). In another review, Puccio and Cabra (2010) compared nine integrative contextual models and found that just one model incorporates the physical environment. This model only emphasizes the potentially hindering role of the physical environment (Basadur, 1987).

Despite the limited attention given to the physical environment in integrated models, many researchers do mention the potential creativity-enhancing role of the physical environment but do not include the physical environment in their context models or reviews (e.g., Amabile, 2013; Amabile et al., 1996; George, 2007; Shalley & Gilson, 2004; Woodman, Sawyer, & Griffin, 1993). For example, while presenting their "componential theory," which integrates individual and social context factors, Amabile and colleagues (1996) stated that "physical environments that are engineered to be cognitively and perceptually stimulating can enhance creativity" (p. 249). In a later publication, Amabile (2013) mentioned a "shortcoming" of the componential theory: "the theory does not include the influence of the *physical* environment on creativity" (p. 138, emphasis in original). However, a recent update of the componential model does not include the physical environment either. It appears that after ignoring the physical environment, after pointing primarily at possible negative effects, and after emphasizing the need to include the physical

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environment in integrative models, only one integrative model includes the potential positive effects of the physical environment. Dul and Ceylan (2011) proposed a model that includes twelve creativity-supporting characteristics of the physical environment, such as daylight, indoor climate, and furniture. They found that both the social and the physical environment can boost creativity separately, as well as in combination (Dul, Ceylan, & Jaspers, 2011). They also showed that a combined creativity-supporting social and physical context has a positive effect on the innovativeness of business organizations (Dul & Ceylan, 2014). The physical environment may account for approximately 40 percent of the effect of the context on creativity, and the social environment for approximately 60 percent (Ceylan & Dul, 2007; Dul et al., 2011; Horng et al., 2016).

These findings, and other evidence that specific separate physical characteristics can have positive effects on creativity (e.g., illumination, Knez, 1995; plants, Shibata & Suzuki, 2002), have sparked the interest of researchers on the effect of the physical work environment on creativity, given the increase in number of publications about the topic. Although traditional interpretations of Press in the Four P model as social press are still around (e.g., Dorniak-Wall, 2016; Horng et al., 2015), in recent interpretations Press is considered to also have a physical dimension (e.g., Nouri, 2016; Williams, 2013). Not only recent interpretations of the Four P model include the physical environment as a potential creativity-supporting factor; also extensions of the model include a physical dimension. For example, the physical environment is part of the Affordances concept of the Five A model by Glăveanu (2013) and of the Context concept of the Seven C model by Lubart and colleagues (2019).

This chapter's goal is to explore the relationship between the physical environment and creativity and to combine published ideas and empirical evidence into a theoretical framework. This is not an easy task. The topic is relatively new and has no agreed on concepts, common definitions, or generally accepted models. Additionally, the extant literature on this topic is scattered over several scientific disciplines and professions. These include (1) environmental psychology, where the focus is on analyzing mechanisms and effects on persons of a variety of physical characteristics (e.g., visual cues); (2) physical human factors/ergonomics, focusing on the interaction between humans and the physical environment in terms of ambient conditions and workplaces for developing guidelines for design; (3) architecture and indoor design, focusing on designing the built environment; and (4) facility management, human resource management, and operations management, focusing on the management of the environment. In order to integrate the available dispersed ideas and knowledge, I will use the broad "human factors" lens (Dul et al., 2012). Human factors "is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize well-being and overall performance" (Noy, 2000). This lens is particularly useful because it integrates multiple disciplines and different physical characteristics and aims at providing recommendations for the design of the physical environment. Furthermore, the human-factor lens fits because human factors focus on two related outcomes: performance and well-being. Creativity is about performance (producing novel and useful ideas) and about well-being ("creativity is often healthy": Richards, 2010, p. 208) and the two are correlated (Dolan & Metcalfe, 2012). With the human-factor lens, I attempt to interconnect analysis-oriented, design-oriented, and management-oriented fields. This interconnection results in a theoretical framework that integrates (1) different (implicit) definitions of physical environment and creativity, (2) different mechanisms (intervening/mediating variables) that explain the relationship between physical work environment and creativity, and (3) different views on the type of causal links (necessary, sufficient) between physical environment and creativity.

I first introduce the "triple path" theoretical framework for integrating views and evidence on the relationship between *Physical environment* and *Creativity*, via three possible paths: *Functionality* (the ability of physical environment to facilitate creative activities), *Meaning* (the symbolic meaning concealed in a set of physical properties of the environment), and *Mood* (the ability of physical items to induce emotional responses over the short term). After that, I define and classify the Physical environment. Next, I present ideas and evidence about the role of Functionality, Meaning, and Mood for creativity, respectively. The chapter ends with conclusions.

A "Triple Path" Theoretical Framework

The proposed "triple path" theoretical framework (Figure 23.1) represents how the objective physical environment is linked to creativity via three perceptual paths. The main aim of the framework is to organize and integrate existing scattered

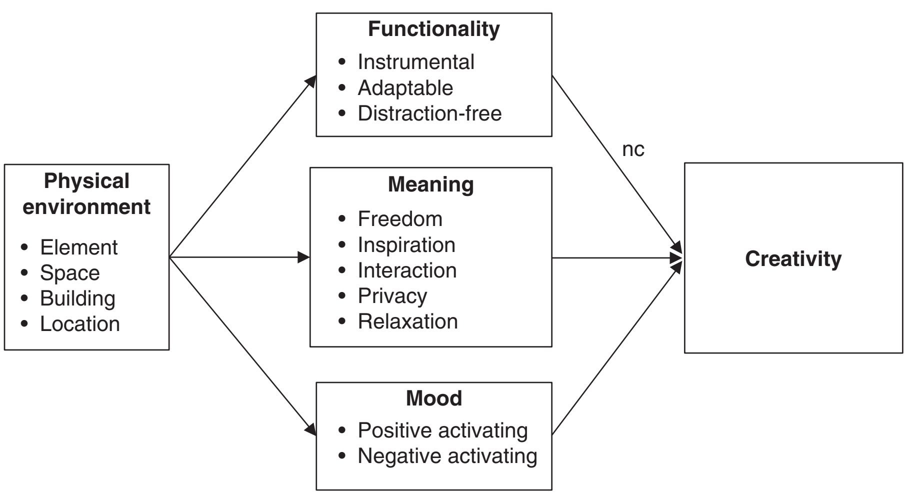

Figure 23.1 *Theoretical framework ("triple path") about the relationship between the objective Physical environment and Creativity via three perceptual paths: Functionality, Meaning, and Mood*
Note: nc means "necessary condition"; see text.

knowledge in the literature. Available studies investigate different paths and concepts. In architecture and indoor design, the focus is on the Physical environment, in physical human factors/ergonomics the focus is on the Physical environment and its Functionality, and in psychology the focus is on Meaning, Mood, and Creativity. The framework elaborates on the physical Press dimension of the Four P model, the Affordances dimension of the Five A model, and the physical Context dimension of the Seven C model.

Concepts

The focal unit of the theoretical framework is the person (individual). Thus, all concepts (represented by the blocks) are defined at the level of the individual, not at the team or organizational level. Every person can be creative to a greater or lesser extent, and every person's creativity can be influenced by the person's physical environment. Hence, the framework applies to any person who performs a creative activity in any environment, independently of age, gender, nationality, culture, and so on. This environment can be the workplace (e.g., in public and private organizations), learning institutions (e.g., in schools, colleges, universities), or in everyday life (e.g., at home, during travel, or leisure). Creativity refers to the person's production of novel and useful ideas (Amabile et al., 1996) during activities done in these environments. This view on creativity and the environment corresponds to the meaning of "everyday creativity" (Richards, 2010), which is defined in terms of "human originality at work and leisure across the diverse activities of everyday life" (p. 190). In this chapter, a "creative activity" is an everyday activity (at work, in school, at home, etc.) where creativity *may* be relevant, although creativity is not necessarily the main goal of the activity. The activity may be a "thinking activity," in which the person produces creative ideas (such as producing ideas for alternative uses of a common item), or a "doing activity," in which the person performs the activity in a creative way or produces a creative outcome of the activity (such as in everyday cooking, which can be done in a creative way or with a creative outcome). Doing and thinking activities are not completely separate. Thinking is a form of doing (internalized) and doing always relates to some level of thinking (even in habitual action).

The proposed framework only considers the effect of the *physical environment* on creativity (via the three possible paths). The framework presumes the existence of three paths but the paths may not be independent. The paths may be present at the same time – for example, furniture is Functional, has a symbolic Meaning, and can induce a certain Mood. The three mediators may also interact with each other. Different combinations of functionality, meaning, and mood may have different effects on creativity. Also, feedback loops may exist, for example, when the person adapts the environment based on perceived functionality, meaning, or mood. The framework does not pretend to be a comprehensive causal structure predicting creativity by including many possible predictors. Although individual characteristics certainly influence creativity (see the Person and Process dimensions of the Four P model) as well as the three paths, individual characteristics are not included in the framework. Hence, the framework focuses on "average trends" without giving attention to individual variations. Also, the social environment (Press in the traditional version of the Four P model) is not included. Furthermore, the model does not take into account different types of creativity. For purposes beyond the scope of this chapter, the model could be expanded to include other predictors and dimensions of creativity.

The proposed framework links the person's objective physical environment to the person's creativity via three mediators (Functionality, Meaning, and Mood) regarding the person's perceptions about that environment. The person may passively accept the environment or may have actively selected or adapted that environment. The three mediating concepts are (distantly) linked to the Ability–Motivation–Opportunity (AMO) framework of behavior, which states that any behavior (including creative behavior) requires the presence of each of the three (Appelbaum et al., 2000, Hauff et al., 2018; Van Rhee & Dul, 2018). Ability is the set of "physiological and cognitive capabilities that enable an individual to perform a task effectively" (Blumberg & Pringle, 1982, p. 563). Motivation is the set of "drives, urges, wishes, or desires which initiate the sequence of events known as 'behavior'" (Bayton, 1958, p. 282) and Opportunity is "the particular configuration of the field of forces surrounding a person and his or her task that enables or constrains that person's task performance and that are beyond the person's direct control" (Blumberg & Pringle, 1982, p. 565). The presence of *Ability* is assured in the framework because it is assumed that all persons have creative abilities (to a certain extent). The framework's Functionality concept is part of *Opportunity*, and the Meaning and Mood concepts are parts of *Motivation*. Intrinsic motivation is considered to be the core of creative behavior (Amabile et al., 1996; see Hennessey, Chapter 18, this volume) but, according to the AMO framework, the person must also have the ability and opportunity for it. Both the physical environment and the social environment can help to provide the required motivation and opportunity for creativity.

Illustration of the Concepts

Figure 23.2 illustrates the concepts of the "triple path" framework using a not so fictive example of a creative task: writing a book chapter. The ***Physical environment*** is the place where writing is done. The *Location* is a countryside, and the *Building* a summerhouse. The *Space* is a living room used as the main working room for writing. This room has various physical *Elements* such as a large wooden table, several chairs, a laptop computer, a stack of printed papers, ballpoints, a pot of coffee, light-yellow walls, a window view to nature, and so on.

This physical whole creates the ***Functionality*** to write a book chapter. The table, chairs, computer, pens, and so on provide the *Instrumentality* that is required for writing. The environment is *Adaptable* because the seats can be arranged as desired. Thinking can be done while sitting, standing or walking (also outside), the room temperature can be set, the elements on the table can be rearranged, and so forth. The environment is *Distraction-free*. There is no distracting noise, cold, heat, or bad smells, and no distracting permanent view

Figure 23.2 *The physical work environment while writing a book chapter*

on other people and their activities. Sometimes the local traffic is distracting when farmers pass with their tractors. This physical environment has a certain ***Meaning*** to the author: Its isolation from everyday working life gives a sense of *Privacy* and *Freedom*. The feeling of freedom is further enhanced by the open view on the natural surroundings. The view on nature and the walks in the garden provide *Relaxation*. Nature also gives *Inspiration* and the presence of papers (about topics related to the book chapter) and a computer (for internet searches) are inspiring as well. With a Wi-Fi connection, it is possible to have virtual *Interactions* with colleagues for discussing ideas. This environment helps to have a positive activating **Mood** (happiness, cheerfulness) while writing the chapter. In all, the Functionality, Meaning, and Mood provided by the physical environment help to perform the writing task in a creative way.

Relationships

The positive effect of the Physical environment – via Functionality, Meaning, and Mood – on Creativity has been formulated in the literature in terms of the physical environment that can "boost," support," "affect," "shape," "be conducive for," "encourage," "foster," and "enhance," creativity. This relationship can be linear (more X leads to more Y) or curvilinear (more optimum level of X leads to more Y). The arrows in the framework represent *causal* relations: X causes Y. X is the antecedent (cause) that precedes Y, which is the consequent (effect). Based on Hume (1777), two types of causes exist: the sufficient cause and the necessary cause (Dul, 2016). In the proposed framework, the antecedents are *sufficient causes* for the consequent: The antecedent helps to "produce" the consequent. Furthermore, the relation between antecedent and consequent is presumed to be probabilistic: The antecedent produces the effect "on average" (not always, not for all individuals). One exception in the framework is that one group of antecedents (Functionality; see below) is defined as a *necessary cause* for the effect: If the antecedent is absent, it produces the guaranteed *absence* of the effect. The absence of the right level of the antecedent cannot be compensated by any other antecedents (no additive logic as presumed in existing models). Hence, the proposed causal relations shown by arrows in the theoretical framework can be expressed as:

1. Physical Environment likely produces Functionality
2. Physical Environment likely produces Meaning
3. Physical Environment likely produces Mood
4. Functionality likely produces Creativity
5. Functionality is necessary for Creativity
6. Meaning likely produces Creativity
7. Mood likely produces Creativity

What Is the Physical Environment?

Classifications

The physical environment is defined as the material surrounding of a person. Several classifications exist for the physical environment. The classification can be based on the level of "artificiality": a natural environment has a low level of artificiality (Plambech & Konijnendijk van den Bosch, 2015), a human-made/built environment with natural elements has a medium level of artificiality (Haner, 2005), and a virtual environment has a high level of artificiality (Thornhill-Miller & Dupont, 2016; Guegan, Nelson, & Lubart, 2017). Malinin (2016) made a classification of the physical environment based on types of architectural settings: "Building sites," which is the location of the building and its infrastructure, "Building structures," which is the layout of the building, and "Rooms." Weinberg and colleagues (2014) used the level of fixity (immobility) ranging from fixed to adjustable: Architecture (referring to the building), Furniture (referring to the interior design elements such as movable furniture), and Resources (referring to further equipment and work material). Hemlin, Allwood, and Martin (2008) classified the physical environment as facilities, buildings, architecture, location, climate, and equipment but do not define these classes.

Hierarchical Classification

In this chapter, I propose a hierarchical classification of the physical environment by combining and selecting from existing classifications (Table 23.1). Hierarchical means that higher-order classes encompass lower-other classes. Because of the chapter's emphasis on the human–environment interaction, this classification is based on proximity, that is, how far or how close the environment is to the person. Ranging from proximal (close) to distal (far), I use the following four classes. *Element* is a specific characteristic of a person's immediate material environment that can be sensed, such as an ambient condition (light, sound, indoor climate) or an artifact (furniture, plants). *Space* is the spatial entity where the person performs a specific activity (room, office, workplace). Space includes elements and their spatial organization (configuration,

Table 23.1 *Characteristics of the physical environment related to creativity, with examples of empirical studies*

Class	Subclass	Characteristic	Keywords	Sources
Element	Ambient condition	Light	Quantity of light, color temperature of light, daylight/artificial light, windows	Ceylan et al., 2008, Stone & Irvine, 1994; McCoy & Evans, 2002; Boubekri et al., 1991; Boyce et al., 2003; Knez, 1995, 2001; Kwallek & Lewis, 1990; Steidle & Werth, 2013; Hoff & Öberg, 2015; Galasiu & Veitch, 2006.
		Sound	Positive sounds, negative sounds, music, noise	Lesiuk, 2005; Toplyn & Maguire, 1991; Furnham & Strbac, 2002; Mehta & Zhu., 2009.
		Smell	Positive smells, negative smells	Leenders et al., 2016; Knasko, 1992.
		Color	Color temperature of objects/walls. Warm colors, cool colors	McCoy & Evans, 2002; Stone, 2003.
		Indoor climate	Air temperature, air quality, draught	Hygge & Knez, 2001.
	Artifact	Materials	Natural materials (e.g., wood), manufactured materials (e.g., metal)	McCoy & Evans, 2002.
		Plants	Natural plants, potted plants, flowers	Ceylan et al., 2008; Shibata & Suzuki, 2002, 2004; McCoy & Evans, 2002; Hoff & Öberg. 2015; Plambech & Konijnendijk van den Bosch, 2015; Bringslimark et al., 2007.
		Furniture	Chairs, tables, cupboards, etc.	Ridoutt et al., 2002; Hoff & Öberg, 2015; Rittiner et al., 2016.

		Information sources and technology	Computer, books	Hoff & Öberg, 2015; Lee, 2016.
		Decor	Art, aesthetic, design	Kallio et al., 2015; Hoff & Öberg, 2015.
Space	General space	Individual	Individual room	Kim & de Dear, 2013; Samani, Rasid, & Sofian, 2014.
		Shared	Open room >1 person	Stokols et al., 2002; Lee & Brand, 2005; Hoff & Öberg, 2015.
		Flexible	Possibility to change rooms	Wessels, 2017.
	Dedicated space	Inspiration and interaction	Space for divergent thinking, brainstorming, collaboration, convergent thinking	Hoff & Öberg, 2015; Rittiner et al., 2016; Haner, 2005; Lee, 2016; Bieraugel & Neil, 2017.
		Privacy	Space for isolation, reflection	Bieraugel & Neil, 2017; Wohlers & Hertel, 2017.
		Relaxation	Space for relaxation and informal communication	Hoff & Öberg, 2015.
	Special space	Nature	Space in nature, built space predominantly with nature elements (plants, water, wood)	Plambech & Konijnendijk van den Bosch, 2015.
		Nonsedentary	Space for nonsitting body postures, movements (standing, stand/sit, walking)	Van der Lans, 2015; Beatty & Ball, 2011; Blanchette et al., 2005; Opezzo & Schwartz, 2014; Knight & Baer, 2014.
		Virtual	Space in the virtual environment	Guegan et al., 2017.

Table 23.1 (*cont.*)

Class	Subclass	Characteristic	Keywords	Sources
Building		Creativity-based	Dedicated building for creative tasks	Van der Lans, 2015; Hoff & Öberg, 2015.
		Activity-based	Flexible building	Wessels, 2017.
		Cell-based	Conventional building (school classes, private offices)	Coradi, Heinzen, & Boutellier (2015); Wineman, Kabo, & Davis (2009).
		Home	Everyday living environment	De Paoli, Sauer, & Ropo (2017).
		Unusual	Out-of-the-box environment for creative tasks	De Paoli, Sauer, & Ropo (2017).
Location		Innovation park	Dedicated group of buildings and infrastructure for creativity and innovation	Laursen, Masciarelli, & Prencipe (2012).
		Campus	Dedicated group of buildings and infrastructure for learning of students	Bieraugel & Neill (2017); Lundström, Savolainen, & Kostiainen (2016).

layout). I specify three types of spaces: general spaces where a person performs a variety of activities (e.g., an individual office), dedicated spaces for support of creativity (e.g., a private space for creative thinking or a meeting space for brainstorming with others), and special spaces (e.g., a space in nature). *Building* is the physical entity consisting of several interconnected spaces and their spatial organization (e.g., office building with general spaces and dedicated spaces). *Location* is the geographic place of the physical environment such as neighborhood (a set of buildings connected by infrastructure, town, region, country, etc.; for example, a regional cluster of innovative companies). Building and Location will be sparsely covered in this chapter because environments that are more distal may have less influence on individual creativity than environments that are more proximal (Shalley & Gilson, 2004). Table 23.1 shows this classification, examples of characteristics of the physical environment, keywords describing the characteristic, and examples of studies that link the characteristic to creativity. Several of these studies are discussed below in more detail.

Objective vs. Subjective

Table 23.1 defines the *objective* physical environment, that is, its actual material manifestations. This objective environment is distinct from the subjective (perceived) environment, although the two correlate. Perceptions of the environment are of utmost important for creativity (Amabile et al., 1996). The objective environment drives the subjective environment and the subjective environment drives creativity. Hence, perceptions of the environment mediate the relationship between the objective environment and creativity. In the next three sections, I discuss the perceptual links (Functionally, Meaning, and Mood, respectively) between the objective physical environment and creativity.

Path 1: "Must Have" – The Physical Environment and Its Functionality for Creativity

The first link of the proposed "triple path" framework (Figure 23.1) is the link between the physical environment and creativity via Functionality. Functionality is fundamental: It *ensures* that the creative activity can be done properly. Bitner (1992) refers to functionality as "the ability of [physical] items to facilitate performance and the accomplishment of goals" (p. 66). Functionality may be closely related to the affordances concept (Gibson, 1986; Glăveanu, Tanggaard, & Wegener, 2016). In the context of this chapter, Functionality means that physical items *enables* creativity. Consequently, when any enabling physical characteristic is absent, creativity is hindered (constrained).

Necessary

There is a good reason for the early emphasis in integrative context models on the hindering role of the physical environment. The absence of creativity-enabling characteristics of the physical environment may block creativity. The logic that enabling physical characteristics block creativity when absent corresponds to the logic of "necessary conditions" (Dul, 2016). Enabling factors are *necessary conditions*: "hygiene" factors that accommodate, facilitate, or allow an outcome. When a necessary condition is absent the outcome cannot occur; hence, the necessary condition is a "must-have." Just like intelligence (an ability) is necessary for creativity (Karwowski et al., 2016), functionality (an opportunity) is necessary for creativity (Dul, Karwowski & Kaufman, 2019). Necessary conditions can be formulated "positively" as critical factors that must be present or "negatively" as bottlenecks (constraints) that must be prevented. People may have different perceptions about the conditions necessary for their creativity. Therefore, I introduce Functionality as a perceptual concept: *Functionality is the extent to which characteristics of the physical environment that are necessary for a person's creativity are perceived to be in place.* The creativity-*enabling* role of the physical environment is captured in this concept of Functionality. Therefore, a functional (enabling) physical environment is essential for high creative performance. It must be there but its presence does not produce the outcome (the necessary condition is not sufficient).

Instrumental

Functionality for creativity may have three aspects: Instrumental, Adaptable, and Distraction-free. *Instrumental* refers to the assurance that the (creative) activity can be performed well (required technology, tools, furniture, space, etc.). In her essay on "How to kill creativity," Amabile (1998) states: "It is almost conventional wisdom that creative teams *need* open comfortable offices" (p. 82, emphasis added), implying that the absence of open comfortable offices kills creativity. Similarly, McCoy and Evans (2002) suggest that working in an uncomfortable environment is an *obstacle* for creativity. The creative activity cannot be performed well without instrumental functionality and, hence, the absence of instrumental functionality may block creativity. The specific instrumental requirement depends on the activity. For a design task, a person may perceive that pencil and paper are necessary for creativity. For long-lasting cognitive activities, the person may perceive that ergonomic furniture may be essential; for performing manual activities, equipment, tools, and adequate light may be essential; for physical activities, adequate space may be fundamental. Only after such basic requirements are met can the person do the intended activity in a creative way. At any level of the physical environment (element, space, building, location), instrumental functionality may be required for creativity. At the level of element and space, Hoff and Öberg (2015) mention three functional requirements that can be considered as instrumental for creative office work: adequate space, lighting, and ergonomics tools and furniture. They interviewed "digital artists" from the creative industry (graphic designers) and report:

> the digital artists mentioned ergonomic furniture and proper tools as being among the most important aspects for functional support of the environment. Among tools, computers, large screens and software are of utmost importance. Also, because they work with computers in a sitting position for many hours, it was considered crucial

> to have good chairs and tables that could be adjusted to standing position and ergonomic keyboards. (p. 1896)

Adaptable

The second type of functionality (*Adaptable* functionality) refers to the assurance that the environment is adaptable to individual needs (i.e., can the environment be changed, selected, adjusted?). Physical environments are commonly designed for the "average user" or the "majority of users." For example, a room with fixed illumination level may be optimal for the (nonexisting) average person but too bright for half of the users and too dim for the other half of users (presuming a normal distribution). Allowing personal adaptability (selecting high illumination level and using a dimmer) can avoid such situation. Just the presence of a control is not enough (Veitch & Gifford, 1996); people should have the possibility to find their optimum before positive effects can be expected (Newsham et al., 2004; Lee & Brand, 2010). In general, owing to large individual differences, the physical environment should be adaptable to ensure high creative performance for each individual, and people may need time and support to find their personal optimum. Adaptable functionality may be required at any level of the physical environment (element, space, building, location). In their study of office work, Hoff and Öberg (2015) report on the importance of "personal space":

> Some respondents said that personalization of their space was a necessity. One artist pointed out: "I have to make it mine, I just have to. There's no reason why I shouldn't change it. I think it's very important for every creative person." Some reported that it was essential for them to be able to express their creativity in their personal space as well. (p. 1896)

Wells, Thelen, and Ruark (2007) estimate that 70–90 percent of American workers personalize their workspace, indicating that personalization seems to be a basic need. Samani, Rasid, and Sofian (2015) suggest that personal control over the physical environment can avoid distractions that are detrimental to creativity. Rittiner and colleagues (2016) find that a space with adaptable furniture and artifacts can help to accommodate different phases of the creative process. Having the possibility of choosing where to work, such as in flexible workplace arrangement, is an example of adaptable functionality in an office building (Wohlers & Hertel, 2017). Hoff and Öberg (2015) suggest that buildings designed for creativity should be flexible and dynamic, with different room sizes and floor levels, with open and hidden spaces, and less strictly designed.

Distraction-Free

The third type of functionality (*Distraction-free* functionality) refers to the assurance that the environment is free of distracting conditions (noise, heat, smell, etc.) that hinder creativity. Distractions may disturb the cognitive processes needed for creativity. Stokols, Clitheroe, and Zmuidzinas (2002) state that environmental distractions may restrict the person's creativity by interfering with concentration on the creative activity.

They show that three distractions in an office environment can have a negative effect on perceived support for creativity: noise, foot traffic, and visual exposure (lack of visual privacy). Whether sound is distracting depends on the noise level (Mehta, Zhu, & Cheema, 2012), on whether or not the noise is predictable (Kasof, 1997), and on the individual (Toplyn & Maguire, 1991). What is distracting for one person may be less or not distracting, or even supportive, for another person. For example, background music may be as distracting as background noise for introverts, whereas both have only a small distracting effect on extraverts (Furnham & Strbac, 2002). Alencar and Bruno-Faria (1997) asked employees from different organizations about the factors in their work environment that inhibit creativity and identified noise, heat, and lack of space as distracting factors that can block creativity. Other studies also show that lack of space and crowded spaces hinder creativity (e.g., Aiello et al., 1977; May, Oldham, & Rathert, 2005).

Summary

In summary, a physical environment without functionality hinders a person's creativity. A person's creativity cannot be of the highest level without an instrumental, adaptable, and distraction-free physical environment.

Path 2: "Nice to Have" – The Physical Environment and Its Meaning for Creativity

Many characteristics of the physical environment are not necessary but may help to increase creativity. These "nice-to-have" factors have the potential of the physical environment to *enhance* (rather than enable) creativity. In contrast to the "must-have" characteristics, these factors are replaceable. If one factor is missing, another factor can compensate for it. The first group of "nice-to-have" factors, which form path 2 of the theoretical framework, is about the psychological "meaning" that people attach to the objective physical environment. The (psychological) literature suggests that certain meanings are drivers for creativity. A person attaches a meaning to the physical environment (Williams, 2013). Meaning refers to the perceived "symbolic meaning concealed in a set of physical properties" (Rafaeli & Vilnai-Yavetz, 2004, p. 93; see also Bitner, 1992; Elsbach & Pratt, 2007).

Meanings

Several researchers have formulated meanings that are supposed to have positive effects on creativity. McCoy and Evans (2002) define five such conducive (i.e., those that contribute to creativity) meanings as "underlying dimensions of physical settings salient to creativity" (p. 410): Nature, Challenge, Freedom, Support, and Coherence. White and Lorenzi (2016) define six partly different conducive meanings of the environment that are supposed to enhance creativity: Open, Light, Dynamic, Stimulating, Unexpected, and Cozy. Kallio and colleagues (2015) state that the physical environment can shape an organizational culture that is conducive for creativity by symbolizing: Equality, Openness, and Collectivity. For example, openness "provides a fertile ground in which to cultivate freedom, including freedom of expression and the freedom to experiment, a sense of control over one's work and idea" (p. 400). Lee (2016) proposes a framework with seven yet other conducive meanings: Disengaged place, Doodle space, Unusual/fun atmosphere, Relaxing environment, Stimulating senses, Technology interface for collaboration, and Balanced layout.

Selection of Meanings

To integrate these different and partly overlapping creativity-enhancing meanings, I formulate five overarching concepts of the creativity relevant meanings. These meanings are *Freedom, Inspiration, Interaction, Privacy,* and *Relaxation*. Table 23.2 provides definitions of these meanings and how they relate to the original meanings of the four models.

Freedom

When a person in the physical environment perceives the meaning "freedom," the person may feel open to experience and freedom to choose and explore (McCoy & Evans, 2002), which may enhance creativity. Steidle and Werth (2013) studied the effect of illumination level on creative task performance via the meaning *freedom* and show that a low illumination level (darkness) can induce a perception of freedom, which enhances creativity. In dim-lit environments, people may elicit a feeling of being free from constraints, which may trigger a risky, explorative processing style that can be beneficial for creativity.

Inspiration

A person in the physical environment may perceive the meaning of *inspiration*. Hoff and Öberg (2015) suggested that different levels of the physical environment can provide inspirational support, such as creative furniture and artifacts (physical elements) or a creative building design (with different levels and dynamic spaces). The location can also be inspirational, such as a place in nature. "In nature you are allowed to think wild ideas, and big thoughts, and dream yourself away into one's inspiration where it all starts to get exciting" (Plambech & Konijnendijk van den Bosch, 2015, p, 259).

Interaction

Open-plan offices stimulate *interaction*. When the physical environment expresses interaction, people may feel stimulated to exchange ideas. Both privacy and interaction have been found to be important for creativity in a learning setting (Bieraugel & Neill, 2017). Quiet spaces enhance reflection and thinking (Wohlers & Hertel, 2017)

Table 23.2 *A person's perceived symbolic meaning of the physical environment conducive for creativity*

Concept	Definition	Related concepts of McCoy & Evans (2002)	Related concepts of White & Lorenzi (2016)	Related concepts of Kallio et al. (2015)	Related concepts of Lee (2016)
Freedom	A sense of control over one's own activities and ideas (after Amabile & Gryskiewicz, 1989)	Freedom	Open	Openness	Balanced layout
Inspiration	A sense of being mentally stimulated to produce ideas	Challenge Nature (partly) Support (partly)	Dynamic Stimulating Unexpected	Equality	Unusual/fun Stimulating senses
Interaction	A sense of being connected to others	Coherence (partly)	–	Collectivity	Technology interface for collaboration Disengaged (partly)
Privacy	A sense of being excluded from the presence and view of others (after Aiello, 1977)	Coherence (partly)	–	–	Disengaged (partly)
Relaxation	A sense of recovering and being relaxed	Nature (partly)	Cozy	–	Relaxing Disengaged (partly)

Note: Items from McCoy and Evans' (2002) taxonomy relate to the five subconcepts as follows. *Freedom*: This place would give me a sense of independence (Freedom in McCoy and Evans' taxonomy). I would feel open to new experiences here (Freedom). I could do anything I want to here (Freedom). *Inspiration*: This place could prompt my curiosity (Challenge). I would feel intellectually stimulated here (Challenge). I could tackle complex issues here (Challenge). I could come here for inspiration (Nature). This place would encourage me (Support). *Interaction*: I would feel "together" here (Coherence). *Privacy*: I would feel at home here (Coherence). *Relaxation*: This place would give me a sense of personal peace (Nature). I would feel refreshed here (Nature).

and interaction spaces enhance exploration. The seating arrangement of furniture may suggest a sociable setting that stimulates interaction (McCoy & Evans, 2002).

Privacy

When a person in the physical environment perceives the meaning *privacy*, the person may feel a sense of having control over visual and auditory exposure, which may contribute to the experience of high psychological privacy (Wohlers & Hertel, 2017). Research that compares traditional individual offices with open-plan offices has paid much attention to the privacy meaning of spaces. Traditional offices provide more privacy than open-plan offices (Kim & de Dear, 2013; Samani, Rasid, & Sofian, 2014).

Combination of Meanings

In a nature space, people may perceive not only inspiration but also freedom, relaxation, and privacy. For example, in a study by Plambech and Konijnendijk van den Bosch (2015) with creative professionals, one person expressed nature's freedom as: "Just the thought that nature does not want anything from me, it is just there. I can feel that it connects me to the state of mind that I have when I am creative" (p. 259). Another person expressed nature's relaxation as "[w]hen I walk around in the garden, I become calm and loaded with energy – something which can be used when I am creative" (p. 259). One of the digital artists studied by Hoff and Öberg (2015) expressed the privacy and relaxation meaning of nature:

> at the moment, whenever I have a problem that I need to solve I need to go to somewhere quiet where I can think, which usually is the bathroom at the moment. But I'd prefer sitting in a quiet area where there are less environmental distractions, like under a tree or a plant to relax and really think about a solution. (p. 1896)

Hoff and Öberg (2015) also conclude that a window view to nature is preferred over any other view, and over no window.

In a built environment, different meanings of the physical environment can be combined by providing spaces with different meanings that people can select, such as in flexible buildings with dedicated rooms for privacy, inspiration, or interaction (Wessels, 2017).

Objective Environment and Meaning

Few systematic studies exist on how people perceive the meaning of an objective environment. Both McCoy and Evans (2002) and Ceylan, Dul, and Aytac (2008) photographed a variety of office and learning spaces and asked reviewers to rate each space according to the extent to which predefined meanings are present, but did not link these meanings directly to creativity. In other studies, researchers themselves have linked the physical environment to supposed meanings, but also did not link these meanings to creativity directly (White & Lorenzi, 2016; Kallio et al., 2015, Lee, 2016). People may also give a meaning to a virtual space. Guegan and colleagues (2017) compared three spaces (virtual creative space, virtual control space, and real control space) in which subjects were performing a creative task. By calculating a total meaning score from a selection of McCoy and Evans' (2002) conducive meaning items (see Table 23.2), they showed that the virtual creative space had higher conducive meaning score than the two control spaces and had higher levels creativity in terms of fluency, originality, and elaboration.

Summary

In summary, the physical environment can prompt perceived meanings such as freedom, inspiration, interaction, privacy, and relaxation, which can be beneficial for a person's creativity.

Path 3: "Nice to Have" – The Physical Environment and Mood for Creativity

Path 3 of the "triple path" framework considers "nice to have" physical characteristics that influence a person's mood. The (psychological) literature suggests that mood can be a driver for creativity (see Baas, Chapter 12, this volume). Mood is a relatively diffuse, generalized affective state that typically lacks a particular object relation (Davis, 2009). Gorp (2012) added that "with emotions changing from moment to moment, moods describing the pattern of emotional responses over the short term" (p. 46). Mood can be positive or negative. Many researchers suggest that positive mood has a positive effect on creativity (e.g., Amabile et al., 2005; Davis, 2009; Baas, De Dreu, & Nijstad, 2008; Dul & Ceylan, 2011; Isen, Daubman, & Nowicki, 1987). However, it has also been argued that negative mood can foster creativity (e.g., George & Zhou 2002, 2007; Kaufmann, 2003). Russ and Fiorelli (2010) stated that "[r]esearch on mood states and creativity finds that positive affect, and at times negative affect, enhances the creative process . . . Although the mechanisms are not clear, the consensus is that the involvement of emotions broadens the process of associations and improves creativity on a variety of creativity measures" (p. 237). To explain the contradictory finding in the literature about the effects of positive and negative mood on creativity, Baas (Chapter 12, this volume) argues that positive or negative moods that activate people (positive: happiness; negative: anger) have a positive effect on creativity, whereas positive or negative moods that deactivate people (positive: relief; negative: sadness) have no or a negative effect on creativity.

Most studies on the link between the physical environment and creativity via mood focus on the effect of specific physical elements on positive or negative mood, without considering the activation level. These physical elements include ambient conditions (e.g., light, sound, smell, and color) and artifacts (e.g., plants and furniture), which will be discussed below.

Ambient Conditions

Light

The effects of *light* on mood has been much studied. There seems to be consensus that *daylight* is preferred over *artificial light* (e.g., Ceylan et al., 2008; Galasiu & Veitch, 2006; Hoff & Öberg, 2015; McCoy & Evans, 2002). The effect of *artificial light* on mood is unclear because the available studies show inconsistent effects of illumination level and color temperature on mood. Knez (1995) found that warm white light induces more positive mood and better creative task performance but the relationship is less clear in other studies (Knez, 1995, 2001; Küller et al., 2006; Kwallek, 1997; Kwallek & Lewis, 1990; Spivcak et al., 2009). For example, Steidle and Werth (2013) found that manipulating artificial light does not influence mood. Also McCoy and Evans (2002) and Ceylan and colleagues (2008) found contradictory results on the effect of quantity of light on creativity, which may have been caused by individual differences, different types of spaces, or otherwise.

Sound

A positive *sound* (music, nature sounds) can induce a positive mood. Listening to music while performing a creative task has a positive effect on mood and arousal and, subsequently, results in a positive effect on self-rated task performance, including creativity (Lesiuk, 2005). Sounds from nature, such as the wind sighing in the trees and the twitter of birds, support restoration, that is, recovery from stress (Jahncke, Eriksson, & Naula, 2015).

Smell

Smell is a strong "mood inducer" (Leenders et al., 2016). Both positive and negative relations of smell on mood have been observed. For example, negative smells (e.g., sodium-sulfide: rotten eggs) induce a negative mood (e.g., Knasko, 1992; Weber, & Heuberger, 2008) and positive smells (e.g., lemon, melon, lavender) induce a positive mood (Leenders et al., 2016). No consistent results are found for the subsequent link of mood with creativity.

Color

The *color* in the physical environment (e.g., on walls, on artifacts) may influence a person's mood. Warm *colors* (e.g., red, yellow) and cold colors (e.g., blue, green) may have different effects on mood. People may have a slightly more positive mood in a blue rather than a red space (Stone, 2001) but Küller, Mikellides, and Janssens (2009) found no difference between a creative performance in a blue room or a red room. Lichtenfeld and colleagues (2012) found better creative performance with green color in comparison to white, gray, red, and blue colors. McCoy and Evans (2002) found that cool colors are negatively related to creativity, whereas Ceylan and colleagues (2008) found that cool colors are positively related to creativity. It appears that large individual differences exist on the effect of color on mood and creativity

(Kwallek et al., 1997, 2007) and that the effects on average are small (Ainsworth, Simpron, & Cassell, 1993). Therefore, although color can have an important impact on people's mood, motivation, and behavior (Elliot & Maier, 2014; Kombeiz & Steidle 2018), no general conclusions can be drawn. Hence, a creativity-enhancing environment could allow people to select/control the color that fits them (Ceylan & Dul, 2019).

Combination

Few studies investigate the effect of a combination of several ambient mood inducers on creativity. In three studies (Dul & Ceylan 2011; Landry, 2012; Lukersmith & Burgess-Limerick, 2013), respondents rated the perceived importance of four ambient physical elements that are supposed to be mood inducers (light, sound, smell, and color) for enhancing creativity. The results of these studies are summarized in Table 23.3.

Artifacts

Plants

(Potted) *plants* may have a positive effect on positive mood but the effects on creativity via this path seem not to be strong (Larsen, Jumeno, & Matsumoto, 2016; Shibata & Suzuki, 2001, 2002). It may be that the positive effect of plants on creativity (Ceylan et al., 2008; McCoy & Evans, 2002) is primarily realized via the meaning path (path 2). The color and shapes of plants can be a source of

Table 23.3 *Perceived importance of mood-inducing physical elements for enhancing creativity*

Element	Dul & Ceylan (2011) (1–7 scale; >2000 international respondents)	Lukersmith & Burgess-Limerick (2013) (1–7 scale; 361 Australian respondents)	Landry (2012) (percentage of times mentioned; 129 Canadian respondents)
Light			
Daylight	5.68 (1)	5.38 (1)	–
Daylight and view	–	–	64 (1)
Quantity of light	5.56 (2)	5.31 (2)	–
Artificial lighting	–	–	21 (2)
Sound	5.12 (3)	4.96 (3)	–
Smell	4.65 (4)	4.41 (4)	–
Color			9 (3)
Inspiring colors	3.89 (5)	3.41 (5)	–
Calming colors	3.65 (6)	3.29 (6)	–

Note: Rankings given in parentheses.

inspiration (Hoff & Öberg, 2015; Plambech & Konijnendijk van den Bosch, 2015; Shibata & Suzuki, 2002) or of relaxation (Bringslimark, Hartig, & Patil, 2009).

Furniture

Other artifacts can enhance creativity via mood. For example, aesthetically designed *furniture* may induce a pleasant activating mood and therefore may contribute to creativity. The use of natural furniture materials (e.g., wood) may positively affect mood and creativity as well (Ceylan et al., 2008; McCoy & Evans 2002; Ridoutt, Ball, & Killerby, 2002).

Summary

From the studies discussed, it appears that ambient conditions and artifacts can have an effect on positive or negative mood but the subsequent effect on creativity is not very clear. One reason may be that other dimensions of mood than just valence (positive/negative) play a role, such as activation/deactivation and approach/avoidance (Baas, Chapter 12, this volume). Also it is possible that large individual differences exist regarding the effect of ambient conditions and artifacts on mood and creativity. The light, sound, smell, color, or presence of artifacts that is optimal for one person may be too much, too little, or distracting for another person. This relates to the functional requirement (path 1) of the physical environment: the ambient conditions and artifacts must be functional in terms of instrumental functionality (e.g., enough light to be able to perform the creative tasks), distraction-free (e.g., avoiding distracting sounds), and adaptable (e.g., to avoid individually perceived distractions). Only if these necessary conditions are met is it possible that ambient conditions and artifacts can enhance creativity as a nice-to-have factor. Hence, the ambient conditions and artifacts in the physical environment can induce a mood that is conducive for creativity but their effects via other paths (functionality, meaning) may be more important to ensure and enhance creativity.

Conclusions

The interest of researchers and practitioners in the physical environment as a creativity-contributing factor is relatively new. The available evidence is therefore still limited yet seems to justify the statement that the physical environment indeed affects creativity. The physical environment affects creativity via a Functionality path (the physical environment must be instrumental, adaptable, and distraction-free), via a Meaning path (the physical environment gives a sense of freedom, inspiration, interaction, privacy, and relaxation) and via a Mood path (the physical environment induces a positive activating mood). According to the "triple path" model, the physical environment's provision of Functionality is a necessary condition for creativity ("must-have") whereas the provision of Meaning and Mood are "nice to have." Without having Functionality in place, high creativity is not possible and adding Meaning and Mood has no effect. The purpose of the “triple path” theoretical framework is to classify and integrate available knowledge that is scattered in a variety of research fields. It is clear that the framework needs further development and testing.

The framework suggests that the creativity of anyone in any physical environment can be enhanced when an optimal environment is provided. The user can be an individual who is in school, at work, at home, or in the public domain, and performs everyday activities. When the physical environment is closer to optimum, the everyday activity and its outcome can be more creative. The proposed framework may inspire researchers and practitioners, from indoor design, architecture, human factors/ergonomics, facility management, human resource management, operations management, and so on, to analyze, design, and manage the physical environment for enhancing creativity.

From the available evidence, it becomes clear that a one-size-fits-all solution does not exist. The optimum physical environment depends on individual needs and on the phase of the person’s creativity process. “Freedom” appears a core characteristic: the person must feel free, the person must be able to adapt the environment to individual needs, and the person must be able to choose the environment that best fits the creativity phase.

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PART IV

Creativity in the World

Collaborative Creativity

24 Improving Creativity in Organizational Settings

Applying Research on Creativity to Organizations

Roni Reiter-Palmon, Kevin S. Mitchell, and Ryan Royston

Creativity and innovation have been claimed to be a critical force in organizational performance and survival (Dess & Picken, 2000; Ford & Gioia, 2000; George, 2007; Mumford & Hunter, 2005; Shalley, Zhou, & Oldham, 2004). Changes in technology, globalization, and increased competition have all created an environment in which creativity and innovation are needed to cope with situational demands, economic pressures, and frequent changes (Mumford, Scott et al., 2002; Shalley et al., 2004; West et al., 2004; Woodman, Sawyer, & Griffin, 1993). A recent survey by IBM (2010) indicated that addressing rapid changes and uncertainty is viewed as commonplace for managers and therefore one of the most important skills for managers is that of creative thinking. Consequently, it is not surprising that organizational researchers have increasingly been interested in understanding the antecedents of creativity in organizations.

Creativity has typically been defined by focusing on the creative product. Specifically, creativity has been defined in terms of the production of a "novel product, idea, or problem solution that is of value to the individual and/or the larger social group" (Hennessey & Amabile, 2010, p. 572). From an organizational perspective, this focus on the product or outcome is important, as creative ideas that are not implemented are not beneficial for the organization. As a result, research and practice in the area of creativity and innovation within a business setting focus not only on developing creative ideas but also on the implementation of such ideas.

One important distinction that exists in the management and I/O literature is between creativity and innovation. Similar to the variety of definitions that exist regarding creativity, there is also some variation in how these two are defined in relation to each other. Some researchers use these terms interchangeably. Others suggest that creativity involves the generation of ideas, whereas innovation includes both idea generation and implementation (Anderson, De Dreu, & Nijstad, 2004). Finally, others suggest that creativity is viewed as the generation of ideas and solutions, whereas innovation is defined as the implementation of these ideas and solutions in the organization (Anderson, Potocnik, & Zhou, 2014; West, 2002). Anderson and colleagues (2014) define creativity and innovation at work as the following:

> the processes, outcomes, and products of attempts to develop and introduce new and improved ways of doing things. The creativity stage of this process refers to idea generation, and innovation refers to the subsequent stage of implementing ideas

> toward better procedures, practices, and products. Creativity and innovation can occur at the level of the individual, work team, organization, or at more than one of these levels combined, but invariably result in identifiable benefits at one or more of these levels of analysis. (p. 2)

The definition proposed by Anderson and colleagues (2014) underscores a few issues. First, as noted, they differentiate between creativity and innovation. However, creativity here is defined as idea generation and no (or limited) attention is given to processes that occur prior to that, such as problem identification and construction (Reiter-Palmon, 2018). Second, the focus here is on the outcome and the benefits that will result to the organization. This provides the framework that organizations use to evaluate various approaches to improving creativity and innovation.

In addition, this definition makes it clear that creativity and innovation are viewed as complex and multifaceted phenomena that need to be studied across multiple levels, such as the individual, team or department, and organizational level (Anderson et al., 2014; Mumford & Hunter, 2005; Reiter-Palmon, Herman, & Yammarino, 2008). As such, it is not surprising that findings regarding the factors that facilitate creativity cut across all these levels. However, it has been suggested that the factors that facilitate creativity in one level may be detrimental at another level (Mumford & Hunter, 2005; Reiter-Palmon, de Vreede, & de Vreede, 2013). These two issues, the need to understand creativity and innovation from a multilevel perspective and the notion that factors that are beneficial at one level may not be at another, will be covered within the sections that follow.

There are several ways in which organizations can facilitate creativity. At the individual level, creativity and innovation can be enhanced in two ways. First, organizations can choose individuals who are creative, that is, those individuals who have proven to be creative or have the potential to be creative based on a number of individual difference variables such as personality and motivation (Hunter, Cushenbery, & Friedrich, 2012). The selection for creativity can be based at the individual or team level (Hunter, Neely, & Gutworth, 2018). Second, training for creativity has been viewed as another avenue by which organizations can improve creativity, as research suggests that creativity can be trained (Scott, Leritz, & Mumford, 2004). At the team and organizational level, several important contextual issues have been suggested as ways to facilitate and enhance creativity. One is a focus on team or organizational culture that facilitates creativity (Hunter et al., 2007). Another important issue is that of the rewards provided to creative individuals. Understanding the resources required for creative performance is also an important organizational determinant and, finally, team composition, especially team diversity, can be used as a way to enhance creativity. Across all of these aspects, at the individual, team, and organizational levels, leaders play an important role (Mumford & Hunter, 2005; Reiter-Palmon, Wigert, & de Vreede, 2011). It is not surprising that there is a significant amount of research focusing on ways in which leaders can enhance creativity, either directly or indirectly through their effect on selection, training, culture, team diversity, rewards, and resources.

Selecting for creativity

The Society for Industrial Organizational Psychologists (SIOP, 2003) defines personnel selection as any procedure or measure that is used to make employment-related decisions. These decisions can range from who to hire to who to promote and who is included in specific training programs. At its core, the selection process should be able to differentiate applicants who will successfully perform the desired task versus those who may be unsuccessful (Polyhart, Schneider, & Schmitt, 2006). To this end, increasing creativity and innovation within an organization could be influenced by selecting for individuals that display creative skills and abilities. Selecting individuals, team members, and leaders for creative endeavors requires organizations to understand the antecedents of creative performance, including how contextual factors influence these relationships.

Selecting Individuals and Teams

The effectiveness of creative teams is influenced by a variety of characteristics held by the individual members. Some important predictors of individual-level creativity include cognitive ability such as intelligence or creativity-specific processes such as divergent thinking (Silvia, 2008; Sternberg, 1997). For effective application of these creative cognitive processes, the individual must possess knowledge and expertise in the domain of interest (Vincent, Decker, & Mumford, 2002). In addition, personality factors such as openness (Batey & Furnham, 2006; George & Zhou, 2001) and intrinsic motivation (Amabile & Pratt, 2016; Zhang, Zhang, & Song, 2015) have shown positive relationships with creative outcomes. Openness to experience has shown particular strength at predicting individual creativity (Feist, 1998; Furnham & Bachtiar, 2008; Hornberg & Reiter-Palmon, 2017; Patterson & Zibbarras, 2017). Other individual differences of importance for predicting creative performance include creative self-efficacy (Tierney & Farmer, 2002), mindsets of creativity (e.g., Hass, Katz-Buonincontro, & Reiter-Palmon, 2016; Karwowski, 2014; Royston & Reiter-Palmon, 2017), and creative personal identity (Karwowski, 2011). Past research has determined the efficacy of each of these variables as predictors of creativity, as well as showing that each can be measured in a reliable and valid way. However, predicting individual creativity is complex and requires multiple assessments and components (e.g., Batey & Furnham, 2006; Furnham & Bachtiar, 2008; Hunter et al., 2012; Runco, 2004); thus, a combination of well-established measures (e.g., divergent thinking, intrinsic motivation, and creative self-efficacy) may yield better results than a single measure for creativity. In addition to the use of well-established measures of psychological constructs, biographical inventory measures allow organizations to identify individuals who are open to experience, willing to take risks, and demonstrate proactivity in engaging in creative endeavors as evidenced by past experience producing creative products (Malakate, Andriopoulos, & Gotsi, 2007). Beyond formal and well-established measures of creativity, organizations such as Amazon and Google have sought to identify creative individuals through other approaches such as nontraditional interview items that require flexible thinking and adaptive problem-solving (Jaussi & Benson, 2012). However, as Jaussi and Benson further point out, there is little research on the validity of some of these nontraditional methods of identifying creativity.

Although selecting creative individuals into specific jobs and positions can have benefits to the organizations, it is also important to consider how this selection influences the team. Much of the work conducted in organizations is done in teams, which is true of creative work as well (Reiter-Palmon et al., 2011). When considering how creative individuals effectively function in a team environment, a variety of other characteristics related to social interactions should be considered during selection in addition to creativity. Teams composed of creative individuals often benefit in terms of creative problem-solving due to obtaining multiple perspectives, increased knowledge, and more varied expertise. However, creative individuals also tend to be independent, competitive, critical, and introverted, which may increase incidences of conflict with other team members (Feist 1998; Silvia et al., 2011). Placing too much emphasis on individual predictors of creativity during selection may not allow creative teams to fully realize the benefits of each member's ability because of the danger of noncohesive working relationships (Hunter & Cushenbery, 2015). Therefore, when focusing on selecting for team creativity, it is useful to also consider individual differences that promote teamwork, such as the ability to appropriately handle conflict and communicate effectively (Salas, Sims, & Burke, 2005). Specifically, communication, information sharing, trust, psychological safety, and collaboration have been identified as important mechanisms that facilitate creative work in teams (Reiter-Palmon et al., 2011). Individual difference characteristics can also have an effect on these social processes. For example, willingness to participate and collaborate with others are important individual characteristics that influence team creativity (Janssens & Brett, 2006). Participation refers to the level of effort that each team member will put forth in accomplishing team goals or tasks (Kahai, Sosik, & Avolio, 2003). Willingness to collaborate in creative teams is critical because creative tasks are frequently ambiguous, complex, and require teams to work interdependently (Burke et al., 2006). When teams are composed of individuals who are highly collaborative and participative, they tend to be better able to transform complex ideas into outcomes and products (De Dreu, Carsten, & West, 2001). Increased willingness to collaborate and cooperate with others is related to creative performance due to elaboration and evaluation of ideas presented by others (Mathieu et al., 2008).

In addition to the ability to work well in a team environment, another consideration is the creation of teams with diverse knowledge, experience, and expertise. The use of interdisciplinary teams is a result of the rapid change and adaptation required to ensure organizational success and survival, as well as the complex problems that organizations face (Kozlowski & Bell, 2008; Rosen et al., 2011). Therefore, organizations must also consider the diversity of knowledge and expertise of the team members. As a result, it is not enough to simply consider individual creativity during the selection process, but to consider the context in which that individual will work and how the context will allow that individual to effectively demonstrate their creativity. As creative individuals must often work in groups, it is necessary to consider how well individuals work with others in social contexts.

An example in an organizational context highlighting the importance of ensuring team members possess not only creative ability but also critical team and social skills is that of Pixar's "Braintrust." This team was composed of individuals working within the organization who served as outside critics of movie projects and provided feedback that was unbiased by involvement in the production. They also provided help with creative problem-solving. Ed Catmull, one of the co-founders of Pixar, was adept at ensuring teams were made up of individuals who were not only highly creative but also worked together well. Catmull (2014) describes the environment of the Braintrust as one of shared trust and psychological safety in which each member could share ideas and provide constructive criticism without the others belittling them or becoming defensive. He recognized the importance of selecting creative individuals who would work efficiently together in a team setting. For this reason, Steve Jobs, though another co-founder of Pixar, was prohibited from participating in the Braintrust because Catmull recognized that other group members would neither share ideas in his presence nor criticize his ideas even when they disagreed with him. Consequently, creative individuals working in team environments should not only be highly creative but be willing to collaborate and work interdependently with others to accomplish creative tasks.

As discussed, myriad predictors can be used when selecting for creative individuals. Selecting for individuals who are high in openness to experience, creative abilities, confidence in their creative abilities, and with experience in creative production allows organizations to ensure they are hiring individuals who can enhance the problem-solving effort. However, it is critical to ensure that the context in which these individuals work is considered. When working in team settings, it is important that individuals effectively collaborate, communicate, and cooperate with one another, as well as engage in appropriate task conflict to facilitate the creative effort.

Leadership and Selecting for Creative Leaders

Not only have we seen an increased focus on identifying individual- and team-level creativity but companies are increasingly searching for leaders who can lead creative individuals and teams. Executives have pointed to the need for leaders to be creative, often crediting creativity and innovation as a key competitive edge in the marketplace (IBM, 2010). Many of the individual and team-level predictors discussed above also apply when selecting leaders of creative teams; however, additional characteristics must be evaluated. Besides examining certain individual traits that are known to predict creativity (e.g., openness to new experiences), there are certain leadership skills and behaviors that have been shown to positively impact subordinates' creativity. These include manager support for creativity, creative expectations, and evaluation and implementation of creative ideas (Reiter-Palmon & Royston, 2017).

Managerial support and expectations are important factors that can positively influence employee creativity. When leaders support new ideas and promote a safe psychological space for employees to discuss original ideas, there is the potential for increased creative performance by those employees (Carmeli, Reiter-Palmon, & Ziv, 2010). Borrowing from goal-setting theory and expectation setting, we also understand that when leaders expect their employees to perform more creatively, those employees generate more creative outcomes (Carmeli & Schaubroeck, 2007; Tierney & Farmer, 2004). This matching of expectation to outcome could be viewed as some form of a creative Pygmalion effect. The positive effects on creativity seen from leader behaviors of support and expectation of creative outcomes can offer valuable insight into how an organization selects creative leaders. A leader who constructs a psychologically safe environment, is genuinely supportive of creative efforts, and sets expectations for employees to be creative is the leader an organization should consider for a creative role.

Moving from broad support and expectations, effective leaders of creative individuals and teams should facilitate the creative processes associated with creativity (Reiter-Palmon & Royston, 2017). Although much of the research on creative processes rests at the individual-level, there has been work examining how leaders influence these processes to increase their employees' creativity. Leaders who support specific creative problem-solving processes (e.g., problem construction) tend to positively influence employee creative production (Mumford et al., 2002; Redmond et al., 1993). The logic here is that if a leader can better support and guide employees at the front end of structuring the problem, then those employees will more likely produce a novel solution. Moving toward the back end of the creative problem-solving process, leaders can act as a clearing house for ideas. As a clearing house, a creative leader needs to be adept at evaluating the ideas generated by the team for quality and originality. Creative leaders supplement their employees' skills by weighing consequences and outcomes to assist in the best course of action that would ultimately lead to a creative outcome (Mumford, 1986; Mumford et al., 2007). Considering these findings from a selection perspective, organizations should strive to find those individuals who not only are generally supportive of creative endeavors but also display skills and abilities in assisting in specific creative problem-solving processes.

Personality and motivational factors also play a key role in selecting the best leaders for creativity. Openness to experience has been consistently shown to predict creative outcomes (Fiest, 1998; Hornberg & Reiter-Palmon, 2017). In regard to the other four factors of the Big Five, the relationships are not as clear; however, we propose that, for leadership purposes, extraversion and conscientiousness most likely play a role in leader creativity and leading creative individuals and teams. Extraversion has been shown to be positively related to creative performance involving others (Hornberg & Reiter-Palmon, 2017). In terms of conscientiousness, when certain rules and procedures need to be followed, as in scientific domains, we see increased creativity (Feist, 1998). Leaders who are higher in openness, conscientiousness, and extraversion may display a profile that is related to increased creativity (Mitchell & Reiter-Palmon, in press). However, these personality traits may also have the possibility of leading away from creativity. For example, a leader high in extraversion may focus on interpersonal relationships at the expense of task performance, which could lead away from creative efforts and performance.

One method by which organizations select and groom leaders is the use of high-potential programs. These programs aim to identify and develop high-potential individuals for future roles within an organization (Church et al., 2015; Silzer & Church, 2009). The programs fill a dual role of selection and training and development. Whereas most high-potential programs do not focus on creative leaders as the target, the same principles apply. In a high-potential program, organizations could place potential creative leaders in situations where they are observed and evaluated for how that individual would construct a workspace for their employees as well as how they respond to employees who produce creative products. These stretch or growth activities may also include how the leader supports specific creative problem-solving processes within the employees as well as the leader's ability to properly evaluate original ideas.

The selection of creative leaders, similar to creative individuals, can involve the use of assessments and measures of individual difference variables related to creativity. The challenge facing organizations is what makes the most sense for selecting creative leaders. From a predictor side, organizations need to consider the complexity of the selection system. Assessment centers, which have traditionally been used to select managers and leaders, may be particularly effective as they allow for the use of multiple selections, using different constructs, and the use of more realistic approaches. This way, organizations can evaluate the potential for both creative thinking and managing creative individuals and teams. Organizations may consider whether implementing a high-potential program makes sense (e.g., Silzer & Church, 2009) or emphasize the activities that comprise the most efficient selection process. Further, as is the case in selecting individuals for creative teams, characteristics that may facilitate leadership may not necessarily facilitate creativity. Organizations may need to evaluate which of these characteristics are more critical to select for, and possibly use training and development to allow individuals to acquire the rest of the important characteristics.

In short, there are a variety of methods and measures that organizations can use in the selection process. A critical note for any organization implementing processes to select for creativity is to consider how contextual and individual differences interact. Personnel selection is only one way that creativity can be influenced in the organization. Training and development is a second major way that creativity can be influenced in organizational settings. Whereas selection focuses on getting the creative people in the door or in the right positions, training and development focuses on building skills and abilities within the existing individuals, team members, and leaders.

Can Creativity Be Developed?

As organizational leaders continue to recognize the importance and competitive advantage that employee creativity has in developing innovative products, they have sought ways to increase both individual and team creativity and innovation (Sternberg & Lubart, 1999). In addition to selecting the right people into jobs, training and development have been viewed as a way for organizations to enhance the creative potential of its workforce (Marlow et al., 2018; Montouri, 1992; Scott et al., 2004).

In a meta-analysis of the effectiveness of creativity training, Scott and colleagues (2004) found that training was linked to notable changes in divergent thinking, problem-solving, creative-task performance, attitudes, and behaviors. Each of these aspects of creativity has been shown to be important to an organization's productivity, creativity climate, utilization of resources, and employee psychological well-being (e.g., Amabile, 1996; Mumford & Gustafson, 1988; Rasulzada & Dackert, 2009; Reiter-Palmon & Illies, 2004; Runco, 2004; Shalley, Gilson, & Blum, 2000).

Training that emphasizes the cognitive-processing activities that underlie creativity, such as problem identification, information gathering, conceptual combination, idea generation, idea evaluation, and implementation, appears to be most effective at increasing creativity (Mumford, Hunter, & Byrne, 2009; Scott et al., 2004). Most effective creativity training programs also share a focus on divergent thinking as a basis for instruction (Baer, 1996; Scott et al., 2004). These training programs can help individuals and teams to generate a greater number of ideas, which then increases the number of ideas that can be implemented by the team or organization (Baruah & Paulus, 2008; Birdi, 2007). Both idea generation and idea evaluation are typically desired outcomes for creativity training programs. However, Birdi (2007) found that while creativity training was indeed positively related to both idea generation and idea implementation, creativity training appeared to have a greater impact on idea generation. Further, Birdi (2007) found that environmental factors such as managerial support and organizational climate had a greater effect on idea implementation than creativity training. Therefore, despite the benefits of creativity training, organizations should ensure that environmental conditions are conducive to employees also being able to implement in their jobs what they learned from creativity training.

Teams can be trained in effective idea generation by following rules for brainstorming and learning effective ways to share information while avoiding process loss (Osborn, 1953; Paulus & Brown, 2003). Rules for brainstorming include generating as many ideas as possible, expressing any ideas that come to mind, ideation without criticism or evaluation, and combining and building on ideas to develop new ideas (Baruah & Paulus, 2008; Paulus & Brown, 2003). Teams can be trained in brainstorming rules, thus increasing the quality and quantity of ideas (Goldenberg, Larson, & Wiley, 2013; Litchfield, Fan, & Brown, 2011). Similarly, teams can be taught efficient ways to share information and make connections between the pieces of information shared (Baruah & Paulus, 2008). It has been suggested that effective idea generation may be inhibited due to process loss, in which information is lost or restricted due to limits to the amount of time that each individual may share information (DeRosa, Smith, & Hantula, 2007). Process loss often occurs because individuals are not able to present their ideas while also listening to others, which results in a decreased amount of time for individuals to share ideas (Paulus et al., 2006). Training may focus on helping teams effectively share ideas without superfluous discussion that prevents others from contributing, paying particular attention to shared ideas, encouraging each individual to share ideas to gain diverse perspectives, and making new connections with shared information (Dugosh et al., 2000; Goldenberg et al., 2013; Paulus et al., 2006).

Additionally, it is useful to train individuals to properly define problems and identify relevant information related to the problem. Basadur (2004) pointed out that people often are quick to move on to evaluative stages of problem-solving rather than gaining a complete understanding of the problem. Hasty evaluation and inadequate problem definition is problematic because individuals often narrow the problem too soon and may miss the overall goal or objective (Basadur, 2004). This problem can be increased in group settings when influential individuals such as the leader or a dominant personality steers the problem-solving process and other group members do not feel comfortable speaking up (Cronin & Weingart, 2007; Reiter-Palmon et al., 2011). Creativity training may focus on helping teams to pay attention to ideas presented by all group members, to encourage reticent group members to speak up, to question their own assumptions about how they approach the problem, and to actively engage in combining their own ideas with those of their teammates (Harvey, 2014; Mobley, Doares, & Mumford, 1992; Mumford et al., 1997).

Successful problem-solving also requires teams and individuals to effectively evaluate and implement ideas. Idea evaluation includes appraising ideas against standards and determining whether any ideas from the generation phase should be implemented or revised, or otherwise rejected (Mumford, Lonergan, & Scott, 2002). Teams and individuals should be taught to integrate and synthesize information to develop a complete solution. Training in idea evaluation may include strategies for questioning assumptions, combining information and ideas together in new ways, and ensuring that each member has provided information on the problem (Harvey, 2014).

Creativity training may also take the form of teaching employees to work and produce within constraints. Organizational settings often present a series of challenges to effective creative problem-solving, thus employees may benefit from training that teaches them strategies for identifying and working within constraints imposed by the workplace (Miron, Erez, & Naveh, 2004; Peterson et al., 2013). Constraints common to the workplace may include time pressures, availability of resources, individual skills or capacities, and the level of supervisory or team support for creativity (Li, 1997; Mandal, Thomas, & Antunes, 2009; Mueller & Kamdar, 2011). Peterson and colleagues (2013) suggested that providing training on working within constraints may also increase individual creative self-efficacy and motivation, which then increases creative problem-solving performance.

In addition to creativity training that emphasizes cognitive processes and working within the organizational environment, creativity training can focus on the individual by increasing positive attitudes toward creativity or increasing individual characteristics related to creativity such as openness to experience, creative mindsets, or creative self-efficacy, which in turn increase their creative performance

(Karwowski, 2014; Tierney & Farmer, 2002). Creative self-efficacy, or individual beliefs in their own creative capacity and their confidence in handling tasks that require creativity, has received a great deal of attention as an individual characteristic that is associated with creative performance and can be increased through training (e.g., Tierney & Farmer, 2002, 2011; Karwowski, 2014, 2016). One way that organizations can increase individual confidence in their creative ability is training them to be confident in taking the initiative to seek out or anticipate potential problems, changes, or opportunities (Basadur, 2004; Miron et al., 2004). Basadur (2004) pointed out that, oftentimes, individuals wait for others, such as their leader, to identify problems. However, when individuals are comfortable taking the initiative and comfortable taking interpersonal risks, teams can benefit from considering multiple perspectives and approaches to the problem (Bradley et al., 2012; Jehn, 1995).

In regard to increasing positive individual attitudes toward creativity and receptivity of training, one issue is determining how individual differences influence the effectiveness of the training. Individual differences such as motivation and creative self-efficacy may present challenges in employee engagement in the training (Jaussi & Benson, 2012; Kabanoff & Bottger, 1991). When training is offered as an optional opportunity, individuals who are already highly creative or experience a high level of intrinsic motivation may self-select into the program, which may create a ceiling effect on how effectively the training increases individual creativity (Kabanoff & Bottger, 1991). Similarly, organizations may have difficulty making creativity training appealing to individuals who do not identify as creative individuals or those who do not see creativity as being important to their everyday tasks (Jaussi, Randel, & Dionne, 2007). Therefore, organizations should carefully consider how to enhance the creative self-identity and motivation of individuals who do not strongly identify as a creative individual, while simultaneously providing opportunities for creative individuals to further enhance their creative abilities. Finally, creative mindsets, or viewing creativity as malleable and changeable and therefore trainable, rather than fixed and therefore not trainable, is likely to be related to the degree to which individuals would benefit from training (Makel, 2009; Royston & Reiter-Palmon, 2017). Specifically, it is expected that those that view creativity as malleable, will be more likely to self-select into creativity training and also gain the most benefit from training (Royston & Reiter-Palmon, 2017).

Developing Creative Leaders

Similar to personnel selection, developing creative leaders builds on many of the individual- and team-level constructs discussed in the previous sections. In a leadership sense, many of the training interventions that could yield benefits involve how that leader can best foster creativity within their workers and workspace.

Returning to our discussion on managerial support, it is important for leaders to support their employees' creative endeavors. When leaders are more supportive of employees engaging in creativity, those employees perform more creatively (e.g., Barnowe, 1975; Amabile et al., 2004). If personnel selection is not the primary intervention of choice for supporting creativity, then soft-skills training could provide a leader with increased understanding of how to foster more creative production given specific leadership behaviors. For example, leaders can be taught how to provide feedback in a way that is constructive and facilitates creativity, how to create an environment in which team members feel comfortable sharing ideas, and how to show support for creativity (Carmeli et al., 2010, 2013).

Outside of supporting creativity, creative leaders must be able to recognize creative ideas and the products that come from them. As discussed, training that focuses on the cognitive processes underlying creativity appears to impact creative outcomes (Mumford et al., 2009; Scott et al., 2004). When combining this with the research that leaders who support specific processes increase creativity among their employees, training that helps leaders better understand the cognitive process should yield positive results that mimic the individual-level results. In addition, leaders have a particular need for training during the convergent stages of creative problem-solving, as they are frequently responsible for ensuring that the team effectively identifies and elaborates on solutions (Gebert, Boerner, & Kearney, 2010). For this purpose, organizations should ensure that leaders are trained in standards used to judge the effectiveness of solutions and are adept at leading team problem-solving efforts (Reiter-Palmon et al., 2008).

Further, leaders are often faced with organizational problems that are paradoxical, that is, situations that require solving issues or concerns that may be conflicting. These paradoxical situations may force leaders to engage in more short-term resource exploitation or longer-term resource exploration (Lewis, 2000; Smith, 2014; Smith & Lewis, 2011). Combining these actions of exploiting and exploring has been termed *ambidextrous leadership* and this balancing act of engaging paradoxical situations has been shown to relate to innovation (Zacher & Rosing, 2015; Zacher, Rosing, & Rosing, 2014). From a training perspective, leaders who are better able to recognize their options and leverage resources in an ambidextrous way should lead to increased innovation. To this end, leaders who are made aware of how to identify paradoxical situations and ways in which to leverage for exploitation/evaluation may show gains in innovation (see also Mumford, Martin, Elliott, & McIntosh, Chapter 25, this volume).

Resource allocation may be another fruitful area for training leaders to be more innovative. Leaders are perceived as the ones responsible for procuring and distributing resources. This allocation of resources can build on the overall strategy implemented by the leader and can build on their skills to engage those paradoxical situations in an ambidextrous way. Research has shown both that too little resources can lead to innovation (Kanter, 1985; Ohly & Fritz, 2010; Scott & Bruce, 1994) and that adequate resources can lead to innovation (Amabile et al., 1996; Sonenshein, 2014). In fact, resource availability may have a curvilinear relationship with innovation (Mumford & Hunter, 2005) or certain resources may be viewed and used in a creative way (Sonenshein, 2014). To this end, leaders trained in managing and allocating resources may lead to increased creativity in their employees. This notion of training leaders in resource allocation does have some traction. In an article by

Henry Doss (2013), he argues that innovation leadership training fails because the company focuses on training to lead others rather than building and leading systems. Consequently, organizations should not only focus on training leaders how to lead a team of individuals but help them recognize and consider how the team interacts with the greater organization.

To this point we have discussed selecting and training individuals for creativity. Further, we have highlighted important considerations when an organization is selecting into a team or selecting a leader for a creative role – as well as training teams and leaders in creativity and innovation. We shift to a broader context now with a review on how organizational factors influence creativity and innovation.

Broader Organizational Interventions

As a result of the numerous benefits of creativity and innovation in the workplace, researchers and organizations alike have explored ways to enhance organizational creativity, including encouraging creativity through incentives, team diversity, shaping organizational climate, and resource allocation (Scott et al., 2004).

Team Diversity

Teams have been studied as a context in which individuals can thrive and be creative (Reiter-Palmon et al., 2013). Team composition, specifically the diversity of the team, has long been considered an important factor that should facilitate creativity (Hulsheger, Anderson, & Salgado, 2009; Woodman et al., 1993). Early work in the area of team composition and creativity assumed that diversity in team composition would be beneficial, resulting in increased creative output of teams, as a product of the diverse knowledge and experiences of the team members (Guzzo & Dickson, 1996; McLeod, Lobel, & Cox, 1996). However, research suggests that the impact of team diversity is much more complex (Hulshger et al., 2009; Reiter-Palmon et al., 2011). Research focusing on demographic diversity, that is, diversity based on age, gender, race, and the like has found mixed results in relation to creativity. For example, O'Reilly, Williams, and Barsade (1997) found moderate positive effects for racial diversity on creativity and innovation; however, gender and tenure diversity had no effect, while Curseu (2010) found that team diversity (defined as gender, age, and national diversity combined) was moderately and positively related to the creativity of team output. On the other hand, Paletz and colleagues (2004) reported no differences in creativity between ethnically diverse and ethnically homogeneous teams and McLeod and colleagues (1996) found ethnic diversity to hinder team creativity. Choi (2007) found that groups diverse in terms of gender were less creative, whereas groups with age diversity were more creative. Adding to the complexity, Baer and colleagues (2008) found that demographic diversity was negatively related to team creativity in an initial task but not in a later task.

The results of this research paint an inconclusive relationship between demographic diversity and creativity.

In an attempt to explain how diversity can sometimes be positively related to creativity and at other times negatively related to creativity, Li and colleagues (2017) evaluated the role of valuing diversity. They found that the cultural diversity of teams was related to increased creativity and even more so when teams viewed diversity as important. The importance of viewing diversity as important and positive was also underscored in a study by Homan and colleagues (2015), which found that diversity training for teams facilitated creativity in nationally diverse teams, especially for teams that did not value diversity before the training. That is, training that was designed to facilitate understanding and acceptance of diversity improved creativity for diverse teams that did not hold these views prior to training. The results of these studies suggest that the relationship between creativity and demographic diversity may be more complex than initially thought. It is possible that different variables (age vs. gender vs. ethnic diversity) will have different effects on creativity and innovation. The research by Baer and colleagues (2008) is also intriguing as it suggests that time and experience in a team may moderate the effects of diversity on creativity and innovation. In addition, perceptions about the role and importance of diversity for creativity may also shape the effect that team diversity has on creativity.

Demographic diversity is easily detected and observed and therefore may be more salient. However, differences based on attributes that are relevant to job performance, such as diversity in education, function in the organization, and job-relevant knowledge, skills, and abilities (termed functional diversity), while not initially salient, are more likely to influence team creativity (Milliken, Bartel, & Kurtzberg, 2003; Woodman et al., 1993).

Most research evaluating functional diversity found positive effects for functional diversity, suggesting that teams comprised of members from different and diverse functional backgrounds outperform homogeneous teams in terms of creativity and innovation (Choi, 2007; Fay et al., 2006; Keller, 2001). However, Ancona and Caldwell (1992), using forty-five new product teams, found that functional background diversity was related to lower evaluations of innovation, that is, diverse teams were evaluated as less innovative. Further, more recent research using product development teams suggested an inverted-U relationship between functional diversity and creativity (Dayan, Ozer, & Almazrouei, 2017). A meta-analysis suggested that functional diversity is positively related to team creativity and innovation (Hulsheger et al., 2009). Richter and colleagues (2012) suggested that functional diversity can serve as informational resource for teams and therefore functional diversity would be related to creativity if teams are able to capitalize on these resources. Their study of 176 employees in thirty-four research-and-development (R&D) teams found that functional diversity was related to creativity for employees with higher creative self-efficacy.

The results presented here suggest that demographic diversity may not be the most effective in facilitating creativity in teams, while functional diversity may be more beneficial. However, the relationships are complex and therefore just creating diverse teams may not be the solution for improving creativity. The first issue that organizations must address is how to create diverse teams and what team diversity means. Here we discussed two specific aspects, demographic diversity and functional diversity, but even within these there are multiple dimensions. For example, a team can be diverse in terms of gender but not in terms of age, race, or culture. A team can be diverse in terms of educational background but not in terms of gender or other specific abilities. In many cases the call for diversity in teams results in a focus on demographic diversity without attention to functional diversity. Given that demographic diversity may have minimal effects on creativity (Hulsheger et al., 2009), it may be more beneficial for organizations to focus on creating cross-functional or interdisciplinary teams. As such, organizations can create teams in which different departments in the organization are represented. It is also important to think broadly about which departments may be relevant to the work performed by the team and not only include those that may be the most obvious. Similarly, when selecting individuals to work in these teams, it is important to consider multiple ways in which the team can be diverse, including demographics, but also in terms of educational background and specific knowledge and skill.

The review of the literature also suggests that team diversity may not have a direct and linear relationship with creativity. Some of the research suggests that, in order to benefit from the diversity that is present, individuals must value diversity and view it positively (Homan et al., 2015; Li et al., 2017). Others suggest that only when teams are able to overcome some of the difficulties inherent in diverse teams and capitalize on the diversity of information available will creativity result (De Dreu et al., 2011; Reiter-Palmon et al., 2013). As noted by Homan and colleagues (2015), training may be one way in which teams and individuals within teams can learn to recognize the importance of diversity and accept diversity. In addition, training may be used to mitigate some of the difficulties that diverse teams may encounter, such as difficulties in communication, developing trust, and sharing information, as well as the potential for increased conflict. All of these social processes can be trained and allow for improvement in team performance (Marlow et al., 2018). Once teams overcome the social barriers that inhibit communication and information sharing and develop trust, teams and individuals can capitalize on the diversity of information offered by diverse teams.

Finally, leaders can have a profound effect on how teams react to diversity and whether teams can overcome the social process barriers inherent in diverse teams. There are a number of ways in which leaders can facilitate the development of effective social processes and acceptance and appreciation for diversity. Leaders can model appropriate social processes such as effective communication and information sharing, as well as acceptance and appreciation of diversity. In addition, leaders can facilitate the creation of a culture of acceptance of diversity and open communication, which will be discussed next.

Organizational Climate

Organizational climate is one the most researched areas in the study of creativity and innovation in the workplace (Hunter et al., 2007). A number of theoretical frameworks have been suggested to understand the factors that contribute to a climate that facilitates creativity (Amabile & Conti, 1999; Anderson & West, 1988; Ekvall, 1996). In a qualitative review of the climate for creativity literature, Hunter, Bedell, and Mumford (2005) found that most frameworks included common dimensions such as positive relationships with peers, support from top management, challenge, autonomy, intellectual stimulation, and support for risk-taking. Similarly, a meta-analysis conducted by Hunter and colleagues (2007) found, overall, that these climate dimensions were related to creative performance of individuals and teams in the organization. Further, the strongest climate dimensions were those related to having positive relationships, intellectual stimulation, and challenge. The importance of positive relationships is not surprising given the importance of social processes such as information sharing, communication, and trust for creativity and innovation. Intellectual stimulation and challenge speak to the importance of the cognitive factors. Together, these findings suggest that a work environment in which people are presented with meaningful and challenging work and that allows for the exchange of thoughts and ideas is critical for creativity.

In addition to effects on the individual, research suggests that having a supportive team is related to team creativity. Wang and Hong (2010) found that group support for creativity led to higher team creativity and that this relationship was mediated by psychological safety. Pirola-Merlo and Mann (2004) found that team climate affected team creativity indirectly through individuals' creativity. Similarly, Kessel, Kratzer, and Schultz (2012) found that high levels of psychological safety significantly predicted team creativity and performance, with these effects mediated by knowledge sharing. Finally, Gilson and Shalley (2004) examined teams' engagement in creative processes and found that teams that were higher on engaging in creative processes also were more likely to have shared goals, valued participative problem-solving, and had an overall team climate that was supportive of creativity. Although not exclusively evaluating team climate, in their meta-analysis, Hulsheger and colleagues (2009) found moderate to strong relationships between team creativity and team psychological safety, team support for innovation, and focus on creative tasks. Finally, top management support for innovation, another climate dimension, has also been linked to creativity and innovation (Damanpour & Schneider, 2006).

Leaders have long been viewed as important creators and transmitters of organizational climate (Amabile et al., 2004; Schein, 2010; Schneider, Brief, & Guzzo, 1996). Leaders can help in facilitating more effective discussions, creating positive team interactions that would lead to increased trust and psychological safety, which in turn will lead to improved communication and information exchange within the team (Carmeli et al., 2013). Leaders have some control over workflow, work assignment, the degree of autonomy individual workers and the team have over the work, and as such can contribute to the development of a climate of creativity as it relates to intellectual stimulation, challenge, and autonomy. In addition, leaders can help employees find meaning in their work, by ensuring that workers understand the nature of their contribution and how their work fits into the organizational vision and mission. In addition, the leaders at the top of the organization – the top management teams – can develop and shape a climate for creativity and innovation through the creation of a mission and vision as well as a strategy that focuses on creativity (Isaksen, 2007).

Rewards and Incentives

The effect of rewards on creativity has been debated for a number of years. Early work and theorizing by Amabile (1982, 1996) suggested that intrinsic motivation was critical for creativity and innovation and that external motivation, including rewards, was detrimental. However, in the last two decades, the negative relationship between creativity and external rewards has been questioned (Eisenberger & Rhoades, 2001). For example, Eisenberger and Cameron (1998) suggested that rewards offer individuals information about what the organization values and what is important and therefore should facilitate creativity. Malik, Butt, and Choi (2015) found that extrinsic rewards can influence intrinsic motivation and therefore will not always negatively impact creativity by introducing extrinsic motivation. Eisenberger and Armeli (1997) found that, when rewards were large, they had a negative impact on creativity. A meta-analysis by Byron and Khazanchi (2012) found that rewards improved creativity when rewards were contingent on creative performance, when feedback regarding creative performance was provided, and when individuals are offered more control. This meta-analysis suggests that the relationship between rewards and creative performance can be positive, given certain circumstances. Adding to the complex nature of the relationship, a study by Caniels, De Stobbeleir, and De Clippeleer (2014) summarized twenty-two case studies of creative individuals in organizations and suggested that rewards may inhibit idea generation as external rewards are viewed as a form of pressure. However, extrinsic rewards were viewed as facilitating implementation of creative ideas. This study indicates that the stage of the process in which rewards are offered is also important.

In recent years, researchers and theorists have been moving away from an all-or-nothing approach to understanding the relationship between creativity and rewards. Rather, a more complex view, in which studies have focused on boundary conditions, has emerged. That is, researchers are interested in understanding the conditions that make external rewards effective in facilitating creativity (Malik & Butt, 2017). The results of these studies suggest that rewards can have a positive rather than negative influence on creativity but need to be managed carefully. Organizations hoping to use rewards to motivate employees to be creative must do so carefully so that intrinsic motivation is not hurt. Rewards should not be overly large, rewards should be provided for creative performance so that employees are clear on what is expected, and feedback about creative performance should be provided.

Resources

Another important organizational factor that can influence creativity is that of resources. Resources here refers not only to materials and funds but also to infrastructure and facilities, personnel (including having the right personnel), and time (Amabile & Gryskiewicz, 1989). The development and implementation of new ideas is time-consuming and can be expensive in terms of personnel, material, and time. As such, the availability of resources is likely to influence creativity and innovation. Klein, Conn, and Sorra (2001) found that successful adoption of innovation was related to the availability of financial resources. Dougherty and Hardy (1996) studied product development teams and found that resource availability over the course of the product development effort was related to project success. It has been suggested that slack resources may facilitate creativity by allowing for experimentation, risk-taking, and working on multiple promising projects simultaneously (Noriah & Gulati, 1996). Slack resources also allow organizations to be better prepared for changes in the environment and respond to those more successfully (Pfeffer & Salancik, 2003).

On the other hand, others have suggested that resource constraints may facilitate creativity as organizations needed to find creative ways to address problems while lacking resources (Choi & Chang, 2009; Hoegl, Gibbert, & Mazursky, 2008; Weiss, Hoegl, & Gibbert, 2011). Specifically because they lack the resources, these companies must respond creatively to market and external forces and do this quickly or the organization will not survive (Hoegl et al., 2008). In addition, it has been suggested that, while organizations that have resources available may be able to experiment and take risks, these organizations are reluctant to do so (George, 2005). In a series of four experimental studies, Scopelliti, Busacca, and Mazursky (2014) found that financial constraints led to the development of more creative products with fewer inputs and a lower budget. Mehta and Zhu (2016) found that resource scarcity resulted in less functional fixedness, which in turn resulted in greater creativity.

These contrasting findings have led to the suggestion that there is possibly a curvilinear relationship between constraints and creativity. The Goldilocks proposition of constraints suggests that too few constraints will result in the organization not being willing to develop and implement creative ideas or having too many ideas being developed, while too many constraints will result in the organization not being able to develop and implement creative ideas (Mumford & Hunter, 2005). For example, Graves and Langowitz (1993) found that, after a certain level, increased spending on R&D did lead to more new products. Noriah and Gulati (1996) also found this curvilinear relationship between resources and creativity. Medeiros, Partlow, and Mumford (2014), in an experimental study that manipulated the number of constraints participants encountered, found that too many constraints were not beneficial for creativity and that task constraints were particularly beneficial. It is therefore important for organizations to evaluate what resources are available to employees. On the one hand, too few resources may lead to difficulty in developing creative ideas, while, on the other hand, too many resources may result in the development of many ideas but ones of limited creativity. It is not clear at this point what the specific optimal level of appropriate resources is and what kind of resources (money, equipment, personnel, and information) are needed.

Conclusion

In this chapter, we have provided an overview of the various ways in which organizations can improve creativity. Table 24.1 provides an overview of the issues and recommendations for organizations. Following the theoretical and empirical work on creativity, these recommendations can be clustered around individual and contextual factors. Further, as creativity and innovation are complex phenomena, and reside at multiple levels, a multilevel approach, evaluating factors related to the individual, team, organization, and leadership, is recommended. At the individual level, selection of people into the jobs and focusing on the appropriate attributes that would facilitate creativity and innovation has been discussed. The focus with selection is the identification of individual difference variables such as openness to experience and creative ability that would facilitate creativity for individual and teams. In addition, creativity can be facilitated through training. Aspects of individual difference and team functioning that are amenable to training should be trained and developed. While other aspects of individual differences that are more difficult to change and train are best used for selection.

From a contextual standpoint, issues relating to team diversity, organizational climate, and availability of resources have been suggested as important to organizational creativity and innovation. The team diversity literature suggests that the relationship between diversity and creativity and innovation is complex. Therefore, it is important to address this complexity if organizations choose to design diverse teams as a way to improve creativity. Specifically, it is important to consider multiple ways in which teams can be creative, with a particular focus on functional diversity. In addition, it is important to find ways to manage the possible negative impact of diversity on social processes such as communication and trust, so that the positive effects of diversity may be manifested. Organizational climate is an important way in which organizations can facilitate creativity. Organizations should strive to establish a climate in which creativity and innovation are viewed as positive and beneficial and not as a negative, should provide support for innovation from all members (co-workers, supervisors, and top management), and should allow for risk and failure without negative consequences. Creating such an organizational climate typically involves leaders setting the tone, being role models, and creating an environment in which individuals feel safe. Finally, resources, broadly defined, are critical for creativity and innovation. Research suggests that having just the right amount of resources, not too much and not too little, will support creativity and innovation, and it is up to the organization to identify which resources are critical and which are not.

Table 24.1 *Summary of recommendations for improving organizational creativity*

Topic	Recommendation
Selecting for Creative Individuals	Use multiple types of measures as well as multiple constructs to select creative individuals
	Use well-established measures of constructs that have been shown to be related to creativity (e.g., openness to experience, creative self-efficacy) as predictors in the selection battery
	Balance the use of individual-level predictors of creativity with consideration of other social and contextual factors
Selecting for Creative Teams	Include measures of how an individual functions in team environments (e.g., collaboration and cooperation with others, ability to appropriately handle conflict)
	Balance the use of predictors of creativity with predictors of effective teamwork
Selecting for Creative Leaders	Selecting individuals to lead creative individuals and teams requires a focus on managerial supportive behaviors
	Select leaders based on their ability to successfully facilitate the creative process within the team
	Consider using high-potential programs or assessment center tasks to measure and track leaders for positions where they will lead creative individuals
Training Creative Individuals and Teams	Use training focused on the cognitive processes that underlie the creative process (e.g., problem identification, idea generation, idea evaluation)
	Creativity training can also focus on improving attitudes toward creativity as well as increasing beliefs in one's ability to be creative
	Train teams in effective rules for brainstorming to improve idea generation and reduce process loss. For example to pay attention to others' ideas or combine ideas with the ideas of others
	Training individuals and teams to work within constraints can help them work within limits on their resources, time, and skills
Training Creative Leaders	Develop soft-skills training focused on managerial supporting behaviors
	Organizations should help leaders understand the cognitive processes underlying creativity to better

Table 24.1 (*cont.*)

Topic	Recommendation
	understand how to support each phase of the problem-solving effort
	Train leaders to focus on how to identify, evaluate, and implement creative ideas
	Provide training on ambidextrous leadership, or combining actions aimed at short-term exploitation of resources and longer-term resource exploration
	Train leaders in effective resource allocation
Broader Organizational Interventions	Create interdisciplinary and cross-functional teams that can provide the team with a variety of experience, knowledge, and skills that improve creativity
	Train teams and leaders in the value diversity
	Create a culture of acceptance of diversity, model effective communication, promote an environment of psychological safety, and support for innovation
	Select and train leaders that will facilitate the creation of an organizational culture that is conducive to creativity
	Work to instill a culture of intellectual stimulation, challenge, and autonomy
	Implement rewards and incentives to facilitate creativity
	Ensure that creative individuals and teams have sufficient resources but not too many

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25 Leading for Creativity

A Tripartite Model

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Creativity has, at least traditionally, been conceived of as a property of the individual (Mumford & Hunter, 2005). Thus, students of creativity often focus on capacities of the individual – for example, divergent thinking (Runco, 1991) – that make creative thinking possible. Creativity, however, refers to the production of high-quality, original, and elegant solutions (Besemer & O'Quin, 1999) to complex, novel, and ill-defined, or poorly structured, problems (Mumford & Gustafson, 2007; Weisberg, 2015). People's production of creative problem solutions are of interest, of course, because they provide the basis for the production of innovative, new products and services (Ikeda & Marshall, 2016) – new products and services that promote both economic and "social" growth (Hyman, 2015; Phillips et al., 2015).

In the real world, however, the production of creative problem solutions, and the development and fielding of innovative new products and services, is no simple task. Multiple different forms of expertise must be brought to bear to understand problems and generate creative problem solutions – expertise no single individual may possess (Nijstad & Stroebe, 2006). Turning creative problem solutions into viable innovative products requires the support of many groups – from top management teams to production and marketing (Gu, Schniederjans, & Cao, 2015). The complex nature of creativity and innovation in "real-world" settings has an important, albeit often overlooked, implication – creativity and innovation in the "real-world" requires leadership (Mumford et al., 2002; Mumford et al., in press).

In this effort, we will examine how leaders, at least those effective in leadership, contribute to creativity and subsequent innovation. We will begin by describing what we mean by the term "leadership" and the impact of leaders on followers' creativity. Subsequently, we will present a model of the critical activities, or functions, that must be executed by those leading creative efforts. Broadly speaking, this model indicates that effective leadership of creative efforts requires three critical functions: (1) planning the work, (2) managing the group, and (3) selling the work to others. Each of these three functions is, however, more complex than it might, at first glance, appear. In the present effort, we will examine what leaders must do in executing each of these three key functions as they seek to encourage the development of new ideas about potentially viable new products and services.

Leadership

Leadership, and leader performance, is a complex phenomenon in its own right. Accordingly, multiple models have been used to account for leadership and performance in leadership roles. For example, leadership has been understood as a form of charisma (Mumford, 2006); as articulation of engaging, emotionally evocative visions; as positive social exchange between leaders and followers (Akinlade, Liden, & El Akremi, 2015); as transformational leadership behaviors (Judge & Piccolo, 2004) or idealized influence, inspirational motivation, and intellectual stimulation; and as structuring behavior and consideration (Kim, Eisenberger, & Baik, 2016), to mention a few. Ultimately, however, the standard definition of leadership is that it is the effective exercise of influence over others (Bass & Bass, 2008; Yukl, 2011).

Of course, there are multiple ways leaders might exercise influence – resulting in the proposal of multiple models of leadership. What is perhaps most clear, however, is that regardless of the model employed, effective leadership contributes to creative performance. For example, Keller (2006) assessed the performance of 158 research-and-development project teams with respect to outcomes such as technical quality of the work, schedule performance, cost performance, and speed to market. The extent to which leaders evidenced structuring behavior was assessed by followers. It was found that leader structuring behavior was correlated in the 0.30 range with these criteria. Other work by Barnowe (1975) also indicates that leader structuring behaviors (e.g., planning, goal setting), especially when accompanied by technical skill, were strongly positively related to creativity and innovation ($r \approxeq 0.35$) among some 900 chemists working in some fifty research and development teams.

Other work by Tierney, Farmer, and Graen (1999) has examined the impact of leader–member exchange on creativity. These researchers asked 191 research and development personnel in a chemical firm to complete a measure of positive exchange relationships between leaders and followers. They assessed the number of invention disclosures as well as managerial appraisals of employee creativity. It was found that positive exchange relationships between leaders and followers were positively related, in the mid-0.30s, to invention disclosures and managerial appraisals of employee creativity at work. Other studies by Atwater and Carmeli (2009), Lee (2008), and Qu, Janssen, and Shi (2015) also point to the positive impact of viable leader–follower exchange on follower creativity.

Shin and Zhou (2003) examined the relationship between transformational leadership and follower creativity among 290 employees and their supervisors. Creativity was assessed through managerial appraisals of follower innovative/creativity behavior. It was found that leaders evidencing more transformational behavior (e.g., intellectual stimulation) contributed to follower creativity. Other work by Shin and Zhou (2007) indicates transformational leadership contributes to team creativity. Jung (2001) has shown that transformational leadership is positively related to follower divergent thinking. Eisenbeis and Boerner (2013) also found a positive relationship between leaders' transformational behavior and the creativity of 416 research and development employees, although this sizable positive relationship was reduced if transformational leaders induced feelings of dependency in followers.

In yet another study along these lines, Černe, Jaklič, and Škerlavaj (2013) examined the impact of the variables included in yet another model of leadership, authentic leadership (e.g., sincere, ethical leader behavior). They assessed authentic leadership based on follower reports, where managers appraised the creativity of 289 followers working in research and development teams. They found authentic leadership to be positively related to measures of both individual and team creativity – producing correlational relationships in the mid-0.30s to mid-0.40s. Other research by Rego and colleagues (2012) and Ma and colleagues (2013) also indicates that ethical, or authentic, leadership behaviors contribute to follower creativity.

Creative Leadership

Taken as a whole, the findings obtained in these studies indicate leadership effectiveness is strongly positively related to creativity. Indeed, the effects of leadership appear quite robust. Measures of effective leadership are positively related to indices of invention disclosure, schedule performance, team performance, and divergent thinking, as well as managerial appraisals of creative performance. By the same token, the measures of leadership commonly employed in these studies are all based on followers' perceptions of the leader and, such perceptual measures, have only limited value in telling us what exactly must leaders do to lead for creativity (Marta, Leritz, & Mumford, 2005; Van Knippenberg, in press). Recognition of these points led Mumford and his colleagues (Mumford, Bedell-Avers, & Hunter, 2008; Mumford et al., 2014; Robledo, Peterson, & Mumford, 2012) to formulate a model describing the key work activities that must be executed by those asked to lead creative efforts. This model was based on five key assumptions made about the demands placed on those asked to lead creative efforts.

First, real-world creative efforts represent an inherently cognitive phenomenon. One must remember much of the work people do is not especially novel, or complex, and it has been well defined by the firm (Peterson et al., 1999). When people must do creative work in firms, it is to appraise new problems or new potentialities (Cohen & Levinthal, 1990). The need to address new problems or new potentialities, in turn, implies that ultimately those asked to lead creative efforts are leading an exploratory problem-solving effort where problems unfold over time, leading to the progressive refinement, or development, of innovative products and services that might serve to address the problem (Mumford, Bedell-Avers, & Hunter, 2008).

Second, to address and solve novel, complex, ill-defined problems in a viable fashion in firms – and it is the leader who is accountable for these problem solutions – one must have expertise. In fact, prior work by Vincent, Decker, and Mumford (2002) showed that expertise is a critical influence on the effective execution of many of the key processing activities (e.g., problem definition, conceptual combination, idea generation) underlying creative thought. More centrally, Thamhain and Gemmill (1974) conducted a study examining the effectiveness of various influence tactics – expertise, reward, coercion – for research and development personnel. They found that the only truly effective influence tactic of leaders was influence based on expertise.

Third, creative work in organizations unfolds over time in breadth and complexity as one moves from an initial idea to an innovative product or service. Indeed, Gordon (2016) has argued that it is not one creative idea but chains of ideas that result in innovation – remember cars need roads and stoplights. Moreover, owing to the novelty, complexity, and ill-defined nature of creative problems, failure is likely and one must learn from failure (Cohen & Levinthal, 1990). To complicate matters further, expertise must be drawn from different functional areas in a firm, with the expertise needed becoming more complex as projects proceed to fielding (Cooper & Kleinschmidt, 2000). Complexity, uncertainty, and interdependent chains of creativity all indicate that planning will be crucial in the leadership of creative efforts (Mumford, Schultz, & VanDoorn, 2001). Indeed, the work of Cardinal and her colleagues (Cardinal, 2001; Cardinal & Hatfield, 2000; Cardinal et al., 2015) indicates that planning by leaders is a critical influence on the success of firms working in creative industries such as pharmaceuticals.

Fourth, the importance of leader planning, plans that may give creative followers both autonomy and direction (Caughron & Mumford, 2008), seems even more significant when one recognizes creative work is costly, or resource-intensive. Some costs of creative work are indirect in that creative ideas and new products may disrupt organizational routine. However, personnel costs, equipment costs, and marketing costs must be absorbed in the course of developing creative ideas into innovative products (Nohria & Gulati, 1996). These costs, however, require leaders to acquire the resources needed to pursue creative work. In firms, it is appeals to business strategy and business efficiency that result in the allocation of resources to creative efforts. Put differently, leaders must be able to "sell" the work to acquire requisite resources.

Fifth, even as leaders think, plan, and sell the work, it must be recognized that the leader is not doing all the work – although they may do a significant amount of the work. Rather, leaders are working with a team of people, and various attributes of team processes and social interactions within the team influence people's willingness to invest in creative efforts and provide other team members with the expertise they need to do their work. Leaders, therefore, must lead the team, and lead the team as *people*, recognizing the value of dissent, ensuring open participation, encouraging appropriate collaborations, and so on (Jaussi, Randel, & Dionne, 2007; Maier & Solem, 1962; Parry-Smith, 2006; Parry-Smith & Shalley, 2003; Taggar, 2002). Not only must leaders exhibit behaviors encouraging effective group process (Paulus & Nijstad, 2003) but they must also establish a work environment, a perceived climate, that will encourage creative thinking. Indeed, a creative climate, like leadership, has been found to be strongly positively related to creative and innovative achievement in "real-world" settings (Hunter, Bedell, & Mumford, 2007). However, in this regard, it is important to recognize that climate, especially climate in creative teams, is largely defined by the leader and his or her actions (Isaksen, 2017; James, James, & Ashe, 1990).

Model of Creative Leadership

Leading the Work

These points led Mumford and his colleagues (Mumford et al., 2014; Robledo, Peterson, & Mumford, 2012) to formulate their model of the key functions that must be executed by those leading creative efforts. This model is presented in Figure 25.1. It holds that the key to effective leadership of creative efforts is leading the work – a sociocognitive activity calling for substantive creativity on the part of leaders.

To lead the work, leaders must be scanning and gathering information from both the profession and/or the firm that has granted them a leadership role (Kickul & Gundry, 2001). What should be recognized here, however, is that leaders must know what sources to scan and be able to appraise the significance of the information gained from different sources with respect to both (1) technical capabilities and the possibility for exploitation and (2) the significance of potential work for the firm and the profession (Wise, 1992). Put somewhat differently, information gathering and problem definition are critical to the effective leadership of creative efforts. In keeping with this observation, Mumford and colleagues (2000) examined the nature of the creative-thinking skills leaders developed over the course of their career, finding that problem-definition skills evidenced substantive growth as leaders moved from more junior to more senior positions.

Leaders' problem-definition skills are noteworthy in part because leaders must identify the key themes to be pursued in creative work. Typically, viable themes are defined with respect to certain fundamentals (Hughes, 1989) – for example, DuPont's systematic sustained exploration of the properties of long chain polymers

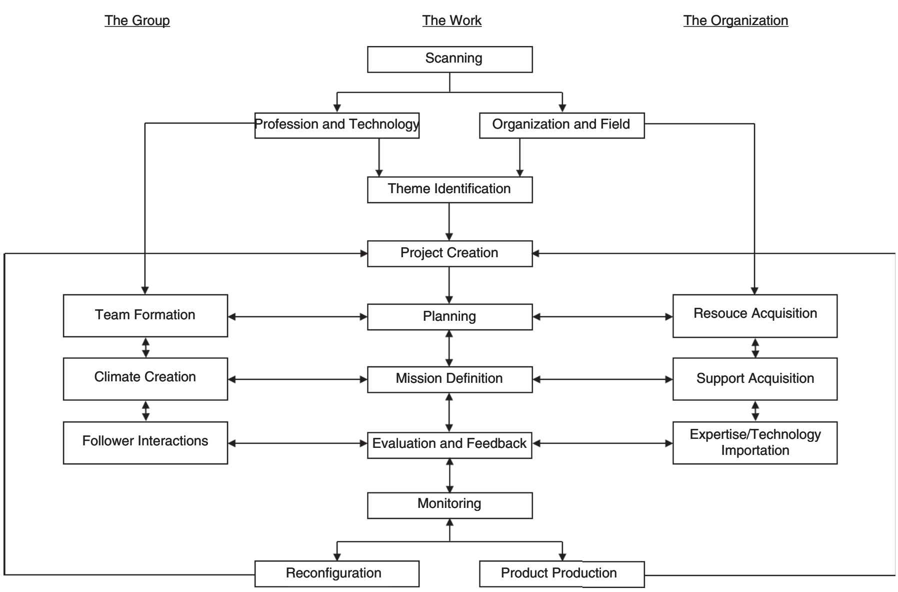

Figure 25.1 *Model of critical leadership activities*

(Hounshell, 1992). What should be recognized here, however, is that work on any one theme is inherently uncertain. Thus, leaders must identify a limited number of plausible themes in which creative teams might work. In this regard, however, it should be recognized that these themes must be integrated such that what is learned in one theme of work will contribute to other themes. Root-Bernstein, Bernstein, and Garnier (1995), in a study of scientific leaders, Nobel Prize winners, found that work was done on a limited number – three to five – of integrated themes.

Theme identification leads to definition of the projects to be pursued by creative teams. Project creation, however, is not simply a matter of pursuing a theme. Instead, the knowledge and/or new products and services emerging from these projects must be work of value to both the profession and/or the firm. Put somewhat differently, leaders must be able to identify the key critical issues to be pursued in project work. As Andersen, Barker, and Chen (2006) have pointed out, this involves identification of the critical causal issues that must be addressed. In other words, leaders must have strong, viable, mental models of the thematic area and, in project creation, expressly focus on key causes or key capabilities to be explored. This is noteworthy because it points to the need for creative thinking on the part of leaders with respect to mental models and putative causes within these models. In fact, Zaccaro and colleagues (2015), in a twenty-year longitudinal study of some 1,800 army leaders, found that creative-thinking skills on the part of the leaders were a powerful ($r \cong 0.40$) positive predictor of leader survival and leader performance.

Not only must leaders think creatively in project creation but they must also be able to forecast, or think downstream, in envisioning the outcomes of both project success and the factors that might give rise to project failure. Some support for this proposition has been provided in a study by O'Connor (1998). She conducted a qualitative study of eight leaders who had directed projects resulting in radical innovations. Those leaders able to envision, or foresee, the long-term implications of project work for emerging technologies and the firm as a whole were those who led the development of radical innovations.

Project creation, however, is not only a matter of creative thinking and forecasting vis-à-vis mental models. Leaders must also identify the constraints to be imposed on those working on creative teams. Although it has been held that constraints inhibit creativity, more recent work has shown that the imposition of constraints may be critical to creative work (Stokes, 2008). Thus Medeiros, Partlow, and Mumford (2014) have shown that the imposition of a balanced set – not too many, not too few – of constraints results in production of higher quality, more original, and more elegant solutions to creative problems. Notably, however, this imposition of appropriate constraints provides leaders with a mechanism, potentially a key mechanism, for structuring the work of creative teams (Mumford, Todd, & Higgs, in press). In fact, Kidder (1981), in a qualitative study of innovation in computer sciences firms, found that leader imposition of appropriate constraints was a crucial determinant of eventual fielding of successful new products.

With project creation and the definition of constraints to be imposed on project work, it becomes possible for leaders to formulate project plans. In fact, leaders' project planning appears, at least in the perception of leaders of creative efforts, to be a critical activity. Thus, Hemlin (2009) investigated the leaders of 84 research groups working in universities and for-profit biotechnology companies. He found that leaders of creative groups were unwilling to delegate project planning, seeing this step as a critical task. In fact, project plans are a critical mechanism by which leaders structure creative teams' work and build support for creative efforts.

Planning has, unfortunately, been viewed as a simple matter of establishing schedule and performance standards. As Frese, Mumford, and Gibson (2015) have pointed out, however, planning is a far more complex activity, requiring envisioning the course of future work and the identification of critical unknowns and key action steps as the work proceeds (Mumford, Schultz, & Van Doorn, 2001). In the leadership of creative teams, however, four key planning activities must be executed by leaders. First, leaders must identify the skills needed and resources to be employed as team members work on the project. In other words, project plans provide the architecture for the work of the creative teams. Second, leaders must identify obstacles to plan execution and approaches for managing obstacles encountered. In fact, Caughron and Mumford (2008) found that systematic analysis of obstacles in planning contributes to the production of higher quality, more original, and more elegant solutions as people work on creative problem-solving tasks. Third, leaders' plans provide a framework for developing backup plans, which allow adaptive responses to obstacles that might arise in the course of project work. Fourth, leaders' plans allow definition of the standards to be employed in appraising project work.

Plans provide a basis for leaders' articulation of the mission to be given to those working on project teams. The significance of leader mission definition has been established in Hunter, Bedell, and Mumford's (2007) meta-analysis of the effects of climate perceptions on creative problem-solving and innovation in firms. They found that leaders' articulation of an important, technically challenging, mission was one of the strongest climatic influences on the success of creative teams. The term articulation here, however, is of some importance. Leaders must understand the nature and needs of team members, communicating the mission for the project in such a way that it encourages team members to invest resources in creative work and provides a shared understanding among team members as to the leaders' expectations for the work. In fact, leaders of creative teams seem especially skilled at articulating intellectually challenging missions for project teams, engaging team members not only in the project at hand but also in the broader significance of the work being done (Bird & Sherwin, 2005).

With the definition of project plans and the articulation of a team's mission, creative work begins. Although overly close supervision, and the associated reduction in autonomy, can inhibit team creativity (Zhang & Bartol, 2010), Andrews and Farris (1967) found that scientists working in research and development teams explicitly seek feedback from leaders on the merits of their work and the problems encountered. More centrally, Lonergan, Scott, and Mumford (2004) found that when evaluating ideas of varying quality and originality, the most creative problem solutions emerged when leaders evaluated ideas in a compensatory fashion – seeking to improve the originality of high-quality ideas or improve the quality of highly original ideas. This kind of compensatory feedback, of course, implies leaders of creative efforts need substantial expertise. In keeping with this observation, Gibson and Mumford (2013) found that it is providing creative people with deep, rather than superficial criticism, that contributes to the production of creative problem solutions.

Leaders, however, cannot simply sit back and wait for team members to bring them problems. Rather, they must actively monitor progress on project work. Hemlin and Olsson (2011) collected critical incidents bearing on the performance of research and development leaders. They found that leaders of creative efforts routinely met with project teams, using these meetings as both a basis for monitoring project work and for providing team members with requisite feedback. Project meetings and monitoring, however, serve two other purposes. First, Drazin, Glynn, and Kazanjian (1999) have shown that monitoring activities on the part of leaders is critical in resolving the various crises that emerge on the course of creative efforts. Second, as Mumford, Bedell-Avers, and Hunter (2008) have pointed out, active monitoring, albeit not overly close supervision, on the part of leaders allows leaders to reconfigure project work, and project teams, as an effort proceeds from initial idea generation to the fielding of innovative new products and sources.

Leading the Group

Leaders of creative teams must not only lead the work; they must also lead the people doing the work. Although it has not been extensively studied, it should be clear that leading the team also requires recruiting team members. In fact, in his qualitative study of research and development teams in the information technology industry, Kidder (1981) found not only that the expertise and skills of team members were a critical influence in team performance but that the recruitment of team members was largely the responsibility of the leader.

It is not at all surprising that leaders are typically responsible for recruiting team members. Leaders' expertise and their plans for projects provide the background needed to identify the types of expertise needed for creative products. Moreover, by virtue of their more extensive networks, leaders have the contacts needed to recruit people with requisite expertise. In this regard, however, it is important to recognize that creative people are characterized by substantial autonomy and intrinsic interest in professional issues (Hennessey & Amabile, 2010). As a result, team members must be actively recruited by leaders who must "sell" the projects based on the value of the mission to creative people and their careers. To complicate matters even further, leaders must attend to the likely pattern of social interaction among those recruited – recruiting team members who will engage in effective technical exchange – recognizing that not all people, or combinations of people, will result in viable intellectual exchange (Gertner, 2012). Finally, it should be recognized that recruitment is not a "one shot," one time, affair. New team members must be recruited as project work proceeds. And, when new team members are recruited to join extant teams, the effects on team cohesion of incorporating new team members must be taken into account (Joo et al., 2012).

Leaders must not only recruit team members, they must ensure team members share a common understanding of the mission at hand. Day, Gronn, and Salas (2006) indicated that the availability of shared mental models among team members is a critical, perhaps the critical, influence on team performance. In keeping with these findings, Mumford, Feldman, and colleagues (2001) found that availability of shared mental models, even task-irrelevant mental models, was a key determinant of the ability of teams to produce creative problem solutions. This observation of course begs a question: How should leaders attempt to induce shared mental models?

In fact, multiple different actions will be required of those asked to lead creative efforts to ensure team members, in fact, possess a shared mental model. First, leaders must clearly articulate the nature and significance of the mission at hand. Second, they must describe the key technical challenges likely to be encountered as the work is pursued. Third, they must articulate the nature and significance of the various types of expertise need to execute this mission. Fourth, they must describe the key constraints that need to be addressed as work on the project proceeds. Fifth, they must articulate the critical ambiguities, or likely problems, that will emerge as work on the project proceeds.

Leaders' induction of shared mental models, however, is likely to have a number of other beneficial effects for teams working on creative projects. To begin, the availability of shared mental models focuses debate on critical technical issues. Prior research (Chen, Tjosvold, & Liu, 2006) has shown that encouraging technical debate, while discouraging personal debate, is critical to team creativity. Next, the availability of shared mental models promotes information sharing in teams – and active participation and information sharing in teams have been shown to contribute to team creativity (De Drue & West, 2001). Not only does the availability of shared mental models contribute to effective information exchange within project teams but it also encourages effective communication with other external team members – both others in the firm and others in the profession. Effective external communication has been found to be a noteworthy positive influence on the success of research and development teams. Thus, Ancona and Caldwell (1992), in a study of forty-seven product development teams, found that the extensiveness of communication outside project teams was positively related to both schedule and budget performance.

Of course, leaders can encourage intellectual debate, participation, and information exchange through a number of other mechanisms aside from induction of shared mental models. For example, intellectual debate might be encouraged by leaders by asking team members to criticize proposed technical approaches to problems (Gibson & Mumford, 2013). Alternatively, leaders might encourage external communication by providing team members with access to their network (Perry-Smith & Shalley, 2003). In this regard, however, it is important to bear in mind the findings of Carmeli, Cohen-Meitar, and Elizur (2007) and Jaussi, Randel, and Dionne (2007) indicating that leader modeling of appropriate behaviors is critical in the formation of viable team processes for creative efforts.

Leader modeling of desired team behaviors is important not only to team formation but also in establishing the kind of work environment likely to encourage creative work by teams. Over the years, a number of efforts have been conducted examining the nature of the work environment contributing to team and individual creativity (Abbey & Dickson, 1983; Amabile et al., 1996; Curral et al., 2001; Ekvall

& Ryhammar, 1999; Lapierre & Gioux, 2003). Hunter, Bedell, and Mumford (2005) in a review of this literature, identified fourteen dimensions commonly examined in studies of creative climate: (1) positive peer group, (2) positive supervisory relations, (3) resources, (4) challenge, (5) mission clarity, (6) autonomy, (7) positive interpersonal exchange, (8) intellectual stimulation, (9) top management support, (10) reward orientation, (11) flexibility, (12) product emphasis, (13) participation, and (14) organizational integration.

In a subsequent meta-analysis study, Hunter, Bedell, and Mumford (2007) found that climate perceptions were strongly positively related to indices of creative performance (Cohen's $\Delta = 0.75$), with this relationship generalizing across criteria measures of creativity. The impact of climate proved especially powerful ($\Delta = 1.03$) in group- or team-level studies. Although all those dimensions were positively related to team creativity, the strongest effects were produced by positive interpersonal exchange ($\Delta = 0.91$), intellectual stimulation ($\Delta = 0.88$), and challenge ($\Delta = 0.85$).

What should be recognized here is that leaders and their behavior are a powerful force shaping those climate perceptions (James, James, & Ashe, 1990). Thus, leaders, by challenging followers' work in a positive, technically focused fashion, may help establish a climate of intellectual stimulation. Leaders may induce a climate of both professional challenge and intellectual stimulation by asking questions and challenging answers. Leaders, by helping followers establish meaningful professional relationships, may also encourage intellectual stimulation – through positive exchange among team members. Along other lines, by establishing and articulating challenging professional goals, leaders may induce a climate characterized by professional and intellectual challenge (Shalley, 1995). Indeed, Isaksen (2017) has provided a list of the various leader behaviors that give rise to a climate encouraging creativity.

Climate, of course, refers to perceptions of the team's work environment. Leaders, however, must also interact with individual followers. The pattern of leaders' interactions with individual followers is another variable shaping the effectiveness of creative people and creative teams. Thus, Tierney, Farmer, and Graen (1999) found that positive interpersonal exchange between leaders and followers was positively related to both managerial appraisals of creativity and invention disclosures among chemists. What should be recognized here, however, is that positive exchange relationships between leaders and followers working on creative efforts will induce feelings of creative self-efficacy on the part of followers. Creative self-efficacy has been shown to contribute to creative performance (Tierney & Farmer, 2002). Notably, however, Atwater and Carmeli (2009) found that positive leader–follower exchange and creative self-efficacy resulted in feelings of psychological safety and greater investment of energy in creative work, with this investment, in turn, contributing, presumably, to creative performance. Thus, leaders, by having positive interactions with followers where the leader acknowledges followers' creative capabilities, may create conditions where followers both have the psychological resources needed for creative work and are willing to invest those resources in creative efforts.

Leading the Firm

By establishing a viable team, shaping an appropriate work climate, and interacting effectively with followers, leaders create conditions where the team, and team members, can be creative. These efforts, however, will come to naught if not adequately resourced. Accordingly, one key requirement of those leading creative efforts is the acquisition of requisite resources. The importance of resource acquisition items has been examined in studies of project championing (Howell & Higgins, 1990; Markham & Griffin, 1998; Markham & Smith, 2017). Championing, a particular form of leader behavior, involves the leader acquiring requisite support for creative efforts.

A review of early work in championing has been provided by Markham and Aiman-Smith (2001). They found that championing requires an extensive network of contacts throughout the firm and/or profession. Effective champions, moreover, were found to be politically skilled visionaries who evidenced strong communication skills. Put differently, the leaders of creative efforts must be able to "sell" the creative efforts to key stakeholders, not just the people working on the creative effort. Also, they are able to build a network that provides them with the opportunity to sell the creative efforts.

The basis for leaders' championing activities has been examined in a study by Howell and Boies (2004). They interviewed 19 matched pairs of champions and nonchampions involved in one of 28 new product development efforts. Interviews were content-analyzed to assess knowledge, idea promotion, idea packaging, and selling. They found that contextual knowledge, knowledge of firm strategy and operations, was a powerful influence on both the packaging of ideas and the sale of those ideas to others. Thus, to champion, the leaders of creative efforts must have a strong understanding of the firm and/or the profession, not just the technical work being conducted, and they must be able to explain how creative projects contribute to the advancement of the profession's or firm's strategy.

This observation, however, brings to the fore a new question: Exactly who are they selling to? A variety of studies indicate the focus of these sales efforts is the top management team. A study by Dougherty and Hardy (1996) found that engagement of the firm's senior management in creative efforts was critical to the successful introduction of new products. Similarly, Hiltzik (2016) has shown engagement of policy and granting agencies is critical to the success of "pure" science work. The significance of the engagement of top management, or granting agencies, in creative efforts is that these groups provide the tangible fiscal resources needed for creative efforts to occur. However, the support of these groups is noteworthy, not only with respect to the resources provided but because they also serve to legitimize the creative effort – legitimacy that is critical to others' willingness to advocate and support creative efforts. Thus, Meyer and Goes (1988), in a study of 12 medical innovations in 25 hospitals, found that CEO advocacy of the creative efforts was positively related to adoption of the innovation and its routine use by hospital staff.

Although it is important to sell top management, or granting agencies, on the value of creative efforts, such sales efforts are not unto themselves sufficient. Jelinek and Schoonhoven (1990), in a qualitative study of a failed new product development effort, found that failure occurred despite top management support and a viable prototype product due to the unwillingness of other organizational units to support the innovative effort. Thus, leaders of creative efforts not only must champion to "top management" but must also champion the creative efforts to other vested stakeholders in a firm or in a profession. Although many of the skills needed to champion an effort to "top management" are also needed in selling creative efforts to other relevant stakeholders, some additional skills are required.

First, leaders of creative efforts must be aware of those who have a vested interest in the development and/or fielding of a creative product. Put differently, leaders must know who has "skin in the game." Second, leaders must understand how the creative effort will affect the routine operations of these different stakeholder groups. Third, the leaders of creative efforts must explain to those stakeholder groups the nature of the creative efforts and how, if successful, the creative effort will affect their operations. Fourth, the leaders of creative efforts must help stakeholders resolve problems induced by the deployment of innovative efforts. Indeed, this requirement may cause leaders to pull staff away from a creative effort to help a key stakeholder group resolve potential problems broached for them by the creative effort.

More broadly, these observations imply that leaders of creative efforts must be able to teach. They must help others understand the implications of the creative efforts for their operations and help them resolve problems broached by the creative effort. Not only must the leaders of creative efforts help others make sense of the creative effort but they must build in these key stakeholder groups a sense of shared investment in the success of the creative effort, where key stakeholders are viewed as partners in turning a creative problem solution into a viable new product (Mumford et al., 2014).Thus, the leaders of creative efforts cannot live in a "white tower" but instead must reach out to, and educate, others to build the absorptive capacity in organizations that allows for the successful fielding of new products.

Leaders' outreach to key stakeholders, however, is not merely a socially desirable service activity. As leaders reach out to key stakeholders, they not only build connections with those stakeholders, and stakeholder support for the creative effort, but leaders become familiar with both the capabilities and staff skills of members of these stakeholder groups. Acquisition of knowledge about, and connections to, key stakeholder groups is critical for the successful leadership of creative efforts in another way.

As creative efforts unfold over time, they move from initial idea exploration to idea refinement, prototyping, and fielding (Mumford, Bedell-Avers, & Hunter 2008). As work on creative projects progresses, a wider array of knowledge and skills is required. A case in point may be found in information technology firms where marketing is typically involved in prototyping as well as new product fielding. What is clear is that both the speed with which creative problem solutions are turned into viable new products and services and the success of these products and services are contingent on the incorporation of other relevant forms of expertise. Thus, Allocca and Kessler (2006), Keller (2001), and Thamhain (2003) have all provided evidence that incorporation of cross-functional expertise into new product development efforts contributes to both schedule performance and project success.

Although cross-functional teaming has value at certain, later, stages of new product development efforts, the inclusion of cross-functional expertise will create new challenges for those asked to lead a creative effort. First, induction of new people and with different skills will introduce new perspectives. Although these new perspectives may result in new intellectual challenges, the leader must help extant followers understand, or make sense of, the new challenges being brought to the fore (Drazin, Glynn, & Kazanjian, 1999). Second, induction of new forms of expertise, and new people, may act to disrupt the cohesion of creative teams. Thus, as creative projects move to cross-functional teaming, leaders must make special efforts both to build team cohesion and to encourage recognition of the value of "outsiders" brought into a creative group (Bird & Sherwin, 2005). Third, with the addition of cross-functional expertise, new problems and new concerns will enter into the creative effort that will both entail loss of process efficiency in the group (Cardinal, 2001) and complicate, or disrupt, the creative problem-solving of team members (Friedrick & Mumford, 2009). Thus, the leaders of creative efforts not only must manage the team more professionally but must help team members understand how new problems, and new ideas, provided by cross-functional team members will contribute to the development of a stronger, better, product or service.

Conclusions

Before turning to the broader conclusions flowing from the present effort, certain limitations should be noted. To begin with, work on the leadership of creative efforts is, in fact, a relatively recent effort, beginning with the efforts of Mumford and colleagues (2002). As a result, it is not clear that all relevant facts and phenomena relevant to understanding the leadership of creative efforts have, at this point, been identified.

Moreover, as is the case with any emergent phenomena, multiple alternative models to the model proposed by Mumford and his colleagues (Mumford et al., 2014; Robledo, Peterson, & Mumford, 2012) exist. For example, another model of creative leadership has been proposed by Mainemelis, Kark, and Epitropaki (2015). In this regard, however, a study by Vessey and colleagues (2014) is of some note. They obtained biographies of some one 100 eminent scientists and appraised scientific performance with respect to various criteria – H-index, awards, rated professional impact. They found that the three-dimensional model presented herein – leading the work, leading the people, leading the firm – appeared to produce the most appropriate model for accounting for the effective leadership of creative efforts.

What should also be recognized is that each of those three functions – leading the work, leading the people, and leading the firm – reflects a complex set of skills and requisite behaviors on the part of leaders. In recent years, evidence has been provided for the impact of many of the capabilities implied by this model on the effectiveness of those asked to lead creative efforts. For example, Marta, Leritz, and Mumford (2005) have shown that planning skills are critical to the successful leadership of creative efforts. Byrne, Shipman, and Mumford (2010) and Shipman, Byrne, and Mumford (2010) have provided evidence indicating that leaders of creative efforts must be able to forecast. Marcy and Mumford (2007, 2010) have shown causal analysis skills are critical for the effective leadership of creative efforts. Lonergan, Scott, and Mumford (2004) have provided evidence indicating idea evaluation skills are needed by those asked to lead creative efforts. Mederios, Partlow, and Mumford (2014) have provided evidence that leaders must set constraints. Gibson and Mumford (2013) have shown that leaders must provide deep criticism. Although these studies provide support for many of the key propositions flowing from this tripartite model of the functions involved in creative leadership, it should be recognized that many potential issues remain unexplored. For example, we lack research on how leaders recruit others for creative work. We lack research on how leaders of creative efforts integrate multiple themes, or streams, of work. Also, we lack research on how leaders monitor creative teams and learn from failure.

Although further work, substantial additional work, is needed to develop a comprehensive model of the requirements for leading creative efforts, the evidence accrued to date does suggest that the leaders of creative efforts, to prove effective, must be able to execute three key functions: (1) lead the work, (2) lead the people doing the work, and (3) lead the firm or profession. Unless all three of these key functions are taken into account, it is unlikely we will form a truly comprehensive understanding of what is needed to lead creative efforts.

What should also be recognized is that the leadership of creative efforts is an unusually complex and demanding activity. Leaders of creative efforts need substantial expertise. In addition, they must be able to think downstream about their own and others' work. Also, they must be able to evaluate complex technical work with real depth. Indeed, one might make the case that exceptional technical expertise is the hallmark of any individual who proves effective in his leadership of creative efforts.

However, expertise unto itself is not sufficient for the effective leadership of creative efforts. The leaders of creative efforts must themselves be able to think creatively about problems arising in the course of the work (Mumford, Connelly, & Gaddis, 2003). They must be able to plan a complex, multifactor, set of activities. Also, they must be able to reflect on, and learn from, both successes and failures (Strange & Mumford, 2005).

Unto itself, these tasks are daunting. However, one must also remember that the leaders of creative efforts must be able to recruit autonomous, rather difficult, people to their projects and be able not only to manage them but to have positive interactions with them. They must, moreover, be able to establish a viable positive climate under conditions where clashes, hopefully only technical clashes, are not only likely but necessary. To complicate matters even further, while managing the people and the work, they must also be able to "sell" the work to both top management and other key stakeholders, even as they educate themselves, and the stakeholders, about the nature and implications of the creative effort.

These observations point to an important conclusion. The leadership of creative efforts is an unusually daunting and demanding enterprise. It is certainly much more difficult than many of the other forms of leadership we encounter (Bass & Bass, 2008; Yukl, 2011). Indeed, a case might be made that it is more difficult to lead a creative effort within a firm than it is to lead the firm itself. This observation, however, begs a question: Where do we get these people from?

At one level, it seems evident that the leadership of creative efforts will simply take time – time to acquire the professional expertise, networks, and social skills needed to lead creative efforts. However, given the complex nature of creative efforts, it seems that the systematic structure of career experiences, along with formal developmental programs, may well be necessary (Mumford et al., 2000). We hope the present effort serves as an impetus for further work along these lines – work intended to both understand the nature of creative leadership and develop people's potential as creative leaders. Given the substantial impacts effective leadership has on the success of creative efforts, work along those lines seems amply justified.

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26 Individual and Group Creativity

R. Keith Sawyer

Along with most creativity researchers, I define creativity as a process leading to the generation of a product that has two characteristics: It is new – different in some significant way from products that already exist – and it is judged to be "appropriate" by some social or professional community. Using this definition, creativity research is the science of how these new products come into being. As with all sciences, the purpose of creativity research is to gather empirical data capturing this process and to develop the best explanations for these data. In addition to this basic scientific purpose – observation and explanation – creativity researchers are often interested in the practical application of these scientific findings. How can we use these explanations to provide advice to people, groups, and organizations about how to increase their ability to generate new and useful things?

Data is neutral regarding explanation. In almost all sciences, the data gathered from empirically observed phenomena can be explained using a variety of theoretical frameworks. As with all scientific inquiry, the creativity research community makes determinations about which theoretical explanations are best, with the "best" explanation being determined according to a range of criteria: most useful, able to explain more about the data observed, and able to help us make predictions about future empirical observations.

As with all sciences, creativity researchers use rigorous methodologies to gather data that capture the target phenomenon. For the purposes of this chapter, that phenomenon is the process whereby people generate something new and appropriate. Other target phenomena studied by creativity researchers include the person – creative traits of certain individuals – and the product – characteristics of those products that are both new and appropriate. The data that are gathered from this scientific exploration of the process that generates something new then lead to a search for explanation. In many cases, the best explanations of these data are couched in the language of psychology. The process that leads to the generation of something new and appropriate might be best explained in terms of properties and laws about people's mental states, personality traits, and behaviors. However, there is a second possible outcome to this research project: The data might be best explained in terms of groups or in terms of social and cultural context. These two possibilities might combine to lead to a third possible outcome: The best scientific explanation of empirically observed data of the creative process might be hybrid, incorporating properties of both individuals and groups. This is the issue I address in this chapter: What is the proper level of analysis at which to explain how new things are created?

Drawing from the philosophy of the social sciences, and from sociological theory, I provide a framework that is designed to help researchers determine whether individual-level explanations are more successful or whether group-level explanations are more successful, for a particular set of empirical data. This review discusses several influential arguments in favor of both individual explanation and collective explanation. These arguments have a long history in the philosophy of the social sciences and in sociological theory, and they have been applied to a wide range of psychological and social phenomena, including economic behavior, social evolution, and social and cognitive development. Building on my review of this literature, I present a framework, collaborative emergence, that combines both individual and collective explanation (Nathan & Sawyer, 2014; Sawyer, 2003b). I apply this framework to analyze two empirical examples of group creativity – an improvisational performance and a work team. My discussion of these examples demonstrates how the framework of collaborative emergence can be used to determine the relative benefits of individual-level explanation and group-level explanation when examining any specific case of creativity. I conclude by proposing that, in most cases, the best scientific explanations of creativity will involve multiple levels of analysis: They will incorporate properties and laws associated with individuals and with groups. I provide some guidelines for how to proceed, drawing on how other scientific disciplines approach these same issues regarding levels of analysis and scientific explanation.

Scientific Explanation

As creativity researchers, we want to explain the emergence of new things from human activity. Explanations are attempts to account for why things happen – singular events or regular, repeatable patterns. In this chapter, I focus on creativity as a process and, in the study of the creative process, the things of interest to creativity researchers are specific instances of new things emerging or regular repeatable patterns of new things emerging. In the philosophy of science, there is a long history of discussion surrounding scientific explanation; I briefly describe two influential positions: the deductive-nomological (DN) or covering-law approach (Hempel, 1965) and the mechanistic approach (Bechtel & Richardson, 1993; Hedström & Swedberg, 1998).

In the covering-law approach, a phenomenon is said to be explained when salient properties of the event are shown to be consequents of general laws, in combination with known antecedent conditions. A strength of the covering-law approach is that laws both explain and predict; once a law is discovered, it can be used both to explain past phenomena and also to predict when similar phenomena will occur in the future. In this view, the best explanation is one that optimally explains observed phenomena and also successfully predicts what data will be observed in the future, when a similar methodology is used to gather similar data.

Covering-law models have always been problematic in the social sciences – including in psychology – primarily because of difficulty translating the notion of "law" to social reality. Try to think of a creativity law: It's hard to identify a lawful relation that is supported by creativity research, one that both explains and predicts. One possible candidate is the widely reproduced finding that brainstorming groups have fewer ideas than nominal groups composed of the same number of solitary individuals (Paulus & Nijstad, 2003), a law that holds at the group level of analysis rather than the psychological level. But is this a law in the same sense as the ideal gas law (pressure equals temperature times density)? The problem is that candidates for psychological and social laws always have exceptions. On average, brainstorming groups have fewer ideas than nominal groups but there could occasionally be an unusual brainstorming group that proved to be an exception. Laws with exceptions are problematic in the DN approach and this is why there is a history of debate concerning whether psychological or social laws exist at all. Philosophers of social science have taken various positions on the status of these laws (Beed & Beed, 2000; Blau, 1983; Giddens, 1984; Kincaid, 1990; Little, 1993; McIntyre, 1996). Much of this discussion centers on what constitutes a law: Must it be invariant and universal or can it admit of some exceptions? Even the strongest advocates of lawful explanation admit that there are no exceptionless laws outside of the natural sciences; all laws in the social sciences have exceptions and the issue regards how many exceptions are too many before we can no longer consider the proposed regularity to be a "law."

In the 1990s, philosophers of biology (Bechtel & Richardson, 1993; Craver, 2007; Machamer, Darden, & Craver, 2000) and philosophers of social science (Elster, 1989; Hedström & Swedberg, 1998) began to develop a new approach to explanation that is based on causal mechanisms rather than laws. In the mechanism approach, a phenomenon is said to be explained when the realizing mechanism that gave rise to the phenomenon is sufficiently described. The "realizing mechanism" for an observed event includes the causal processes and interactions leading up to that event and it also describes the processes and interactions that make up the event. Rather than a covering-law explanation in terms of laws and regularities, a mechanism approach provides explanations by postulating the processes constituted by the operation of mechanisms that generate the observed phenomenon. A mechanist would argue that the brainstorming law I proposed above, although it describes an observed regularity, is not an explanation of the observed phenomenon because it does not describe the mechanism that leads to this observed regularity. A mechanist would attempt to explain the regularity by identifying individual mental processes of the participants, and the interactional processes among the participants, that ultimately resulted in the total number of ideas generated by the group. This fundamentally reductionist approach is called methodological individualism: It attempts to explain an observed group-level regularity in terms of mental states and actions of the individual members of the group. Psychologists who study creativity are, for the most part, methodological individualists – they use methodologies designed for the study of individual minds and behaviors to explain the generation of something new and appropriate and their explanations rarely incorporate group-level properties or laws.

Mechanisms and Emergence

Many systems in nature contain hundreds, thousands, or millions of components, all of which interact in dense, overlapping networks. Many such systems are chaotic: highly nonlinear and essentially impossible to explain and predict from mechanisms and laws. The atmosphere is a chaotic system and this makes weather prediction difficult. Weather forecasts are not derived from mechanisms and laws relating individual molecules in the atmosphere but instead from historical trends and averages. But, in some systems, a relatively simple higher-level order emerges from quite complex lower-level processes. Such systems manifest many features that make them difficult to explain using a reductionist approach that would first analyze and explain the components, and then the components' interactions, to derive an explanation of the higher-level pattern. Complexity scientists have long invoked the human brain as a prototypical example of a complex system (Bechtel & Richardson, 1993). We can develop explanations of human thought and behavior, in terms of individual-level properties, even though the realizing mechanism – the networks of neurons in the brain – is so complex and distributed that it largely defies explanation. It is this complexity that enables the human mind to generate novelty. More recently, complexity scientists have argued that many social systems are complex systems that share many systemic properties with other complex systems, including the human mind (Sawyer, 2005). This raises the possibility that complex social systems could generate novelty, just as the complexity of the brain results in individual novelty (cf. the concept of "distributed creativity": Sawyer & DeZutter, 2009). If so, a complete scientific explanation of creativity would have to include detailed accounts of both psychological and social mechanisms.

In my empirical work, I study mechanisms of collaborative emergence in small groups (Sawyer 2003b). Group behavior must be thought of as emergent in those cases where there is not a structured plan guiding the group and where there is no leader who directs the group. Examples of collaborative emergence include everyday conversation, small-group collaborations, brainstorming sessions, and discussion seminars. All of these phenomena are improvisational because there is no director and no guiding script. Consequently, as the purest form of collaborative emergence, I have conducted several studies of creative improvisational performances, including jazz, improvisational theater, and children's fantasy play (Sawyer, 1997, 2003a, 2003b). Example 26.1 presents an example of collaborative emergence drawn from my study of improvisational theater (Sawyer, 2003b). After completing these studies, I began to apply the group-level explanations that emerged from analyzing these groups to study a broader range of group creative phenomena, including project teams, study groups, classroom discussions, and leadership teams. Example 26.2 presents an example of collaborative emergence in a work team.

The transcript in Example 26.1 is taken from a performance from Spring, 1993, by the Chicago theater group, Jazz Freddy (Sawyer, 2003b, pp. 193–194). On this night, the group asked the audience for an event and a location. The suggestions taken were "The Olympics" (the event) and "A convent" (the location). The group then proceeded to perform for almost an hour, with an intermission halfway through the performance. Example 26.1 represents the first 2.5 minutes of the performance. Note that the actors do not use props; all actions described are mimed.

EXAMPLE 26.1

Lights up. MAN carries a chair to front stage right and sits facing audience. He mimes working at a desk – takes a cap off of a pen, opens a book, starts to make underlining motions as he studies the page. He stops to rub his eyes. He then turns the page, and underlines some more. The other actors watch intently from the sides of the stage; the audience is completely quiet. After about 20 seconds, WOMAN stands up from her position at the opposite side of the stage, and walks over to MAN, miming the act of carrying something in both hands, held in front of her:

1	WOMAN:	Here are those papers.	Puts down the "papers."
2		(2 second pause)	She remains standing.
3	MAN:	Thanks	Looks up to face WOMAN
		(2 second pause)	
4		I really appreciate your doing those copies for me.	
5	(A second man, MAN 2, approaches from stage left, also carrying "papers," and stops next to WOMAN.)		
6	MAN 2:	Here are those papers.	Puts down the papers.
7	MAN	Thanks a lot,	Still facing the two
8		You guys have really been great.	
		(2 second pause)	
9		I'm gonna stop booking for now	Closes book on desk.
10	WOMAN:	//OK//	
11	MAN 2:	//Sure//	
		(1 second pause)	
12		I'm gonna go get some more papers.	
13	MAN:	Alright	He stands up
		(1 second pause)	
14		Thanks a lot, I appreciate it.	
15	MAN 2:	You're welcome.	
		(1 second pause)	
16		We mean it.	
17	(As he says this, MAN 2 touches WOMAN's arm; woman reaches up her other hand to grasp his hand; they stand holding hands.)		
18	MAN:	Thanks for being in my corner.	
19	MAN 2:	We always will be.	

This improvisational theater dialogue displays the essential characteristics of collaborative emergence. First, note the many pauses between turns, more frequent and longer than a typical conversation. The actors do this to leave space for everyone to contribute equally and to wait for inspiration to emerge collectively from the group. Improv theater has an egalitarian ethos; there is no group leader and actors frown on actors who try to control a scene too much.

The second feature to notice is the relative lack of specificity. After two-and-a-half minutes, it is hard to understand what is going on. This is intentional; the actors leave many things unresolved, knowing that the group will eventually collectively begin to make sense of these unfolding dialogues. In these early stages, the actors are actually trying to generate complexity and ambiguity because they know from experience that the complexity of information leads to greater group creativity later in the performance.

The third feature of this dialogue is moment-to-moment contingency: At any moment, the scene can take a wide range of different directions and no single actor's action ever fixes the future flow of the performance. Unlimited options are available at the beginning of the scene, of course. MAN could have chosen a different activity; or another actor might have entered the scene first. The determination of who will begin the scene is itself emergent from the split-second decisions of all ten actors. Likewise, any of the nine remaining actors could have entered the scene next, during the twenty-second period when all of them were watching him "study." The ensemble does not choose which actors will be in a scene, nor their order. A different actor may have been just a split-second away from deciding to stand up but WOMAN made the first move.

At line 1, WOMAN could have chosen a wide range of activities and utterances. Improv actors are taught that everything introduced by a fellow actor must be accepted and then elaborated – the "Yes, And" rule. Thus WOMAN must accept everything MAN has done nonverbally – and it is fairly clear to this largely college-educated audience that he is studying. By saying "Here are those papers," she provides several new pieces of information – she implies that the man's activity is part of a larger project; that there is a group of individuals (at least two) participating collaboratively in the effort. She also suggests that not only are books involved but "papers" as well. This is not surprising; but neither would hundreds of other possible actions have been any more surprising. For example, she could have said "Joe! What are you doing in my neighborhood coffee shop?," suggesting a casual friendship and a public location. She could have said "Staying late again today, eh?," suggesting a collegial office encounter between peers. She could have established a status relationship by saying, for example, "Don't forget to take care of that Johnson report before you leave."

Likewise, in his response at lines 3 and 4, MAN has hundreds of possible actions that would have seemed equally coherent and plausible. At line 4, MAN suggests an asymmetrical status relationship, by proposing that WOMAN has done the copies for him. It would have been just as dramatically coherent for MAN to take on a subordinate relationship; for example, he could have said "I can't believe you're giving me more work, it's already 8pm!" Or he could have hinted at a conspiratorial scenario: "I can't believe you managed to get those papers! Who did you pay off?" The contingency that is present at each line of dialogue multiplies from turn to turn, resulting in combinatorial complexity of possible scenes. This is a classic property of complex dynamical systems – their rapidly expanding combinatorial possibility.

A fourth feature of this dialogue is retroactive meaning: No single actor can know the real meaning of his or her own utterance until the other actors have responded. The meaning of each line is retroactively determined by the collective flow of the dialogue. For example, WOMAN's line 2, "Here are those papers," could have been treated as either the command of a supervisor or the report of a subordinate. The complete meaning is dependent on the flow of the subsequent dialogue. And not only these two actors are involved; all ten actors are involved because the entire group collaboratively determines – through their actions and nonactions – which actors will enter a scene. Because meaning is retroactively determined, any one actor's intentions and goals have limited explanatory power.

By line 19, a few dramatic elements are starting to emerge. MAN and MAN 2 seem to be coworkers, yet MAN's repeated "Thanks" also seems to imply that MAN 2 and WOMAN are helping him out of friendship or that they are going beyond the call of duty. This seems to be a high-pressure situation, one that involves working late, a large volume of work already done, and still more to be done; and a possible "us against them" mentality. All of these dramatic elements are emergent – they have emerged from the collective interaction and creative contributions of all three actors. No single actor has determined the direction of the scene.

By the intermission, thirty minutes later, Jazz Freddy had created two completely independent plot lines, one inspired by each of the two audience suggestions. The Olympics plot was about a baseball team training for the Olympics, and John had become an umpire who wasn't very good and probably needed glasses. The second plot took place at a convent, where nuns were staying up late playing cards and spray-painting graffiti on the religious murals. In the second act, the actors managed to weave these two plots together. The baseball games get ugly as the team becomes filled with hate for their opponents, and the play ends with several of the female baseball players quitting the sport to join the convent. Note how little of this could have been predicted after reading the initial dialogue in Example 26.1; this unpredictability is characteristic of collaborative emergence.

Example 26.2 presents a second example of collaborative emergence, this time drawn from a creative work team. This is a transcript of a meeting of ten artists and writers working on the Cartoon Network's cartoon *Samurai Jack*. Although the meetings are led by the cartoon's creator, Genndy Tartakovsky, he does not direct the course of the meeting; instead, he fosters a spirit of participatory collaboration designed to encourage new ideas to emerge from the group's conversation. In Example 26.2, a writer named Andy has come up with the seed of an idea for a new episode. Whenever one of the others speaks up I have simply indicated "Artist."

EXAMPLE 26.2

Story meeting of the Samurai Jack *team (from Wilkinson, 2002)*

Andy	We're looking to do the story we talked about, where Jack gets infected with a virus and it takes over his arm. Then it would slowly take over his whole body. Then half of him becomes evil, and he's going to fight himself.
Tartakovsky	How do we set it up?
Artist	Could he have battled Aku, and Aku has a cold, and he sneezes on him?
Tartakovsky	(nods) It's almost like we're at the end of another show with a great fight. Except this one starts with a battle. And he's fighting these robots, and Aku's commanding them. It's cold and drafty, and Aku starts sneezing, and says, "Oy, I've got to get some chicken soup."
Artist	Oy?
Artist	How do we get it out that he's infected?
Artist	We had talked about him showing a guy his face. And it's half in shadow.
Artist	He becomes Aku.
Artist	He becomes Jaku.
Artist	The more evil he becomes, the more erratic his body is.
Artist	Maybe somebody's getting robbed, he saves him, and the guy thanks him, and he's walking away, and in Jack's other hand is the guy's watch.
Artist	Do we need to find somebody to summon him? Is there a psychic battle with himself?
Artist	Or a fight in his head? I was thinking, he knows a place to cleanse himself – a monastery. And the monks help him.
Artist	The B story is no one's trusting Jack – they see him and they run.
Tartakovsky	It's always stronger if Jack can help himself. I like the image of Jack as Aku with one eye. I like it half and half. The more I think about it, the body of the show is him fighting himself.
Artist	He realizes he'd better get out of the city before he hurts someone, so he travels to a village.
Tartakovsky	I still want to keep it real simple, though.
Artist	At the monastery, they tie him up so he can't do any harm.
Tartakovsky	Does Aku know that Jack has what he has?
Artist	No, he's too sick.

As with staged theater improvisations, in Example 26.2 no one is in charge and no one creates any more than anyone else. Even though the discussion started with Andy's idea, he said nothing after getting it started. And even though Tartakovsky is the group leader, he does not dominate the group. The cartoon that is eventually produced, a collective creation of ten people, collaboratively emerges from the group's dialogue. This is a common mode of operation for the creative teams that generate movies, video games, music videos, and television shows (Pritzker & Runco, 1997; Sawyer, 2017).

Examples 26.1 and 26.2 demonstrate how collaborative emergence results from the interactions of individuals. But, although these examples of group creativity emerge from individual creative acts, and the realizing mechanisms are the individuals and their conversational interactions, these group phenomena are difficult to understand by simply analyzing the members of the group individually. In this case, the methodological individualism of psychological explanations may not provide the best explanations. Explanations focused on the mental states and behaviors of individual actors cannot provide a complete explanation of how the final performance emerges from the group. For example, because meaning is retroactively determined, an actor's intentions when forming an utterance are not explanatorily relevant to how that utterance contributes to the scene. Also in brainstorming groups (Sawyer, 2017) and in work teams like Example 26.2, one person's idea is often transformed and reinterpreted by the ensuing thought process of the group. Because of moment-to-moment contingency, no one act meaningfully explains or predicts what happens next.

Many philosophers of mind use emergentist concepts to argue that the mind is emergent from, but not reducible to, the biological brain (Sawyer, 2002a). It could be the case that the psychology of creativity would ultimately reduce to neuroscience. If this comes to pass, *The Cambridge handbook of creativity* in the year 2050 might look very different from today's. But owing to emergence, it could also be the case that neuroscience could never fully explain mental processes of ideation; that a science of creativity would always of necessity involve an irreducibly psychological level of analysis. Using a similarly structured argument, many sociological theorists use emergence to argue that collective phenomena are collaboratively created by individuals, yet are not reducible to individual action (Sawyer, 2005). These accounts argue that although only individuals exist, collectives possess emergent properties that are irreducibly complex and thus cannot be reduced to individual properties. These arguments likewise provide grounds to claim that some creative processes and outcomes could require social-group level explanations and are not reducible to individual psychological explanation.

How could one determine whether or not a given psychological phenomenon was reducible to neurobiological explanation? Likewise, how could one determine whether or not a given social phenomenon was reducible to individual psychological explanation? To answer this question, I have developed an account of emergence that I call nonreductive individualism (NRI) (Sawyer, 2005). Some emergent social properties may be real – and necessarily figure in scientific explanations, just like real properties at any other level of analysis, including at the psychological level. For example, psychologists study individual phenomena such as memory, attention, and decision-making, even though, in some sense, one could argue that these phenomena are not "real" because they are nothing more than the realizing mechanism of the brain's neurons and their interactions. However, the scientific paradigm of contemporary psychology assumes that these individual-level phenomena are real and have causal power. A presentation of this account is beyond the scope of this chapter; but, in the following section, I draw on this account to help answer the question: Which instances of creativity are likely to require both individual- and group-level explanations?

Characteristics of Collaborative Emergence

Ultimately, the determination of whether or not the emergence of something new can be explained at the individual psychological level of analysis, or whether the complete explanation requires group-level properties, laws, and mechanisms, is an empirical question that must be resolved anew with each instance of creativity. (This is why I argue that creativity research must be interdisciplinary and incorporate explanations at multiple levels of analysis.) However, there is a large body of research in complexity science, and on emergence more generally, that has identified the characteristics of systems that are more likely to be irreducible to scientific explanations solely in terms of the component parts of the system. Creative outputs from social systems that have the following characteristics are more likely to require group-level accounts:

1. Unpredictability
2. Nonreducibility to models of participating agents
3. Processual intersubjectivity
4. Individual agency and creative potential on the part of individual agents
5. The cost of explanation

Unpredictability

Almost all emergentists argue for the unpredictability of complex emergent system behavior from laws at the lower level. In the improv theater transcript in Example 26.1, no actor knows what is going to happen next. At each point in the improvisation, the actor can choose from a wide range of moves to propel the dramatic frame forward. Each turn is unpredictable and novel, accumulating to result in a collaboratively created, novel performance. No actor knows how his turn will be interpreted by the others; each turn gains its final meaning only from the ensuing flow of discourse. Thus, the actor’s intention does not fully constrain the eventual dramatic meaning of the turn; each turn of dialogue, although spoken by a single actor, eventually takes on a dramatic meaning that is determined by a collaborative, emergent process.

Not Reducible to Models of Component Parts

Bechtel and Richardson (1993) argue that emergent systems do not demonstrate any of the characteristics of reducible systems: direct localization, near decomposability, functional and physical independence of units, and linearity. The discipline of psychology often implicitly accepts a version of reductionism that is referred to as methodological individualism because it assumes that all properties of group behavior can be reduced to, and ultimately derived from, properties of individuals (Lukes, 1977).

These assumptions lead psychologists to consider creativity – even when it emerges from collaborating groups or complex organizations – to ultimately be a property of human minds, thus requiring psychological explanation. The main threads of creativity research within psychology have all been individualistic: for example, cognitive scientific theories of analogical thinking or conceptual combination; or personality trait researchers' measures of "divergent thinking" or "stylistic preferences." These approaches are methodologically individualist in holding that creativity involves human agency, intentionality, decision-making, and problem-solving, and that social groups themselves cannot be explanatorily relevant to creativity (except in how they impinge on individuals).

Individualist psychology does not provide very helpful explanations of collaboratively emergent phenomena such as improvisational theater. An actor's intention for an utterance is not necessarily the eventual meaning of the utterance; in the above transcript, the actors purposely generate utterances with ambiguous interpretations, knowing that the other actors will later attribute more specific meanings to them. Likewise, no single actor can decide the direction that the scene will take; decision making, if it can be said to exist at all, is a collective social process.

Intersubjectivity

One possible nonemergence account of Example 26.1 would be to claim that the first MAN to enter the stage established the activity of studying and everything that the other actors do simply followed from that. But this cannot be correct; I have suggested a few of the alternative possibilities that were available at each line of dialogue. Nonetheless, this claim gets at an important truth of improvisation: Once properties of the dramatic scene are established, they become collective property and constrain all of the actors. MAN does in fact establish the act of studying (or "working") and this act constrains MAN 2 and WOMAN. Throughout the one-hour performance, there is an ever-changing dramatic emergent – a shared understanding of what has been established and what is going on – and the actors' future creativity has to proceed within the frame established by this emergent drama. But this constraining shared frame is itself an emergent social product: It is ever-changing, created in a bottom-up fashion from the actions of individual actors, yet, once created, it constrains and influences the later actions of those individuals in a top-down fashion.

Traditionally, intersubjectivity is defined as a state of overlapping, symmetrical mental representations; two or more people are said to "have intersubjectivity" when their mental representations of the situation are in agreement. This traditional view is implicitly reductionist because intersubjectivity is reduced to individual subjectivities and their additive relations. In other words, intersubjectivity, and hence all collective activity, is regarded as a simple sum of individual mental states (Matusov, 1996, p. 26).

The traditional account of intersubjectivity is inadequate to describe collaborative emergence because there are many social interactions where participants do not share mental representations, such as disputes, arguments, and debates. In fact, even when there is no overt disagreement, it is unlikely that participants would have identical mental representations of what is going on. In the improv theater transcript of Example 26.1, there is a high degree of ambiguity at each dialogue turn. Although each actor may have a rather different interpretation of what is going on and where the scene might be going, they can nonetheless proceed to collectively create a coherent dramatic frame. The key question about intersubjectivity is not how agents come to share identical representations but rather how a coherent interaction can proceed even when they do not.

The traditional account of intersubjectivity does not leave room for novelty or for emergence because it stresses the reproductive aspects of interaction – in interaction, I recreate something within your mental state and you recreate something that was within mine. This view does not account for how something new could be created by group interaction. To properly represent collaborative emergence, we need to think of intersubjectivity as, following Matusov (1996), "a process of coordination of individual contributions to joint activity rather than as a state of agreement" (p. 34).

Creativity of the Components

Many complex systems in nature generate novelty even though they are composed of noncreative components. The human brain is a complex system and its components are neurons; individual neurons are not creative under even the broadest definitions of creativity. In complex systems with noncreative components, the moment-to-moment contingency of the process of emergence is quite limited, when compared with systems composed of components that are, themselves, creative. Consequently, with the brain, the components – the neurons – can simply be designed to be prepared for all foreseeable emergents – like a computer program or a detailed work-flow diagram. In contrast, in collaborative emergence, the degree of unpredictability of the interaction crosses a threshold at which the individuals – the components of the group system – must engage in creative behavior if they are to participate at all. A member of the *Samurai Jack* writing team cannot predict how the final cartoon will shape up; the potential creative trajectories are innumerable. Thus, collaborative emergence requires individual agency and creative potential on the part of individual participants.

A complete scientific explanation of mental creativity might not require that neurobiological components be explicitly represented in the explanation; most psychologists who study creativity do not couch their explanations in terms of neuroscience. However, because the components of social systems are themselves creative individuals, a complete scientific explanation of social creativity is likely to involve psychological components and to be interdisciplinary in combining explanations at multiple levels of analysis.

The Cost of Explanation

Von Neumann, one of the founders of computer science, was the first to suggest that, for complex systems, the simplest description of a complex system might be its simulation (von Neumann, 1949/1966, pp. 31–41, 47). For such systems, one cannot deduce all of its properties from the description of its mechanism; rather, the simulation must be run to determine its properties. Such arguments have become increasingly widespread in complexity science.

These insights have complex implications for psychological attempts to explain group creativity. First, they raise the possibility that, for the creativity of groups and organizations, the only potential psychological "explanation" would be to develop a simulation of the mechanism that realized the group-level emergent behavior – the individuals in the group or organization, all of their psychological processes, and their interactions – and then to run the simulation. Second and more problematic, running and then analyzing the simulation might be less efficient than explanation in terms of group-level properties and laws. (This is why we still use the ideal gas law, even though statistical mechanics has provided us with a reductionist account of the mechanisms that realize the law.)

Dupré (1993) noted that reductionist work in the human sciences can give us good lower-level theories of how systems do what they do but not exactly what those systems do. Lower-level mechanisms do not make predictions about how the system will change over time; to address these dynamic questions we may need to use the higher level, even when we already have a good mechanistic understanding of the realizing system (Godfrey-Smith, 1999, p. 177). Higher-level properties may be ineliminable because they provide the lowest-cost and highest-benefit descriptions of the regularities in the phenomena at that level (Wimsatt, 1976). If so, there are grounds for the retention of causal explanations at the higher level.

Types of Emergent Novelty

What is new? What is the exact nature of the novelty that emerges from a person, a group, or an organization? Methodological individualists, including most psychologists, claim that groups do not really create because, after all, their creations are just composed of the creative ideas of their members. Why do we need to examine collaborative emergence, if all of the action is in individual minds?

Reductionists of various sorts have used such arguments to accuse emergentists of being nonscientific for more than a hundred years. In the 1890s, the French sociologist Émile Durkheim had to defend his argument for a social level of analysis against individualist critics who accused him of positing a mysterious sociological substance, a "group mind" (Durkheim, 1895; Sawyer, 2005). In the 1920s, advocates of emergent evolution had to repeatedly and explicitly deny that they were vitalists (the belief that living things contained some additional substance in addition to physical matter); they held that their position was compatible with a thoroughly materialistic ontology, while at the same time extending beyond reductionist materialism (Morgan, 1923; Wheeler, 1928). Like their counterparts in the 1920s, today's emergent thinkers go to extremes to avoid associations with spooky, mysterious vitalism, coining terms such as "emergent mechanism" (Bechtel & Richardson, 1993) and "emergentist materialism" (Bunge, 1977).

Emergent thinking often veers dangerously close to dualist ontology: If you claim that an emergent group creation has an ontological status distinct from the ideas of the members of the group, then you seem to be claiming that there is some entity or substance in addition to the material world. And, if you deny that this is your claim, the materialist can accuse you of just being a confused, hypocritical materialist. The goal of most emergent thinkers, from Durkheim through the 1920s to today, is to navigate these difficulties and to establish a middle ground between reductionist individualism and reifying group properties. The difficulty arises because in creative multileveled systems, higher-level emergents seem to take on causal properties and thus take on what seems to be an ontological status independent of the components. But where does this emergent property come from, if not from the lower-level interactions? What is the ontological status of these emergents?

In part, the ontological confusion results from the difference between emergent process and emergent product (Sawyer, 2003a). We usually think of creativity as resulting in a product – a painting, a scientific journal article – that has its own physical existence, apart from the creator, a product that can be copied and disseminated, taking on a life of its own. Something now exists that did not exist before the emergent process generated it. Although generated by an emergent process (conceived of either as being within the brain or as being a social process), the end product is ontologically distinct from that process.

Yet many emergent systems do not generate ostensible products. To take a simple physical example, a volume of a gas inside a container generates the emergent property "pressure" but that pressure is not itself a product that results from the molecules in interaction. When the container is removed and the molecules dissipate, the "pressure" no longer exists. An improv theater performance is ephemeral in the same way as the pressure of a gas. After it is over, nothing remains but the memories of those who were present during the performance. Of course, in recent decades, modern recording technology has made it possible to "productize" improvisational performances, but nonetheless most improvisations are not recorded (whether jazz, improv theater, or ritualized oral performance) and the participants perform with the intention of making the process work for that moment, not with the intention of generating a product to be viewed again. A language like English is emergent and collaboratively created but it does not have an independent physical existence. Of course, several hundred years ago, technologies of printing, publishing, and systems of national standardization resulted in the publication of dictionaries and style guides that attempt to capture this emergent process in ostensible product form. But just as with improvised performance, this recording occurs after the emergence has occurred and does not change the processual essence of the emergence itself.

Keeping these thoughts in mind, I describe three types of emergent novelty:

1. Novel products
2. Collaborative emergence
3. Historical or evolutionary emergence

The latter two forms of emergence do not generate ostensible products. This discussion raises several fruitful questions for future research: Are there fundamental ontological differences between product-generating emergence and nonproduct-generating emergence? Do these differences affect the decomposability or reducibility of such systems?

Type 1: Novel Products

In traditional creative domains, like the arts and sciences, an ostensible product is created. These creative disciplines require manipulation of some set of physical and/or conceptual objects that exist apart from the individual creator. The result of the creative process is an object with an existence independent of the creator. These products, in turn, influence the future creative acts of all members of the discipline upon viewing, analysis, and internalization.

Type 2: Collaborative Emergence

Some emergent processes are ephemeral; once an improv performance is over, there is nothing left. But the emergent nonetheless has top-down effects. In an improv theater performance, at every moment of the performance, the emergent – the collaboratively created dramatic frame – is a socially shared emergent entity, which constrains the next dramatic action.

The school of psychology known as sociocultural psychology has begun to focus on these types of emergent social processes (Rogoff, 1998; Sawyer, 2002b). One of its distinguishing features is its rejection of reductionist methods and its attempt to explore emergent group phenomena. Socioculturalists argue that many phenomena of interest cannot be explained through reductionist analysis because they emerge from group interaction. Sociocultural approaches include the lines of research called social constructivism, activity theory, computer supported collaborative work (CSCW: Stahl, 2006), and situated cognition (Robbins & Aydede, 2008). All of these approaches share a top-down view of human behavior and hold that social groups are emergent phenomena that cannot be understood by analyzing the individual members of the group. These researchers argue that reductionist analysis won't help us understand social groups – families, peers on the playground, or classrooms – because the analyst can't predict characteristics of the higher level from properties of a lower level.

A collaborative emergent is not a final end product; it is a constantly changing ephemeral property of the interaction, which in turn influences the emergent processes that are generating it. This results in both top-down and bottom-up processes; the emergent is initially created with bottom-up dialogic processes but immediately it takes on constraining, or top-down, characteristics. In complex multilayered systems, top-down and bottom-up processes are always simultaneous and bidirectional.

Type 3: Historical Emergence

The emergence of a new molecule, new species, or new sensory organ falls into this category. As Morgan (1933) pointed out, some of these emergents can be retrospectively viewed as deterministic. For example, water is emergent from hydrogen and oxygen and, according to Morgan, the properties of water could not be predicted from those of hydrogen and oxygen before the first occurrence of water; but, after the first time, we can formulate laws with predictive power. Evolutionary biologists generally hold that we cannot predict which species would evolve at time t, even knowing fully the traits of existing species and the features of the environment at time t-1 (Gould, 1989).

Also in this category is the emergence of cultural and historical novelty – a political revolution, a new Creole language. Social entities such as money, systems of exchange, and language are not individual creations but are emergent from complex social systems. Language is perhaps the prototype example of an emergent, collective product that is stable over time, although it is not represented by a product (until perhaps the advent of literacy). These types of emergence also involve processes of type-2 emergence, in complex and poorly understood ways (see Sawyer, 2005, chap. 10).

In economics, the classic emergent is the commodity price (Arrow, 1994). Arrow argued that price formation cannot be explained with individualistic models, writing "What individual has chosen prices? In the formal theory, at least, no one. They are determined on (not by) social institutions known as markets" (p. 4). Arrow concluded that macrolevel social variables – which are emergent and unpredictable from individual behavior – are essential to studying all social systems.

Ratio of Novelty to Preexisting Structure

In emergent systems, the final state is the accumulation of hundreds or thousands of tiny emergent steps. This is the classical view of how new species emerge in evolutionary biology. From an evolutionary perspective, if there is to be continuity and novelty in evolution, "the viable novelty at each emergence must be very small indeed . . . Novelties such as life and mind . . . are of such magnitude that we can regard them only as representing the final accumulative stages of a very long series of minimal emergences" (Wheeler, 1928, p. 24).

Incremental emergence is also characteristic of collaborative emergence. At each dialogue turn, an actor can modify the emergent only a small amount; after all, that has to be the case if it is to be collaborative. Is one turn the analog of one creative product in science? Is the course of a five-minute scene more like the history of a scientific paradigm? These questions have rarely been addressed.

The incrementalist view is compatible with fields such as the history of science, or the sociology of art – which take the position that each advance is only a tiny step forward in a larger historical story. In contrast, psychologists and cognitive scientists tend to think in terms of the ultimate end product of emergent novelty. A higher-level historical or sociological view generally reveals that there is a great deal of stability and structure to creative social systems (defined above the level of the individual) and that each emergent novelty is a rather small modification to the system.

Conclusion

I began this chapter by proposing that creativity researchers, like all sciences, are in the business of gathering empirical data on a phenomenon and then developing explanatory frameworks for those data. In this chapter, I define the target phenomenon as the creative process, the process that precedes and leads to the generation of something new and appropriate. My goal has been to explore the extent to which psychological and/or sociological explanations are best for explaining any particular observed instance of the creative process. I have drawn on well-established concepts in the philosophy of science to present a framework to help us think about the relation between individual and group creativity. This framework, collaborative emergence, does not argue for one or another form of explanation for any particular observed phenomenon. However, it suggests that it is an empirical question whether a specific instance of creativity is best described in terms of individual mental processes or in terms of the social interactions of groups of individuals. It cannot be known a priori whether or not a given creation can be scientifically explained solely in terms of properties and laws about individuals. This means that psychologists should not assume that all explanations of creative processes must be part of psychology and, likewise, sociologists should not assume that group-level explanations would be optimal. Drawing on theories of explanation and on complexity science, I presented several features of complex systems that are likely to lead them to require explanations that incorporate higher-level properties and laws.

Even if one cannot explain a creation using only psychological concepts and laws, creativity researchers might still be able to develop scientific explanations using concepts and laws of sociology, perhaps in combination with individual concepts and laws. In most scientific disciplines, it is uncontroversial that scientific explanation might include systems and mechanisms at higher levels of analysis (Wight, 2004). After all, individual properties such as creative insights and conceptual combinations are themselves realized in the lower-level substrate of neurons and their synaptic connections; on what grounds would a psychologist hold that mental properties should be allowed in a scientific explanation but not social properties (Sawyer 2002a)?

One important implication of my argument in this chapter is that creativity research should be an interdisciplinary endeavor, bringing together scientists who are experts in multiple levels of analysis – neurons, mental states, groups, and organizations. This argument is consistent with proposals by other creativity researchers, including Mike Csikszentmihalyi and Howard Gardner, who have advocated for a “systems approach” that combines individualist perspectives with analyses of the social organization of creative fields and the symbolic structure of creative domains. I have called this the sociocultural approach (Sawyer, 2012). If creative groups generate emergent phenomena that cannot be fully explained using the laws and concepts of individualist psychology, a full explanation of creativity will of necessity incorporate group-level laws and concepts. An interdisciplinary science of creativity has the potential to provide a more complete scientific explanation of how new things emerge from human activity.

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27 Creativity in Classrooms

Ronald A. Beghetto

Beyond the ordinary lies the extraordinary

Philip Jackson (1990, p. xix)

Classrooms are places where students and teachers can be creative. Indeed, creativity scholars have long recognized that classrooms represent ideal settings for expressing and developing creative thought and action (e.g., Barron, 1969; Guilford, 1950; Sternberg & Williams, 1996; Torrance, 1959; Vygotsky, 1967/2004). Many of these same scholars have also noted that classrooms pose serious challenges to creative expression. How then might we understand creativity in classrooms? One way is to become familiar with opportunities and constraints that teachers and students face in classrooms.

The purpose of this chapter is to provide an updated overview of creativity in K-12 classrooms (cf. Beghetto, 2010). The chapter opens with a brief discussion of what makes classrooms unique with respect to creative thought and action. Next, I discuss the ways that teachers and students can be creative in the context of classrooms, including the kinds of constraints and opportunities that teachers and students face in classroom settings. The chapter closes with a brief discussion of future directions for research.

Understanding Classroom Contexts

Although most people have first-hand experiences with classroom environments, their familiarity with classrooms can mask various socio-psychological, material, political, and historical features that influence creative expression in nuanced and surprising ways. Failing to take these features into consideration can result in misattributing research findings about creativity in classrooms to overly simplistic causes (e.g., "schools kill creativity"; "teachers do not like creative students").

A good place to start when attempting to understand creative thought and action in K-12 classrooms is with the unique features of this setting. In what follows, I highlight a few key features of K-12 classrooms that can influence the creative expression of students and teachers. I then discuss the ways teachers and students can be creative in light of these features.

Densely Populated Designs

Classrooms contain a lot of people in a relatively small space. A typical K-12 classroom houses approximately twenty-five students and one teacher (NCES, 2013) in a room of approximately 900 square feet (Abramson, 2015).[1] To put this in perspective, consider that the average size of a one-bedroom apartment in the United States is 678 square feet (DePiertro, 2016). That classrooms are densely populated settings is not what makes them unique. There are numerous places where large groups of people are confined to small spaces (e.g., concerts, airplanes, churches, movie theaters). In most other densely populated settings, however, people do not spend as much time as they do in classrooms (Jackson, 1990). Students and teachers spend, on average, six hours a day, five days a week, 180 days a year for a total of nearly 13,000 hours (across twelve years of schooling) in classroom settings. Moreover, students in US classrooms are required to be in school until their mid-teens, whether they want to be or not.

Given that classrooms are small relative to the number of people occupying them, effective teachers design their classrooms to maximize efficient use of space, time, and materials (Brophy, 1983). Students typically sit in very close proximity to each other. Consequently, their desks tend to be arranged in an effort to focus students' attention on the teacher or task at hand, maximize teacher mobility throughout the room, and limit distractions. Moreover, teachers use the walls and spaces of the classroom to display (and reinforce) various materials (Almeda et al., 2014), including classroom rules and procedures; academic content; student work; and other nonacademic decorations.

The material features of classrooms can influence students and teachers in various ways. Educational researchers, for instance, have long described how the design, decorations, and physical features of the classroom can profoundly influence teacher and student behaviors, attitudes, and motivational orientations (e.g., Ames, 1992; Gump, 1967; Martin, 2006). Understanding how the socio-material features of classrooms influence creative thought and action is an important (Fenwick, Edwards, & Sawchuk, 2015) but often neglected aspect of creativity research. Consequently, creativity scholars should find ways to account for the potential influence that the physical classroom environment has on teachers and students.

Sameness

In response to the sheer number of students being educated in K-12 schools, classrooms have historically been designed on a principle of sameness (Schank, 2004). This approach attempts to maximize efficiency through standardization (Sawyer, 2017). Consequently, students of the same age tend to be grouped in the same classroom, so they can be taught the same topic, in the same way, and at the same

[1] The calculation is based on the recommended square footage allotment outlined in Abramson (2015): 150 square feet of teacher space + 30 square feet per student, which represents an increase of earlier guidelines of 140 square feet + 25 square feet per student.

time (Glăveanu & Beghetto, 2016). Students are then expected to complete the same learning assignments, using the same procedures, and arriving at the same answer.

The principle of sameness is understandable if the goal is to efficiently cover as much academic content as possible. In such an arrangement, however, students have little opportunity or need to develop and share their own unique perspectives on what is being taught. Goodlad (2004) provides a vivid empirical description of this phenomenon. In a multiyear, observational study of more than 1,000 K-12 classrooms, Goodlad and his team found "teachers out-talked the entire class of students by a ratio of about three to one" and that "barely 5% of this instructional time was deigned to create students' anticipation of needing to respond. Not even 1% required some kind of open response involving reasoning or perhaps an opinion from students" (p. 229).

Claxton (2008) described a similar pattern of results from a multiyear survey of more than 2,000 middle and secondary students in the United Kingdom. Specifically, students were asked to report on the three things they most often did during classroom instruction. The most frequently reported activities were "copying from the board or book," "listening to the teacher talking for a long time," and "taking notes while my teacher talks" (p. 22).

The principle of sameness not only shapes the patterns of behavior observed *within* classrooms; it also shapes similarities observed *between* classrooms. Sirotnick (1983), for instance, has asserted that the stark similarities in instructional and learning behaviors observed within and between classrooms "appears to be one of the most consistent and persistent phenomena known in the social and behavioral sciences" (1983, pp. 16–17). There are, of course, alternatives to a standardized approach (Jaros & Deakin-Crick, 2007; Tomlinson, 2014) and not all classrooms operate in this way (Dodd-Nufrio, 2011). Still, the familiar pattern of classroom behavior has not changed substantively in more than a century of schooling (Cuban, 2009; Sirotnick, 1983) as it tends to get passed on from one generation of teachers to the next (Beghetto, 2010; Calderhead & Robson, 1991; Lortie, 1975). Consequently, it is important for creativity researchers to take into consideration the historical and practical aspects of a tendency toward sameness when attempting to understand the constraints placed on creativity in K-12 classrooms.

Predetermined Roles and Goals

Given that classrooms are planned environments, the roles assumed by teachers and students are well defined and most of the activities they engage in are predetermined (Jackson, 1990). Although there are instances where students are asked to take on some of the responsibilities of the teacher (e.g., helping with certain required tasks, helping to support the learning of peers), teachers and student roles tend to be well defined, predetermined, and fixed. Moreover, students and teachers take on subidentities within these roles (e.g., "good student," "trouble-maker," "mean teacher"). These identities tend to "thicken" and become more stable over time by virtue of how individuals are socially perceived and positioned during the routine activities of the classroom (McDermott, 2001; Wortham, 2006).

In addition to teacher and student roles, teaching and learning goals in the classroom also tend to be predetermined and mapped onto the horizontal goals of other classrooms of the same grade level and the vertical goals of previous and subsequent grade levels in a particular school district (Burns, 2000). These goals are further nested in broader educational learning goals, which are shaped by state and national curricular standards. Although curricular standards are predetermined, teachers typically have some say in how specific content and skills will be taught within their classroom.

The flexibility of being able to determine how to teach content tends to be constrained by planning expectations that require teachers to specify yearly, monthly, weekly, and daily instructional sequences. Consequently, teachers often are encouraged to engage in "backward planning" to not only specify student learning goals but also specify in advance the steps that students will take to attain those goals and how those steps will be assessed along the way (Wiggins & McTighe, 1998). Such planning helps reduce uncertainty but it also limits opportunities for pursuing emergent possibilities and the ability to take new directions in the curriculum (Aoki, 2004; Beghetto, 2013). Teachers are also expected to establish and enforce behavioral rules and expectations in an effort to reduce disruptions and help students attain predetermined learning goals (Doyle, 2006; Jackson, 1990). Many of these expectations are unique to classrooms and would otherwise seem peculiar in other social settings (e.g., "do not look at the work of the person sitting next to you"; "raise your hand if you want to speak"; "ask before you use the restroom"; "wait until the entire group is ready or a bell rings to move on to your next assigned task").

Understanding the predetermined roles and goals of classrooms can help provide important contextual information for creativity researchers interested in understanding how and why different patterns of creative expression are welcome in the classroom. This understanding can also help in identifying what aspects of classroom goals and roles can (and should) be modified and those that cannot.

Socio-dynamic

Classrooms are dynamic, social environments. Even though they have somewhat stable features across time, there is a level of simultaneity, multidimensionality, and unpredictability that occurs in classrooms from one moment to the next (Doyle, 2006). Indeed, even the most tightly planned classroom activities tend to be punctuated by unexpected ruptures from students, teachers, and even the physical environment (Aoki, 2004; Beghetto, 2016a). This is to be expected given the numerous potential interactions that can occur in any given moment in a classroom.[2] Indeed, researchers who have studied observational counts of classroom interactions have, for instance, estimated that teachers have somewhere between 500 and 1,000 interpersonal exchanges with individual students on any given day (Doyle, 1996; Gump, 1967; Jackson, 1990).

[2] Consider, for instance, that in a typical classroom of twenty-five students and one teacher there are 325 possible combinations of one-to-one interactions.

In addition to multiple and frequent interpersonal interactions, teachers simultaneously engaged in different activities, such as keeping track of time, monitoring whether students need assistance, and handling various interruptions (Brophy, 1983; Doyle, 2006; Jackson, 1990). Students are also variously engaged in classroom tasks. While some may be trying to follow the prescribed lesson or adhere to behavioral expectations, others are engaged in "unsanctioned" and disruptive behaviors, such as passing a note, playing with a toy brought from home, or daydreaming out the window (Glaveanu & Beghetto, 2016; Matusov, 2009).

Taking into consideration the various socio-dynamic features of the classroom can provide yet another interpretive lens for creativity researchers interested in understanding creativity in the classroom. Rather than dismissing these features and materials of classrooms as statistical noise or unexplained variance, researchers need to develop ways to include these aspects of the classroom in their studies (Beghetto, 2016a). Doing so can help shed new light on the creative thoughts, beliefs, and actions of teachers and students in classrooms.

Overtly Evaluative

Students and teachers are continually evaluated in the classroom in formal and informal ways. Many of these evaluations occur publicly and informally (Jackson, 1990). Even classroom talk has an overtly evaluative component to it. Consider, for instance, the ubiquitous Initiate, Respond, Evaluate (IRE) pattern of K-12 classroom discourse described by Mehan (1979). More specifically, the IRE pattern of classroom talk involves teachers initiating discussions by asking known-answer questions, students attempting to provide an expected response, and teachers immediately and publicly evaluating whether those responses fit what is expected (Beghetto, 2013). This pattern of teacher talk is so common that it has even been observed in young children who are playing school (Cazden, 2001).

In addition to classroom talk, teachers evaluate students in numerous other formal and informal ways, including everything from monitoring student behavior to homework assignments, teacher-designed exams, and externally mandated tests. Students' peers also play an evaluative role in the classroom. In fact, teachers sometimes rely on students to engage in "peer monitoring" in an effort to impose sanctions on the behaviors of peers who deviate from expected achievement standards and behavioral norms (Eder & Felmlee, 1984; Wentzel & Watksins, 2011).

Students are not the only ones being monitored and evaluated in the classroom. Teachers also find themselves under the evaluative eye of their students, colleagues, administrators, and external stakeholders. Although it is true that teachers have been inundated by recent accountability mandates, teachers "have always been under the yoke of surveillance" (Smaller, 2015, p. 151). This includes the potentially stifling self-surveillance that teachers impose on themselves as a result of working in such an overtly evaluative context (Ingersoll, 2003).

Understanding the evaluative nature of classrooms can help creativity researchers better understand the kinds of creative risks teachers and students are willing (and not willing) to take in classrooms. Indeed, previous research has demonstrated that when people expect evaluation, it can stifle their creative expression (e.g., Amabile, 1996; Hennessey, 2017; see also Hennessey, Chapter 18, this volume). Additional work is needed to further understand this feature of classrooms and how teachers and students might better navigate the potentially stifling effects of such an overtly evaluative context. Taken together, these features of classrooms make for a unique and complex environment. In the sections that follow, I highlight how students and teachers can be creative in classrooms in light of these features.

Different Ways of Being Creative in the Classroom

There are various possibilities for how teachers and students can express their creativity in classrooms. As discussed, the unique features of classrooms place nontrivial constraints on those possibilities. Students and teachers can, of course, creatively resist established roles and expectations (and some do). The perceived and actual consequences of deviating from those expectations, however, tend to constrain how teachers and students are willing to express their creativity in classrooms.

As a result, teachers and students have but a "slender autonomy" in the classroom (Cuban, 2009; Smaller, 2015) and they are thereby limited in the ways they can express their creative thoughts and actions. Fortunately, creativity can still thrive within constraints of the classroom (Beghetto, 2016b). In what follows, I provide an overview of how teachers and students can express their creativity in teaching and learning, including the constraints and opportunities that come along with engaging in these forms of creative expression.

Creativity in Teaching

The two major activities that occur in any K-12 classroom are teaching and learning. Within the act of teaching, teachers have an opportunity to express their creativity and support the creative potential of their students. In order for this to happen, however, at least three prerequisites must be met. The first is teachers need to believe that they can assume the role of a creative teacher in context of their classroom (Paek & Sumners, 2017). Next, they need to be willing to assume that role (Hong, Hartzell, & Greene, 2009; Gralewski & Karwowski, 2016; Sternberg, 2015) and, finally, they need to have an understanding of what assuming that role entails (Beghetto, 2017; Schacter, Thum, & Zifkin, 2006; Davies et al., 2012; Sternberg, 2016).

There are several factors that can conspire against teachers meeting the first two prerequisites, including whether teachers believe they themselves can be creative and whether they think nurturing students' creative potential is even possible (Paek & Sumners, 2017). Beyond these fundamental beliefs about the nature of creativity, teachers also need to understand how nurturing student creativity and supporting academic learning can be compatible goals (Beghetto, 2013; Beghetto, Kaufman, & Baer, 2014) *and* they need to feel supported in pursuing both goals. One way that teacher accountability mechanisms influence teachers is by creating a situation where teachers anticipate the possibility of being sanctioned (Ingersoll, 2003).

As a result, teachers may convince themselves that it is better to avoid engaging in otherwise acceptable instructional behaviors that are not clearly endorsed by their administration or external stakeholders (Ingersoll, 2003).

These accountability pressures are not limited to classrooms in the United States. Mullen (2017), for instance, reports that teachers in China felt pressure "from parents who think that children should only be learning material for exams" (p. 113). Pressure also comes from colleagues and administration. Consequently, if teachers believe that engaging in creative teaching might result in an actual or externally perceived deviation away from their primary goal of supporting students' academic learning, then they likely would choose against it.

If teachers are able to get beyond these initial hurdles, then the third prerequisite involves developing the knowledge necessary to engage in creative teaching. A good place to start is to recognize that there are different forms of creative teaching, each of which has a different pedagogical aim and draws on a different pedagogical knowledge base (Beghetto, 2017; Jeffrey & Craft, 2004; Shulman, 1987; Niu & Zhou, 2017; Sternberg, 2005; Sternberg, Jarvin, & Grigorenko, 2009). In the context of K-12 classrooms, there are at least three forms of creative teaching: teaching *about* creativity; teaching *for* creativity; and teaching *with* creativity (Beghetto, 2017).

Teaching about creativity. Teaching about creativity refers to helping students learn about creativity so that they recognize the value of it in learning and life. This includes teaching students what creativity is and is not (Kaufman, 2016; Plucker, Beghetto, & Dow, 2004; Runco & Jaeger, 2012), different manifestations of creativity (Kaufman & Beghetto, 2009; Rhodes, 1961; Simonton, 2016), and how creativity develops within and across domains (Kaufman, Baer, & Glăveanu, 2017).

Constraints placed on teaching about creativity. There is more to teaching about creativity in K-12 classrooms than simply knowing something about creativity and having a desire to teach about it. Knowledge of the field of creativity studies is necessary but not sufficient. Given that, the primary aim of K-12 instruction is to promote students' academic learning, most K-12 teachers do not have the curricular luxury of extra time or space to make creativity a "standalone" topic.

Finding a way to combine content about creativity within the regular academic curriculum is one of the biggest constraints teachers face if they are interested in teaching about creativity (Lassig, 2012). Unless they can navigate this constraint then they likely will view creativity-related content as an extracurricular add-on (Aljughaiman, & Mowrer-Reynolds, 2005) and thereby decide not to teach about creativity (even if they are interested in doing so).

Opportunities to teach about creativity. One way of including opportunities for creative expression in the curriculum is to move away from an *either/or* mindset and toward a *both/and* approach (Beghetto, 2013). A both/and approach helps teachers move away from the concern that they must abandon academic subject matter to teach about creativity and helps them move toward considering how they might infuse creativity into their existing academic curriculum (Baer & Garrett, 2017; Beghetto, 2018; Beghetto et al., 2014; Sternberg, 2016).

Teaching about creativity requires that teachers know about the nature of creativity (Kaufman, 2016), know how to represent it in the subject areas they are teaching, and know how to make this content accessible to their students. Creativity scholars have pointed to several ways that teachers might accomplish this goal. One way to do this is to find and incorporate models of creative expression in the subject areas they are teaching.

Root-Bernstein and Root-Bernstein (2017), for instance, explain that students can and should be taught more than the "what" of academic subject areas (i.e., content that is stripped of all people, problems, processes, and context that resulted in creative discoveries). Specifically, they describe the importance of also teaching the *why, who, how, when*, and *where* of creative work. Doing so can simultaneously help students learn academic subject matter *and* the creative processes that have resulted in key discoveries in that subject area.

Along similar lines, teachers can invite professionals (e.g., writers, historians, scientists, engineers, architects) to visit the classroom (live or virtually) and explain how they put academic content to creative use in their professional work (Beghetto, 2013). This can be complimented by incorporating biographies of creators, relevant news stories, and even "biographies of ideas" (Clapp, 2016) that illustrate creative expression within and across subject areas. Incorporating biographies of ideas into the curriculum is a particularly promising approach as it can be used to trace the development of students' academic and creative ideas as they work together in solving problems (Clapp, 2016).

Teaching about creativity is an emerging area of research and development in the field of creativity studies. Although there are promising examples of work being done in this area, much more work is needed in the K-12 classroom to understand how teaching about creativity might compliment not only students' understanding of academic subject matter learning but also their understanding of creativity within those subject areas.

Teaching for creativity. Teaching for creativity refers to efforts aimed at developing students' creative potential into creative achievement. Although teaching for creativity sometimes refers to creativity training or enhancement efforts (e.g., Scott, Leritz, & Mumford, 2004), in the K-12 classroom, teaching for creativity refers to nurturing students' creative potential in the context of academic subject areas (Beghetto, 2017; Niu & Zhou, 2017). This is not to say that strategies and techniques used in creativity training programs have no relevance to classroom teachers, but rather that those techniques need to be modified so that they can be meaningfully used in the context of classroom instruction. As Baer and Garrett (2017) note, "it is hard to see how listing 100 interesting and unusual ways to use egg cartons will help Johnny improve his scores on state-mandated achievement tests" (p. 51).

Constraints placed on teaching for creativity. Teaching for creativity is constrained by several features of the classroom. Given that classrooms are densely populated settings that tend to require students to engage in the same (or very similar tasks), it is difficult for teachers to provide time and support to the unique creative interests of students that might help them develop their creative potential into creative achievement (Beghetto, 2016c; Beghetto & Kaufman 2007; Runco, 1996).

Teachers therefore need to find ways to work within these constraints to support students' creative expression in whole group formats, such as class discussions as well as small group activities and individual work. Also, given the predetermined nature of what is taught and assessed in K-12 classrooms, teachers typically do not have the time or flexibility to establish teaching for creativity as a separate curricular goal in their everyday instructional efforts (Lassig, 2012). If they are interested in promoting student creativity, then the most direct path of doing so is to infuse it into their existing curriculum (Beghetto, 2013; Craft, 2010; Fairweather & Cramond, 2010; Renzulli, 2017).

When teachers design lessons that provide students with opportunities to express their creativity, they are introducing uncertainty into an otherwise planned and highly structured instructional setting (Beghetto, 2018). Indeed, the lesson can move in unexpected and surprising directions. Although this is part of what is required when teaching for creativity, teachers need to be ready to navigate uncertainties to ensure that they are providing a "just in time" blend of support and flexibility (Beghetto & Kaufman, 2011; Sawyer, 2004). Otherwise they risk drifting too far afield from their intended instructional goals, which can cause student confusion and teacher frustration.

Teaching for creativity in K-12 classrooms also requires that teachers have deep subject matter knowledge, coupled with knowledge of how to support student creativity in the context of that academic subject matter. Teaching for creativity in mathematics would, for instance, require that teachers have a solid foundation in mathematics and know how to support creative expression in the context of mathematics instruction (Niu & Zhou, 2017).

Opportunities to teach for creativity. Creativity researchers have developed various ways to help teachers support creative potential and academic learning (Baer & Garrett, 2017; Renzulli, 2017). Moreover, given the overt focus on assessment in classrooms, creativity researchers have also been developing approaches for assessing creativity in academic domains (e.g., Grigorenko et al., 2008; Lubart & Besançon, 2016).

As with teaching about creativity, research on teaching for creativity is a promising and emerging area of inquiry. Two long-standing challenges for creativity researchers attempting to study creative teaching practices, however, are finding teachers who use creative teaching techniques (Schacter, et al., 2006; Torrance & Safter, 1986) and using methodologies that are robust enough to simultaneously explore the quantitative and qualitative features of the classroom. Studies that use blended methodologies and more purposive sampling techniques can be very helpful in examining and documenting instructional practices conducive to creativity.

One example is a recent study (Gajda, Beghetto, & Karwowski, 2017) that explored different patterns of teacher and student behaviors in classrooms classified as having positive, negative, and null relationships between creativity and academic learning. By classifying classrooms first and then using a blended analytic approach, we were able to examine more micro-level classroom behaviors and interactions, including whether and how teachers in different classrooms taught in ways that were more or less supportive of the development of students' creative potential.

Finally, teaching for creativity also involves knowing how to establish a classroom environment conducive to creative expression. Creativity researchers have identified several aspects of creativity-supportive learning environments (e.g., Beghetto, 2013; Beghetto & Kaufman, 2014; Davies et al., 2012; Hennessey, 2017; Schacter et al., 2006), including

- *Planning for and expecting creative expression from students*. Expect students to demonstrate their academic knowledge and apply their knowledge in creative ways (e.g., coming up with multiple solutions to a problem, developing their own problems, developing their own ways of solving a problem).
- *Providing students with autonomy support*. Students can benefit from having opportunities to exercise their autonomy when engaged in learning tasks (e.g., have some level of choice in how or what they work on). Importantly, this needs to occur in a highly structured learning environment (e.g., clear expectations). Moreover, in cases where teachers need to take a more directive role, students should still be provided with an explanatory rationale for such directives (Reeve, 2009).
- *Provide students with opportunities to view topics from different perspectives and possibilities*. Students can benefit from engaging in possibility thinking (Craft, 2010), which includes imagining how to move from the way things currently are to how they could or should be. This also includes being open to different perspectives (Glăveanu & Beghetto, 2016) as a means for developing new possibilities for how ideas, topics, and situations can be viewed.
- *Providing students with opportunities to view creativity and academic learning as means to other ends.* Students can benefit from learning experiences that require them to put their creativity and academic knowledge to work in solving complex challenges and ill-defined problems facing them, their communities, and beyond. (Beghetto, 2018).

Teaching with creativity. Teaching with creativity refers to approaching the teaching of academic subject matter in a creative fashion. Some creativity scholars have asserted that teaching with creativity is inextricably linked with teaching for creativity (Jeffrey & Craft, 2004). This is because modeling creative thought and action can motivate others to engage in creative behaviors (Lilly & Bramwell-Rejskind, 2004). In this way, teaching creatively is a form of socio-behavioral modeling that can encourage the expression of similar behaviors in students (Bandura, 1997).

Constraints: Teaching with creativity. Similar to the constraints placed on teaching about and for creativity, teaching with creativity is constrained by the unique features of K-12 classroom settings. Just like other forms of creative teaching, teaching creatively is not about using gimmicks (e.g., dressing up in silly costumes) or tricks (e.g., jumping from desktop to desktop). Rather, creative teaching requires teachers to know how to teach specific subject matter, to a particular population of students, in a creative fashion. Teaching creatively therefore requires that teachers strike a balance between demonstrating characteristics of creative behavior (e.g., openness, flexibility, possibility thinking, and sensible risk-taking) and ensuring that they are meeting the academic demands placed on them and their students (Beghetto, 2017).

Although creative teaching may be intrinsically valuable, it also comes with some costs. Teachers seem to be aware of several of these costs. Mullen (2017), for instance, found that teachers she interviewed believed that teaching with creativity takes more time and energy than teaching in a more traditional way. Consequently, creative teaching behaviors may be difficult to sustain over the course of an entire lesson (Gajda et al., 2017). Moreover, given that teachers are not required to teach creatively, and because there is limited (albeit promising) evidence of a positive relationship between creative teaching and academic learning (e.g., Gajda, Karwowski, & Beghetto, 2016; Shacter et al., 2006), teachers may feel that it is not worth the investment of time and energy to teach creatively. Indeed, as Baer and Garrett (2017) assert, "when accountability push comes to testing shove" teachers may quickly abandon more creative approaches to teaching and instead use that time to "drill math facts or practice reading comprehension strategies" (p. 51).

Opportunities to teach with creativity. Even with these constraints, teachers do have the opportunity to teach with creativity and it is likely the case that most teachers do, on occasion, teach creatively. Just like any form of creative expression, there is a time and a place for creative instruction (Kaufman & Beghetto, 2013). Teachers can therefore take some solace in the fact that they need not always be creative in their approach to teaching.

Having the willingness to explore unexpected turns and plan for creative openings in academic lessons can yield creative outcomes for both teachers and students (Aoki, 2004; Beghetto, 2013, 2018). Doing so requires knowledge of the subject matter, knowing how to draw out and explore ideas, trusting oneself and one's students to take learning in unexpected and meaningful directions, and knowing when to return to the planned lesson or park unexpected ideas for later exploration.

Creativity in Learning

Having discussed how teachers can express their creativity in the act of teaching, I now turn to how students can express their creativity in the act of learning. Creativity researchers have long been interested in the relationship between creativity and classroom learning. Not surprisingly, they have conceptualized this relationship in various ways (Beghetto, 2016c).

One way researchers have examined this relationship is to explore whether there is a link between creativity and academic learning. This relationship can be conceptualized as viewing creative thought as part of the process of learning (Guilford, 1950) and thereby a precursor to academic achievement (creativity → academic achievement). Researchers who have examined correlational links between creativity and academic achievement have reported variable results, although a recent meta-analysis (Gajda et al., 2016) indicated that creativity and academic achievement have a positive, albeit modest relationship ($r = 0.22$).

Another way the relationship has been conceptualized is to assert that academic learning influences creativity (learning → creativity). This view is based on the widely held assertion among creativity researchers that domain knowledge is necessary for creative expression (Ericsson, 1996). Researchers have also pointed out that the association does not seem to follow a simple linear pattern. Simonton (2016), for instance, has demonstrated a curvilinear (inverted U-shape) function, suggesting that formal schooling will eventually yield diminishing returns when it comes to creative achievement. One reason why too much formal education can suppress creativity is that it can lead to overly rigid thinking (Plucker & Beghetto, 2004).

Perhaps the most relevant way of conceptualizing this relationship in K-12 classrooms is to view creativity and learning as interdependent (creativity ←→ learning). Indeed, the constructs of creativity and learning share some core features, including that both involve change and both can be conceptualized as a process or product (e.g., Gajda et al., 2016; Alexandar, Schallert, & Reynolds, 2009). It is therefore not surprising that some of the earliest creativity scholars have viewed creativity and learning as mutually dependent and, in some cases, almost indistinguishable phenomena. Guilford (1967), for instance, asserted "creativity and learning are much the same phenomenon" (p. 307).

In recent years, the interdependent view of creativity and learning has been represented in the concept *creative learning.* Several creativity scholars have been working on clarifying what this concept means in the context of classroom settings (e.g., Beghetto, 2016c; Littleton & Mercer, 2013; Sefton-Green et al., 2011).

One way to think about how students can be creative in the context of classroom learning is to view creative expression and learning as simultaneously occurring at the individual and sociocultural level (Beghetto, 2016c). More specifically, as students engage with and attempt to understand new academic concepts, ideas, skills, and experiences they engage in a creative process of combining new stimuli with their existing knowledge structures. If students are able to establish a new and personally meaningful understanding as a result of this combinatorial work, then they have by definition engaged in a creative act, albeit at the subjective or mini-c level (Beghetto & Kaufman, 2007; Runco, 1999; Stein, 1953).

In this way, the personally meaningful learning of academic content involves a subjective, creative act. Given that there is a sociocultural (Vygotsky, 1967/2004) and social-evaluative component to learning (and creativity), it is not sufficient to leave academic learning up to the subjective judgment of students. Indeed, students need the opportunity to test out, receive feedback on, refine, and correct their understanding with the assistance of their teacher and peers. By doing so, they have a chance to not only validate their understanding of academic subject matter but also make a creative contribution to the learning of their peers and their teacher. This can happen when a student's unique perspective provides a novel and academically appropriate representation to peers and their teacher (Beghetto, 2016c).

Constraints on creative learning. The key constraint placed on students' creative expression in classrooms is that it must be deemed acceptable with respect to classroom expectations and academic task constraints. One example is what creativity researchers have described as "brief case" or "subordinate" types of creative expression as opposed to "wild bohemian" or "rebellious" types of creative expression (Dawson, 2005; Karwowski, 2016). The key distinguishing feature between these types of creative expression, at least in the eyes of teachers, tends to be whether students are still able to comply with classroom expectations.

Such expectations are, of course, not uniform across classrooms or even within the same classroom. Given the socio-dynamic nature of classrooms, the parameters of "appropriateness" are not fixed, but rather change based on the particular task, situation, teacher, and group of students (Gajda et al., 2016). Even a teacher who is otherwise open to creativity may dismiss an unexpected (and potentially creative) idea if there is limited time in the lesson, the teacher feels pressured to cover certain topics, or if the idea is perceived by the teacher as disrupting the planned trajectory of a lesson (Beghetto, 2013; Doyle, 2006; Kennedy, 2005).

Consequently, students who are willing to provide creative responses need to learn how and when to balance originality with meeting task constraints in the particular classroom setting. Being able to strike this balance is, by most definitions, what creativity is all about (Beghetto, 2016c; Plucker et al., 2004; Runco & Jaeger, 2012). Students' ability to know how and when to be creative is what has been called creative metacognition (Kaufman & Beghetto, 2013).

Creative metacognition represents one of several interrelated forms of creative self-beliefs that researchers have posited as important to helping determine whether people will be willing to share, receive feedback on, and develop their creative potential into creative achievements (see Chapter 19 of this book). Developing healthy creative self-beliefs can thereby be thought of as an important goal for students.

Even if students are able to know when and how to express their creativity, they still may be reluctant to do so given the various socio-dynamic constraints of the classroom. Indeed, as Bandura (1997) has long noted, the link between beliefs and behaviors is reciprocally influenced by a dynamic constellation of environmental, personal, and behavioral factors. One example comes in the form of subtle (and not so subtle) motivational messages of the classroom.

Consider, for instance, a teacher who provides opportunities for students to creatively express themselves on a challenging task. In an effort to generate excitement and task completion, the teacher promises an appealing prize or reward for students who are the first to complete it. Even students who are capable of creative expression may become so focused on winning the prize that they are not willing to take the risks necessary to try doing something new and potentially creative. As Hennessey (2017) has explained, "hundreds of published investigations reveal that the promise of a reward made contingent on task engagement often serves to undermine intrinsic task motivation . . . including creativity" (p. 235).

Opportunities for creative learning. Within the context of K-12 classrooms, students have numerous opportunities for creative expression. In recent years, there have been various options designed specifically to provide students and teachers with opportunities for creative learning, including Makerspaces, design challenges, real-world problem-solving projects, and other activities and tasks that provide semi-structured and ill-defined problems (Beghetto, 2018; Hathcock & Dickerson, 2017; Renzulli, 2017; Saorín et al., 2017). Such opportunities can serve as vehicles for students to blend academic learning with creative expression within the context of the regularly scheduled school day.

Aside from these options, there are also opportunities for creative expression in more conventional instructional activities and assignments. Even a standard mathematical word problem, for instance, can be used as a vehicle for creative expression by requiring students to solve the problem in as many unique and mathematically accurate ways as they can (see Niu & Zhou, 2017). Along similar lines, curricular content standards that establish guidelines for encouraging students to represent their knowledge in multiple ways or engage in open-ended problem-solving provide opportunities for students to simultaneously develop their creative potential while still adhering to subject matter constraints.

Moreover, openings for creative expression appear even in highly planned and structured lessons (Aoki, 2004). Such openings can also serve as opportunities for students and teachers to engage in creative learning (Beghetto, 2016c). Capitalizing on these opportunities requires that students have support from their teachers so that they can learn how to express their own unique perspectives while still adhering to the requirements and expectations of the task at hand. Without systematic guidance along these lines, students may find their ideas dismissed, become discouraged, and possibly abandon their creative aspirations (Beghetto & Dilley, 2016).

Concluding Thoughts

Classrooms represent a promising site for creative expression and creativity research. Realizing the promise requires an understanding of the unique features of K-12 classrooms. With respect to creative expression, students need to have opportunities to develop their creative potential and have continual support and feedback to learn how to strike a better balance between meeting task constraints and novel expression in context of the various academic subject areas.

Teachers also need to have opportunities to develop their understanding of the different forms, aims, and knowledge bases necessary for creative teaching. Simply wanting to support creative expression in the classroom is not sufficient for knowing how to teach with, about, and for creativity. Consequently, teachers interested in supporting their students' (and their own) creative expression will need to become familiar with the field of creativity studies, learn what aspects of the insights from the field are relevant to their professional practice, and learn how to blend their knowledge of creativity with their knowledge of how to teach students within the various constraints of the K-12 classroom.

Classrooms also provide a very promising and challenging site for conducting research on creative thought and action. Although much work has already been done, there is much left to do. Without the efforts of current and future generations of creativity researchers who are willing to develop a deep understanding of the unique features of K-12 classrooms, teachers and students will have limited actionable information to draw on from the creativity studies literature.

Researchers need to go beyond studying classroom creativity at a distance and, instead, be willing to study creativity "in the wild" of the classroom. One way of doing so is for researchers to partner with educators in order to design studies that allow them to take into account the dynamic and nuanced features of creativity in K-12 classrooms. This includes developing more dynamic and blended methodologies and finding ways to make the results of their work more accessible to K-12 teachers and students.

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28 Play and Creativity

Sandra W. Russ and Ellen A. Doernberg

What is creativity? What is play? There are many similarities between the components of a creative act and pretend play. Many of the processes that are expressed in pretend play are also expressed during a creative act. This chapter reviews the similarities in these processes and the research evidence for the link between play and creativity. An important question is whether play facilitates the development of these creative processes or simply reflects them. We review the current evidence and make suggestions for future research.

Defining Play and Creativity

Creativity has been conceptualized both as a product and as processes within the individual. A creative product is one that is original, of good quality, and appropriate to the task (Sternberg, Kaufman, & Pretz, 2002). Although children have not mastered the content of an area to make major contributions to a domain, they can generate products that are creative for their age group and can engage in creative acts. The make-believe in pretend play is one example of a creative act. The processes within the individual that are important in creative production, such as divergent thinking (generating a variety of ideas and solutions), flexibility of thought, remote associations, access to affect-laden cognition and memories, and joy in creative expression, are also important and active processes in pretend play. The fact that so many of these creative processes overlap in creative production and in pretend play has implications for child development (Russ, 1993, 2014).

Although there are different forms of play, this chapter will focus on pretend play because it is pretend play that is associated with creativity. What is pretend play? There are some classic definitions of pretend play. Krasnor and Pepler (1980) described pretend play as involving four components: nonliterality, positive affect, intrinsic motivation, and flexibility. Fein (1987) described pretend play as a symbolic behavior in which "one thing is playfully treated 'as if' it were something else" (p. 282). For example, a Lego piece becomes a dog or a pipe cleaner becomes a giraffe. Fein thought that pretend play is a natural form of creativity and that affect and cognition were intertwined during play. Russ (2014) elucidated examples of how creative processes are expressed in play (see Table 28.1). For example, divergent thinking occurs when the child uses blocks to represent different objects or generates many different story themes. Remote associations are manipulated when the child makes a rocket ship at the breakfast table to blast off cheerios into space. Perspective-taking is evident in role-playing with different characters. Affect-laden cognition occurs when a scary monster carries off a beloved dog and the doll cries. Joy in pretending is evident when the child experiences pleasure and engagement in the play. Cognitive flexibility occurs when story elements are manipulated and the logic of time and space is loosened. Boyd (2009) thought that the kind of flexibility in thinking that occurs in play is crucial for creative work in adulthood. So do many child development theorists such as Runco (2016), Singer and Singer (1990), Fein (1987), and Vygotsky (1930/1967). Vygotsky proposed that imagination developed from children's play and that creativity itself was a developmental process.

There are a number of theoretical explanations as to why pretend play should be associated with creativity. Singer and Singer (1990) conceptualized pretend play as an interaction between cognitive and affective processes. Play and its associated skills serve as an indicator of creative potential not only in later childhood and adolescence but also in the adult years. Singer and Singer (2005) reviewed the genesis of make-believe play in children as young as two years old and described how pretend and storytelling play contribute to cognitive, social, and emotional skill development over the life span. They conceptualized that aspects of adult consciousness (wakeful perception, identification, labeling, encoding, etc.) are enhanced by playfulness and that features of early-childhood play may serve to foreshadow these

Table 28.1 *Model of creativity and pretend play (from Russ, 2014, p. 25)*

Creative Processes in Pretend Play	Examples in Play
Divergent Thinking	Block transformations
Broad Associations	Different story ideas and elements
	Wide fantasy and remote images
Cognitive Flexibility/Recombining Ideas	Use toys in different ways
	Manipulating story elements
	Loosening of time and space
Insight and Problem-Solving	Building novel objects
	Playing with mechanical objects
Perspective-Taking	Role-playing
	Pretending to be different characters
Narrative Development	Story plots and sequences
Affect Themes and Symbols	Monsters; Cops and robbers
	Yummy food
Emotional Expression	Dolls fighting; Dolls hugging
Joy in Pretending	Pleasure and absorption in the play
Integration of Affect/Affect Themes	Placing emotion in an appropriate narrative

later-life skills. They also believed that pretend play was practice with divergent thinking. Kogan (1983) and Dansky (1999) stressed the cognitive flexibility and free combination of ideas and objects that occurred in play as facilitating divergent thinking and creativity. Fein (1987) thought that the manipulation of affect symbol systems in play resulted in a rich store of associations and memories.

Russ (1993; 2014) integrated psychoanalytic theories with these current approaches to explain why expressing affective content in play would be related to creativity. Children who were comfortable thinking about affect themes, especially those that were negative or involved conflict, would have more access to memories, images, and ideas that included emotion. Through pretend play, children could express emotion and conflict and integrate emotions into stories. In this way, children become comfortable with emotion and cope with emotional events. Having more access to emotional images and memories should result in a broader search process. Therefore, more associations and emotion-laden memories could be called on in creative activities. In addition, the ability to go back and forth between logical thinking and illogical more primitive thinking is important in creative expression and in pretend play. Psychoanalytic theorists refer to this ability as adaptive regression (Kris, 1952). Russ also thought that the joy of creative discovery in play gave the child a creative experience that motivated them to engage in more creative activities.

One important characteristic of play is that it is self-generated thought (Russ, 2016). Children make things up from scratch. Self-generated thought has been found to be important in the neuroscience of creativity (Jauk, Benedek, Neubauer, 2015). Runco (2016) pointed out that self-generated thought is consistent with Piaget's (1976) concept of reflective abstraction and that both types of thinking may result in original creative insights.

A synthesis of the definitions and theories about pretend play would include many processes and components. A pretend play episode could involve a few or many of these components and different levels of these processes. The implication of this view of pretend play is that there are many different profiles of pretend play abilities in children, just as there are many profiles of creative abilities in adults. Children express and practice with these different processes in play, perhaps according to their interests and talents.

Current Research on Play and Creativity

Theoretically, there is a link between play and creativity, but what does the current research indicate about this relationship? Research that involves correlations between pretend play and creativity supports the relationship. Experimental research that investigates whether pretend play actually facilitates creativity has mixed findings.

Most of the research on play and creativity in children has focused on play and divergent thinking. There are a large number of studies that have found significant relationships between different measures of pretend play and divergent thinking (for reviews, see Dansky, 1999; Russ, 2014). For example, D. Singer and Rummo (1973) found a relationship between play and divergent thinking in kindergarten boys. Wyver and Spence (1999) found that thematic and cooperative play was related to divergent thinking on a semantic task in preschoolers These correlations were significant when intelligence was controlled. Lillard and colleagues (2013) have criticized some of the play and divergent thinking studies for having the same individual administer the play task and the divergent thinking task, which raises the possibility of experimenter bias. This is an important methodological point. However, there are studies that used different examiners for each task who were blind to performance and found significant associations, as hypothesized, between the play measure and divergent thinking (Lieberman, 1977; Russ & Grossman-McKee, 1990; Singer & Rummo, 1973).

One of the methodological problems in the play research literature has been that different measures of play were used in different studies. The Affect in Play Scale (APS; Russ, 1993; 2014) was developed to assess both cognitive and affective processes in pretend play with a standardized set of instructions, prompts, and scores for children ages 6–10. Children are asked to play with human puppets and blocks for 5 minutes and to have the puppets do something together. A version of the APS was developed for children ages 3–5 that used more toys and structured instructions (Kaugars & Russ, 2009). The APS is scored on a 1–5 scale for imagination, organization of the story, and engagement in/enjoyment of the play. Frequency of affect themes in the narrative is counted, including eleven different affect categories (happiness, fear, aggression, etc.). Variety of affect categories and intensity of affect can also be scored. There is a detailed manual available for coding and interrater reliability is consistently high. Using this standardized play task, the APS pretend play ability has been found to relate to divergent thinking in six different studies with different school-aged child populations and different examiners (Hoffmann & Russ, 2012, 2016; Russ & Grossman-McKee, 1990; Russ & Schafer, 2006; Russ, Robins, & Christiano, 1999; Wallace & Russ, 2015). The preschool version of the APS related to divergent thinking in two studies in four- and five-year-olds (Kaugars & Russ, 2009; Fehr & Russ, 2016). The correlations usually remained significant when verbal intelligence was controlled. For example, in one study, children in the first and second grade who had more imagination and more affect themes in play on the APS could think of more uses for objects on a divergent thinking test than could children with less imagination in play (Russ & Grossman-McKee, 1990). These relations were of medium effect sizes (r = 0.35, $p < 0.001$ and r = 0.42, $p <$ 001 respectively) and remained so when intelligence was controlled.

In addition, several longitudinal studies found that early play ability predicted creative thinking at a later time. For example, Russ and colleagues (1999) conducted a longitudinal study and found that imagination and organization in early play (first and second grade) predicted divergent thinking four years later. Different examiners were used in the original and follow-up studies. In another longitudinal study that followed the children in the Hoffmann and Russ (2012) study, Wallace and Russ (2015) found that pretend play predicted divergent thinking over a four-year period (2015). This replicates the Russ and colleagues (1999) findings. In addition, when baseline divergent thinking was controlled for, play continued to significantly predict divergent thinking. This suggests that components of play in addition to divergent thinking, such as affect expression or narrative organization, are associated with divergent thinking over time.

In most of the studies with the APS, both imagination and affect themes in pretend play related to the divergent thinking measure. This is important because affect has been neglected in the play research area and yet is so important in creativity (see Baas, Chapter 12, this volume). The amount of affect expressed in play, positive and negative affect, related to divergent thinking. Children with more affect expression in the play narrative had higher divergent thinking scores.

Studies have found relationships between play and other measures of creativity as well. Kaugars and Russ (2009) found that pretend play in preschool children related to teacher ratings of make-believe in children's daily play behavior. Fehr & Russ (2016) found a relation between pretend play and creative storytelling in preschoolers and Hoffmann and Russ (2012) found a similar relation in school-aged children. Affect in play also related to affect in stories. The stories were rated for creativity by independent raters. Affect in play has also related to affect in memory descriptions (Russ & Schafer, 2006). These findings suggest that affect expression in play narratives is a cross-situational ability that occurs in other situations that involve access to affect-laden thoughts. There are many descriptions by adult creative artists that describe the importance of using emotional content in creative work. Russ (2016) cited case examples of artists who stressed the importance of affect in memories, such as the poet Stanley Kunitz. Kunitz (2005) described the importance of "getting down to the very tissue of experience" (p. 103) in writing poetry. This ability is important in many forms of artistic expression. Developing this ability, through pretend play and other forms of expression, as a child can set the stage for adult creative work.

Pretend play has related to creativity measures in a large number of studies in different research programs, with different child populations, and in different environments. Some of these studies were rigorous and used different examiners for the different tasks. Therefore, we concluded that there is good evidence for the association between pretend play and creativity and that this association is relatively stable over time (Russ & Wallace, 2013). Although there are no longitudinal studies that have followed children into adulthood to assess prediction of adult creativity from early play, there is research that has found that divergent thinking in children is predictive of adult creativity (Plucker, 1999). There is also evidence that highly creative adults (MacArthur "genius" fellows) reported having imaginary worlds in childhood (Root-Bernstein & Root-Bernstein, 2006).

Further correlational work has examined the connection of pretend play and creativity to milestone developmental skills in cognitive and social abilities, such as symbolic thinking, theory of mind, and counterfactual reasoning. Weisberg (2015) found that theory of mind and pretending in play may serve as mutually supportive skills in development, as they both allow children to focus on the mental states of others. Weisberg also concluded that, given the ability to use pretense in pretend play and create characters, situations, and outcomes, pretend play could serve as a means to facilitate counterfactual reasoning skills in children.

Mottweiler and Taylor (2014) investigated the relationship between elaborated role-play and creativity. Role-play involves empathy and perspective taking when the child pretends to be different characters. Preschoolers and their parents were interviewed about the child's engagement in role-play and asked follow-up questions to elicit elaborations of the made-up characters. To assess children's creativity, the children were asked to draw a picture of a real person and a made-up person and were prompted to complete a story stem about a magic key. Children who had imaginary friends and children who engaged in stable impersonation had more creative story stem completions, and children with imaginary friends drew more creative pictures of made-up people (Mottweiler & Taylor, 2014).

Because the evidence of a relationship between pretend play and creativity is strong, one practical implication is that assessment of pretend play could be useful in evaluating creative potential – especially in very young children (Russ, Fehr, & Hoffmann, 2013). An assessment of creativity in pretend play added to a battery of other creativity measures might identify children who otherwise are overlooked. Pretend play assessment would add a measure that is relatively independent of intelligence. This is an important research question for future assessment of creativity.

Does Play Facilitate Creativity?

A major question is whether pretend play only reflects processes important in creativity or actually aids in the development of those processes. Is there a causal relationship between play and creativity? Does engaging in play have a facilitative effect on creativity? There is controversy in the literature about the rigor of studies that support causation. Lillard and colleagues (2013) concluded that there is no support for play having a causal effect on creativity. They raised a number of valid methodological criteria for play intervention studies, including adequate control groups and experimenters blind to hypotheses and performance on play measures. In contrast, Dansky (1999) and Russ and Wallace (2013) concluded that there are rigorous studies that have demonstrated the facilitative effects of play on creativity. Although there are different opinions about how the results of individual studies should be interpreted, there is a consensus that methodologically rigorous studies with large samples, blinded experimenters, adequate control groups, and valid measures of play and creativity are needed (Lillard et al., 2013).

There is some evidence that play facilitates divergent thinking. In several experimental studies, pretend play did facilitate divergent thinking in preschool children (Dansky, 1980; Dansky & Silverman, 1973). In the Dansky and Silverman study, it was found that children who played with objects during a play period gave significantly more uses for those objects than did a control group. Dansky (1980) refined the earlier study and found that play had a generalized effect on objects that were different from those in the play period.

Smith and Whitney (1987), in a carefully executed study, failed to confirm the hypothesis that play would enhance divergent thinking in preschool children. In their study, they had a different experimenter administer the divergent thinking task after the play task.

A carefully controlled study by Russ and Kaugars (2000–2001) did not find an effect of play on divergent thinking. This study was different from Dansky's study in that children did not play with objects. Rather, they played with puppets and blocks on the APS, making up stories. Also, the children were first- and second-grade children rather than preschoolers. Eighty children were randomly assigned to one of four groups: a happy puppet play group; an angry puppet play group; a free play group; and a control puzzle group. Children were given different instructions about having the puppets play out a happy story, angry story, or neutral story. The Alternate Uses test (divergent thinking) was given immediately following the play, by the same examiner. There was no effect for any of the play conditions on divergent thinking. The experimental affect manipulation did work for the angry group (on a mood check) but not for the happy group. So, the hypothesis remains untested for the positive affect group. Perhaps a more appropriate outcome measure would have been a storytelling measure. This raises the methodological issue of choosing the outcome measure that makes the best conceptual sense in the study.

It is possible that a number of play intervention sessions are needed before effects are demonstrated. Christie (1994) has cautioned against brief one-trial studies in the play intervention area. It may take time for the development of processes in pretend play that would, in turn, facilitate creativity. Also, a one-trial study could be targeting a different variable – such as loosening a set or increasing positive mood – than a series of play sessions. There is evidence that when pretend play occurs in multiple sessions over time, increases in components of creativity occur. For example, Kasari, Freeman, and Paparella (2006), in a randomized controlled study with children with autism, found that a play intervention resulted in increased symbolic play. These were young children from three to four years of age. This was a rigorous study that began the intervention at the child's current developmental level. The training involved modeling and prompting. Children received 30 hours of intervention weekly for six weeks on a daily basis. This was a rather intensive intervention but is necessary for children with autism. Children in the play group, compared with children in joint attention and control groups, had increased symbolic play that generalized to play with mothers.

A play intervention protocol that uses standard story stems, prompts, and a variety of unstructured toys was developed in a pilot study by Russ, Moore, and Farber (2004). First- and second-grade children in an inner-city school with a high degree of poverty received five individual 30-minute play sessions following a standard play intervention protocol. Different examiners blind to the group assignment assessed baseline play and outcome play on the APS. There were two play groups (imagination and affect) and one control group (puzzles and coloring). The play groups had a variety of toys available and played with the adult facilitator. They were asked to play out specific story themes that focused on imagination (have a boy go to the moon) or affect (have a girl be happy at a birthday party). The adult played with the child and followed the child's lead in the story but also praised, modeled pretend and affect expression, and asked questions. There was adult interaction with the child in the control group as well (coloring sheets and puzzles).

The major result of this study was that the play interventions were effective in improving play skills on the APS. The affect play condition was most effective in that, after baseline play was controlled for, the affect play group had significantly higher play scores on all play processes. These children had more affect in their play (both positive affect and negative affect), a greater variety of affect content, and better imagination and organization of the story than did the control group. The imagination play group also had significantly more positive affect and variety of affect than the control group. Another major finding was that, on the outcome measure of divergent thinking, there were significant effects for group. Although the individual contrast comparisons did not reach significance, inspection of the profile plots indicated that the play groups (usually the affect play group) had higher scores on the divergent thinking test. However, one limitation of this study was that no baseline measure of divergent thinking was obtained.

In a follow-up study of these children four to eight months later by Moore and Russ (2008), the imagination group had improved play skills over time. The affect group did not maintain the play changes over this period. It may be that an increase in affect expression from a play intervention is temporary, whereas an increase in imagination and pretend in play could be longer lasting. In the follow-up study, there no longer was a significant group effect for divergent thinking. In fact, the control group now had higher scores. Perhaps booster sessions would have been useful in maintaining the initial group effects.

In a group adaptation of the play intervention, Hoffmann and Russ (2016) found that small group play sessions, when compared with a control group, did result in increased imagination and affective expression in play after six sessions. In addition, there was a transfer effect in that below-average players at baseline increased in imagination in play and also increased performance on a divergent thinking task. To date, in the Russ research program, we have been able to increase imagination and affective expression in pretend play with standardized play intervention sessions with elementary school children. There have been transfer effects to a divergent thinking measure in two studies. On the other hand, we did not find facilitation effects when a similar study was carried out with preschool children (Fehr & Russ, 2016). It is possible that preschool children need parents to play with them at home for more continuity in development of play skills.

There is evidence that pretend play activities foster other skills important in child development. Singer and Singer (1999) developed a video-based program for parents and other caregivers of preschool children that uses make-believe play to enhance literacy. The "My Magic Story Car" video program, in a nationally tested study, resulted in improved literacy skills. Many children continued to play the make-believe games on their own and taught the games to other children.

Goldstein and Winner (2011) examined the development of theory of mind skills in middle childhood and adolescence, using role-play, pretense, and acting as a means of honing skills. Children ages 8–11 years of age participated in this study (n = 36), none of whom had any previous acting training or classes. Participants were randomized to an acting group or a control group. The acting group underwent a training involving improvisational games and playing short scenes from classic children's plays, i.e. role-playing. After training, children were administered two theory of mind tasks: *the Faux Pas* test (Baron-Cohen et al., 1999) – which has participants listen to vignettes of characters committing small social errors, i.e., a women calling a little girl a boy, and then answering questions to gauge their memory/understanding of the story – and *the Reading the Mind in the Eyes* test (Baron-Cohen et al., 2001) – in which participants are shown a series of black-and-white images of people's eyes and they must select the emotion/cognition expressed out a choice of four words per picture. Parents of participating children also completed self-report measures of their children's play, imagination, and social skills. Results from this study indicated that engaging in role-play and pretense predicted theory of mind skills in a sample of middle-school children, regardless of socioeconomic status, age, or verbal IQ. While this study focused the argument on the relatedness of role-play to understanding/perceiving others' mental states, it makes an indirect case for the positive influence of pretense in play on concepts connected with creativity, such as theory of mind.

There is a growing literature on guided play and learning. Weisberg and colleagues (2014) have reviewed research on guided play and facilitation of different types of learning. Guided play is led by the child but scaffolded by the adult with a goal of building skills or knowledge (Zosh et al., 2017). Guided play is part of the concept of playful learning. Zosh and colleagues (2017) concluded that there is solid research support for the effectiveness of guided play in facilitating learning in areas such as math and literacy. They also spoke to the virtues of guided play in promoting creativity in children. They suggested that a prepared mindset that is playful could nurture creativity. This would be an indirect effect of playful learning on creativity.

The play intervention protocol used in the Russ research program described in Moore and Russ (2008) involves guidance in that there are story stems and prompts by the adult that involve praise, modeling of pretend, prompting of affect expression, and so on. However, the goal is to increase imagination and affect expression within the play itself – to foster creativity in the play. One goal is to give children a tool – increased pretend play skills – that they enjoy engaging in that could enable them to use play for a variety of purposes in the future.

There is great potential in using pretend play activities to help children develop the processes that are important for later creativity in future careers or in daily life. However, there are many challenges to conducting research in the play area. It is important to clearly conceptualize the type of play, processes being targeted in the play, and goal of the study. Researchers should follow the guidelines put forth by Lillard and colleagues (2013). In addition, it is important that various play intervention protocols be developed for different goals. Play experiences that help children improve their divergent thinking skills could be different than those that improve creative storytelling. A child's developmental level, play style, and talents should be respected. And, most important, the play experience should be enjoyable for the child.

Play and Creativity in the Future

Times are changing and children engage in free play less than they used to (Hirsh-Pasek et al., 2009). Computers and video games take up an enormous amount of childhood time. Given this reality, can this media be utilized to develop creative processes?

Telehealth Approaches – Videoconferencing

Telehealth, or telepsychology, is the application of psychological tasks and/or services over a remote platform, i.e., videoconferencing. Research indicates that there are numerous potential benefits associated with the use of telehealth methodologies, including cost-effective intervention options, increased ease of access to services, and increased provider system coverage (Langkamp, McManus, & Blakemore, 2015; Wainer & Ingersoll, 2015). Telehealth allows participants to interact directly with clinical researchers and interventionists, allowing for providers to track their patients' progress and understanding through technological applications such as active learning tasks and/or feedback surveys.

Since research suggests that telehealth may serve as a feasible and effective means of remote delivery of psychological services, a major question is whether structured play tasks and play interventions may be administered via videoconferencing methods, and whether children can be guided in pretend play by a partner over this remote platform. Can children engage in pretend play in an authentic way through videoconferencing?

We recently investigated this question in an atypical population, children diagnosed with Prader-Willi Syndrome (PWS). PWS is a congenital genetic neurodevelopmental disorder that is characterized by intellectual impairments, hyperphagia, intense food preoccupations, obesity, characteristic appearance, and maladaptive behavior (Cassidy et al., 2012; Dykens, Cassidy, & King, 1999). It is a rare syndrome (1 in 12,000–15,000 births). Apart from maladaptive functioning due to food preoccupation and difficulty regulating eating behaviors, this population also experiences decreased social and emotional functioning compared with their typical peers, resulting in further problem behaviors (Dykens & Kasari, 1997; Dykens & Rosner, 1999; Holland et al., 2003). Children with PWS also experience deficits in social responsivity and competence, and high externalizing behaviors surrounding their cognitive and behavioral rigidity (Descheemaeker et al., 2006; Dimitropoulos, Ho, & Feldman, 2013; Dykens, Lee, & Roof, 2011). Cognitive rigidity is common in these children and research has shown that they exhibit similarly impaired pretend play skills as do children on the autism spectrum (Zyga et al., 2015). Through recent research, we found by examining the Individual and Joint Play sections of Modules 2 and 3 in the Autism Diagnostic Observation Schedule, Second Edition (ADOS ®-2) that children with PWS show enhanced skills in play with the addition of a play partner, and therefore may benefit in developing play and other generalizable skills with a play facilitator present (Zyga et al., 2015). We designed a novel play-based intervention program in order to promote emotional expression and regulation, cognitive flexibility, and social skills for school-aged children with PWS. Because PWS is a rare syndrome, we conducted this study as a remote intervention program via video platform in order to provide participation opportunities at the national level, while also investigating the feasibility of pretend play via a remote platform. We examined the feasibility and acceptability of this direct telehealth play intervention with children ages 6–12 diagnosed with PWS (n = 8).

Children enrolled in this study underwent the following procedure: an in-person pre-intervention visit to measure baseline cognition, language, affect, behavior, and play ability; twelve remote play sessions over a six-week intervention period (two sessions per week); and an in-person post-intervention visit to measure change in baseline abilities via a link emailed by the play interventionist. Participating families were given a standardized toy kit at the pre-intervention assessment, including blocks, a set of dolls, a toy car, toy animals, toy food and drink, and Lego. Both the play interventionist and the child had the same set of toys. Play sessions targeted cognitive rigidity, transitioning between tasks, emotional expression, and emotional regulation. Sessions averaged 15–20 minutes in length and the interventionist/play partner used story stems of varying complexity to directly engage the child (i.e., a happy story about going to the zoo, building up to a story that focuses on losing a toy, feeling sad, but learning to be okay with it). At the end of the twelve intervention sessions, participating children and their parents were seen for another in-person visit to assess the same language, behavioral, affect, and play abilities measured at baseline. We then asked parents of the participating children to anonymously complete a modified version of the Behavioral Intervention Rating Scale (BIRS; Elliot and Treuting, 1991) to assess feasibility of this approach. Seven of the eight participating families completed this survey, and overall results indicated that the children completed the program with minimal behavioral or technological difficulty (#sessions M = 11.875/12), and the BIRS results indicated good acceptability overall (M = 5.54/6.00) (Dimitropoulos, Zyga, & Russ, 2017). Most notably, results indicate that children with PWS are able to play with a remote play partner over a video platform. Parents reported that children enjoyed the intervention and the interaction with the play partner. This study is still in progress.

Pretend play is typically associated with in-person interactions, but our recent work suggests that remote delivery is a feasible and effective application of pretend play between two or more individuals. To our knowledge, this is the first report of direct play-based intervention using a remote interface in children with a neurodevelopmental disorder and no such remote pretend play intervention has been demonstrated with typical school-aged peers. Future research should include additional study of pretend play intervention with children via telehealth methodologies across typical and atypical populations.

Video Game Play

Over the past few decades, video game play has increased dramatically at the international level. While certainly a source of entertainment, what effect do video games have on creativity? In a recent volume, *Video Games and Creativity* edited by Green and Kaufman (2015), authors review this relationship.

Why might video games increase creativity? In many forms of video games, there are similarities to pretend play. Russ (2014) pointed out that, although video games do not demand a total generation of a story as in natural pretend play, many games do involve partial story generation. Jenkins (1998) proposed that video games involve world making and spatial storytelling. He identified different ways and degrees that narration can be involved in video games. Playing games with narration involved could help children develop their imagination and become comfortable with emotions, make-believe, and fantasy.

Is there sufficient experimental research to support the causal relationship of video game play and subsequent creativity? To date, there is no definitive study but there are studies that are suggestive of causation. Bowman, Kowert, and Ferguson (2015) reviewed the literature. They cited research by Jackson and colleagues (2012) that examined 500 twelve-year-olds over a two-year period that found that children who played more video games in their leisure time than age-matched peers demonstrated higher levels of creativity at the end of the study. Children were given a task to write a story about an elf, and researchers found significant positive correlations between video game play and creativity in drawing forms and writing a novel fictitious story given a prompt. They also cite arguments by Grodal (2000) and Nakamura (2009) that video games allow for construction of a variety of personae/creative identities within play, which leads to increases in creative expression. Interviews with a number of experienced *World of Warcraft* players – a highly popular video game – found that these gamers actively construct stories about the gaming experience – about how the "avatar" (on-screen character) might be affected by the gamer's own thoughts, feelings, and actions (Banks 2013).

Research has demonstrated that a relationship between video game play and creativity does exist but further experimental research is needed to determine whether that relationship is causal. Future study should examine different types of video games and their resulting levels and/or connections to creativity.

Dissemination

As we develop pretend play intervention protocols (or video game protocols) that enhance creativity, it is crucial that we get the word out to parents, schools, and childcare providers.

Making these protocols, games, or apps easily available and easy to integrate into daily life at home and school is important. We also need to disseminate the knowledge that we already have about the relation between pretend play and creativity. Expression of emotion in play is natural and important – both positive and negative affect. Children need time and space to play with support from adults in their lives. Young children and children with developmental problems can benefit by playing with a play partner who can model pretend and scaffold the play. Older children need time for solitary play and play with peers. Most children are always ready to play – adults need to be ready to provide what they need. Research needs to provide the directions for growth in the field. In order to accomplish the necessary research and dissemination, there should be multisite studies with large samples and long-term follow-up. The culture (and funding agencies) need to invest in pretend play in child development.

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29 The Creative City

Richard Florida

The general belief that creativity is an individual undertaking is reflected in countless images of the great genius or tortured artist alone, whether it is Beethoven, Mozart, da Vinci, Michelangelo, Picasso, Andy Warhol, Stravinsky, Louis Armstrong, John Coltrane, or Jimi Hendrix. But, as this volume shows, creativity is, and has always been, a collective, social process that emerges from groups. For centuries, great thinkers, artists, and entrepreneurs – all engaged in creative pursuits – gathered and flourished in places where the cultures and conversations were the most stimulating. They were attracted to these hubs by the inventiveness, imagination, and innovations of other creative people, whose energies, in turn, were fueled by one another. Through these symbiotic relationships emerged the new ideas and businesses that drove growth and prosperity. The denser and larger the community, the more intense the ferment of ideas.

Today, the cities that are truly booming – not just global colossuses like London, New York, Milan, and Shanghai but smaller knowledge industry redoubts like Austin, TX; San Jose, CA; and Boulder, CO – owe their vitality to their ability to attract, retain, and mobilize creative people. However, there remains one big downside. Today's most creative cities are also the most divided and unequal. The same clustering of people and industry that drives creativity, innovation, and economic growth also leads to the sorting of people by class, as the members of the creative class colonize the most economically functional and aesthetically appealing areas of the city, pushing the less advantaged blue-collar and service classes into the more disadvantaged and disconnected areas of the city or, increasingly, out into the peripheries of the suburbs, far away from transit and jobs.

The remainder of this chapter proceeds as follows. The first section discusses the historical role of cities in creativity. Then I turn to the principal characteristics of creative cities today, including their challenges and downsides. The conclusion summarizes my key themes and takeaways, outlining the best ways to build and sustain creative cities going forward.

This chapter draws on research conducted with Charlotta Mellander and my research team. Special thanks are owed to Karen King for help with the research and Ian Gormely for editorial assistance.
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Historical Role of Cities in Creativity

Human progress and creativity are intimately tied to cities. *The Epic of Gilgamesh* (George, 2003), one of the oldest known works of literature, concludes with an awed description of the towering walls of the ancient city of Uruk. In *Republic*, Plato (1973) envisioned an ideal city, a product of the cultural and intellectual tumult of ideas floating around Athens, as well as a broadside against its politics. Dante, Petrarch, Boccaccio, Brunelleschi, da Vinci, and Michelangelo all spent time in or around Florence. Great thinkers, artists, and entrepreneurs don't simply appear out of nowhere. They cluster and thrive in places that attract like-minded creative people, creating an environment that fosters and supports their creative efforts.

Cities provide that environment. As seen above, cities have long functioned as creative containers and mobilizers, attracting creative people while providing the structures, scenes, and ecosystems that support their ideas and innovations. The person most associated with creative cities is the late urbanist Jane Jacobs. In her books *The Death and Life of Great American Cities* (Jacobs, 1961), *The Economy of Cities* (Jacobs, 1970), and *Cities and the Wealth of Nations* (Jacobs, 1985), Jacobs put cities at the center of the processes of creativity, innovation, and economic growth. Although previous economists, like the great innovation theorist Joseph Schumpeter (1934, 1942), saw innovation and economic creativity as the province of great inventors like Thomas Edison, entrepreneurs like Andrew Carnegie, or large firms that could mobilize the resources required for innovation, Jacobs saw innovation as the distinct product of cities. For her, cities generated innovation, creativity, and ultimately economic growth by attracting and pushing together the diverse, creative people who are the generators of new ideas, new art forms, new technologies, and new startup companies.

Cities are perhaps the greatest products of human creativity in and of themselves. They collect and organize people, skills, firms, and physical and economic capital, providing a platform for them to be combined and recombined into new and productive forms. "The diversity, of whatever kind, that is generated by cities rests on the fact that in cities so many people are so close together, and among them contain so many different tastes, skills, needs, supplies, and bees in their bonnets," she argued (Jacobs, 1961, p. 167). When asked what she hoped to be remembered for, she responded:

> If I were to be remembered as a really important thinker of the century, the most important thing I've contributed is, "What makes economic expansion happen?" This is something that has puzzled people always. I think I've figured out what it is, and expansion and development are two different things. Development is differentiation – new differentiation of what already existed. Practically every new thing that happens is a differentiation of a previous thing. Just about everything – from a new shoe sole to changes in legal codes – all of those things are differentiations. Expansion is an actual growth in size or volume of activity. That is a different thing. (Cited in Steigerwald, 2001)

In his search for a fundamental theory of the basic mechanics of economic growth, the Nobel Prize–winning economist Robert Lucas went back to Jacobs' early works, which pointedly placed cities front and center. "I will be following very closely the lead of Jane Jacobs, whose remarkable book, *The Economy of Cities*, seems to me mainly and convincingly concerned (although she does not use this terminology) with the external effects of human capital," he wrote (Lucas, 1988). Building on her fundamental contribution, Lucas identified the multiplier effects that stem from talent-clustering as the primary determinants of economic growth. He contends that cities would be economically unfeasible if not for what he called "Jane Jacobs externalities," the productivity effects associated with endowments of human capital:

> If we postulate only the usual list of economic forces, cities should fly apart. The theory of production contains nothing to hold a city together. A city is simply a collection of factors of production – capital, people and land – and land is always far cheaper outside cities than inside . . . It seems to me that the "force" we need to postulate to account for the central role of cities in economic life is of exactly the same character as the "external human capital." . . . What can people be paying Manhattan or downtown Chicago rents for, if not for being near other people? (Lucas, 1988, pp. 38–39)

The term "creative city" in its modern usage seems to originate from Charles Landry's 2000 book, *The Creative City*. The Swedish geographer Ake Andersson also wrote about the "creative milieu" of cities. As he put it, "Creative people need creative cities" (Andersson, 2011). Andersson explored the flourishing of creativity in four different cities during four very different eras: Athens in 400 BC, Renaissance Florence, Enlightenment London, and fin de siècle Vienna. "The creative city as an informal and spontaneously evolving spatial organization has been the arena for all large-scale creative revolutions," he wrote. "In the course of the past 2,500 years, a small number of relatively large cities have functioned as hotbeds of revolutionary creativity" (Andersson, 2011, p. 39). These four cities attracted an inordinate number of creatively inclined immigrants who, in turn, stoked the growth of creativity among the already present creative population. "Such cities were used both as arenas for presenting findings from elsewhere and as fertile locations for developing new ideas in collaboration with other creative people" (Andersson, 2011, p. 39). In his magisterial *Cities in Civilization*, Peter Hall (1998) outlined the ways that cities have spurred creativity and innovation throughout the whole span of human history.

Indeed, creativity and cities have been connected since prehistoric times. According to a wide body of archaeological and anthropological studies, our creativity – manifested in our ability to generate tools and art forms – stems from our congregation and clustering in communities. The artistic and technological leaps that occurred in Africa and the Middle East tens of thousands of years ago were closely correlated with the growth of local population densities beyond a certain threshold. As people came into contact with one another more frequently, knowledge was shared, retained, and advanced more easily, leading to the invention of rudimentary tools and artistic forms (see, Shennan, 2009;

Richerson, Boyd, & Bettinger, 2009). Many of these creative blooms withered when populations subsequently shrank.

In the 1920s, Robert Park, the pioneering University of Chicago urban sociologist, identified the functional importance of loose ties and anonymous lifestyles to what he called the "mobilization of the individual man."

> Great cities have always been melting pots of races and of cultures. Out of the vivid and subtle interactions of which they have been the centers, there have come the newer breeds and the newer social types. They have multiplied the opportunities for the individual man for contact and association with his fellows, but they have made these contacts and associations more transitory and less stable.

Contrasting the inaction of small, tightly knit communities with the dynamism of cities, he wrote, "In a small community, it is the normal man, the man without eccentricity or genius, who seems most likely to succeed. The small community often tolerates eccentricity," he added. "The city, on the contrary rewards it. Neither the criminal, the defective, nor the genius has the same opportunity to develop his innate disposition in a small town that he invariably finds in the big city" (Park, Burgess, & McKenzie, 1925, p. 40).

Caroline Ware identified loose ties and quasi-anonymity as a fundamental feature of 1920s Greenwich Village in her detailed study of the New York neighborhood. "Many who were drawn to the Village came to seek escape from their community, their families, or themselves," she wrote. The Villagers were "intensely individualistic in both their social relations and their point of view," "independent of virtually all institutions." They scorned "the joining habit" taking "full advantage of both the selectiveness and anonymity the city offered." They "avoided the usual casual contacts with family, friends, neighbors, or members of the same economic or social class and the relations growing out of institutional connections." Rather than this more traditional life, "they maintained individual ties with friends scattered all over the city" (Ware, 1935, pp. 5, 37).

But cities do more than simply providing the broad ecosystem that attracts creative people; they stimulate it as well. According to Dean Keith Simonton, they do this in two key ways. First is their critical role in "creative development." Exposure to mentors and role models during creators' adolescence and young adulthood, says Simonton, is critical. "To the extent that such mentors are more likely to be found in urban areas, this apprenticeship phase will necessarily occur in city environments," he writes. "In fact, research on talent development indicates how often exceptional gifts will have to move to metropolitan areas once they reach a certain stage in their intellectual or artistic growth" (Simonton, 2011, p. 80).

Second, creativity requires cultural heterogeneity. It is enhanced by "early exposure to ideational diversity and conflict, enabling the individual to engage in cultural 'hybridization' or 'cross-fertilization' as an adult creator." Again, this is more likely to occur in urban spaces than the surrounding suburbs or rural areas, as cities have "educational or cultural institutions that help mix up the broth," as well as an overabundance of things to look at. Whenever they hit a roadblock without an obvious solution, creative people will put such quandaries aside temporarily and attend to ordinary or routine tasks, the execution of which exposes them to a host of stimuli that prime association. Given sufficient time, these stimulated pathways can lead to a creative breakthrough – a eureka moment. Given that cities are more likely to offer different languages, cultures, religions, and lifestyles, "it goes without saying that an urban environment will afford a more diverse variety of potential priming stimuli than will a rural environment" (Simonton, 2011, p. 81).

Despite the popular image of the solitary artist creating in isolation, creativity in modern societies tends to emerge in groups, which come together in cities and communities. "Naturally, the members of these problem-solving or brainstorming groups are most often recruited from the immediate environment, whether suburb, town or city," Simonton observes (2011, p. 81).

That said, cities also inspire the creativity of solitary creators, providing the wide range of external stimulation they need. It allows them to essentially pop in and out of their neighborhood and city, affording the spurts of creative stimulation that come from going to an art gallery, museum, or musical performance, stopping by a café, bar, or restaurant, or just taking in the street-scene, while enabling them to retreat to their quiet apartments, studios, or offices to create. There are, of course, a subset of creatives who do not require cities to create but can create in more isolated surroundings in rural areas – examples that come to mind are physicists and mathematicians working out proofs in bucolic university campuses, the French impressionist painters in the countryside of France, or the artists and musicians like Jackson Pollock and Bob Dylan who retreated from New York City to Woodstock in the 1960s – but they are less numerous and often require access and ties to urban centers to commercialize their work and make a living.

Creative Cities Today

My own creative class theory suggests that cities have become even greater platforms for creativity since the rise of the postindustrial economy and society and the rise of the new socioeconomic class that is its hallmark (Florida, 2002, 2012). Up until the nineteenth century, the agricultural class predominated but, by the late nineteenth century and throughout most of the twentieth century, the working class had supplanted it in both numbers and earning power. The creative class, whose members work in high-skill jobs in science, technology, engineering, business, finance, management, law, healthcare, education, and arts, culture, entertainment, and media, is the economically predominant class today (see Figure 29.1). The creative class accounts for more than a third of the US workforce (up from just 10 percent at the turn of the twentieth century). Its members collect half of all wages and salaries and control roughly three-quarters of domestic purchasing power. In the city-state of Singapore and the advanced nations of Scandinavia and Northern Europe, this share of the workforce is even higher, as much as 45 percent (Florida, Mellander, & King, 2015)

The creative class is highly concentrated in cities and urban areas. As Table 29.1 shows, the leading creative-class cities, or metro areas, in the United States include

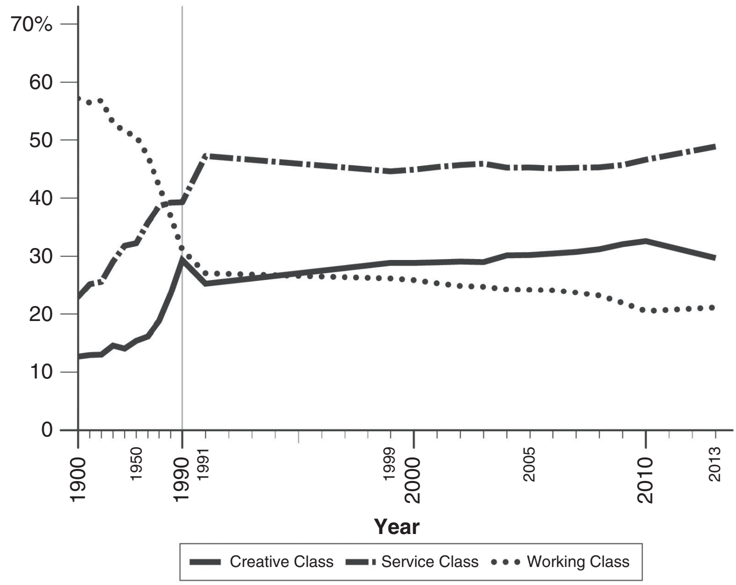

Figure 29.1 *The rise of the creative class* (from Florida, 2012; based on data from the Occupational Employment Statistics, Bureau of Labor Statistics)

the Bay Area, Washington, DC, and Boston, as well as smaller metros, especially college towns such as Durham, NC; Ithaca, NY; Boulder, CO; Corvallis, OR; Ann Arbor, MI; Tallahassee and Gainesville, FL; and Charlottesville, VA.

The key to understanding the new economic geography of the creative class and of the creative city lies in what I dub the "3T's of economic development": Talent, Technology, and Tolerance (Florida, 2012). Talent is the first T. Skilled, ambitious, educated, and entrepreneurial people – what economists refer to as human capital (Barro, 1990) and what I call the creative class – have long been recognized as a central force in economic progress. While economists tend to use college education as a proxy for talent (Glaeser & Resseger, 2010; Glaeser et al., 2014), my creative class theory measures talent as the skills people have and the work they do. The two are closely related to one another but not identical – roughly three-quarters of college graduates work in creative class jobs in the United States but as many as four in ten members of the creative class do not in fact hold college degrees (Gabe, 2009, 2011).

Technology is the second T. Going back to Karl Marx (1887) and Joseph Schumpeter (1934; Rosenberg, 1983, 2011), economists agree that advances in technology are what enable capitalism to constantly revolutionize itself. Technology drives growth by making economies and societies more efficient and productive, from new inventions, such as software, robotics, and biotechnology, to improvements in manufacturing systems and processes.

Tolerance is the third T. Tolerance – openness to diversity – provides an additional source of economic advantage that works alongside technology and talent. Places where different cognitive styles are tolerated generate new ideas quickly and

Table 29.1 *Top-ten metros with highest creative class share of labor force (from Florida, 2012)*

Rank	Large Metro (over 1 million people)	Creative Class Share (%)	Small and Medium Size Metros (less than 1 million people)	Creative Class Share (%)
1	San Jose–Sunnyvale–Santa Clara, CA	46.9	Durham, NC	48.42
2	Washington–Arlington–Alexandria, DC–VA–MD–WV	46.8	Ithaca, NY	44.6
3	Boston–Cambridge–Quincy, MA–NH	41.6	Boulder, CO	44.4
4	Hartford–West Hartford–East Hartford, CT	39.7	Trenton–Ewing, NJ	42.9
5	San Francisco–Oakland–Fremont, CA	39.4	Huntsville, AL	42.6
6	Baltimore–Towson, MD	37.7	Corvallis, OR	41.7
7	Seattle–Tacoma–Bellevue, WA	37.7	Ann Arbor, MI	41.3
8	Minneapolis–St. Paul–Bloomington, MN–WI	37.6	Tallahassee, FL	40.5
9	Raleigh–Cary, NC	37.6	Rochester, MN	39.9
10	Denver–Aurora, CO	37.6	Charlottesville, VA	39.7

efficiently – and different cognitive styles are linked to demographic diversity (Page, 2007).

Openness to immigrants is one dimension of tolerance. Going all the way back to the Scottish-born steel magnate Andrew Carnegie, immigrants have been overrepresented among American entrepreneurs. Even though they make up just 12 percent of the US population, today immigrants generate more than a quarter of the country's global patents and account for nearly a half (47 percent) of science and engineering workers with PhDs. Over the past two decades, immigrants have been among the principals of more than half of all Silicon Valley startups (Florida, 2005; Saxenian, 1994, 1999, 2007; Wadhwa et al., 2007, 2008). Openness to artists and to the gay and lesbian community also signals openness to new ideas and talent of all stripes. My own research finds a close connection between our measures of the concentrations of members of the LGBT community and musicians and rates of innovation and local economic development across cities and metro areas. A leading indicator of a place's openness to different types of people is the presence of a strong and vibrant LGBT or artistic community (Florida & Gates, 2001). If LGBT people and artists are comfortable living and working in a place, it is likely that immigrants and ethnic minorities will feel the same way, as will eggheads, eccentrics, and all the other atypical types whose unique way of looking at the world often gives birth to new ideas. As Bill Bishop put it, "Where gay households abound, geeks follow" (Bishop, 2000).

Another way to think about openness and tolerance comes from psychologists who study different types of personalities and who have found a striking association between people who are "open to experiences" and creativity. The pioneering studies of Peter Jason Rentfrow (2011) have found that open-to-experience people are the most likely to move and the most likely to cluster in dense urban areas. San Francisco has the nation's largest concentration of open-to-experience people, followed by Los Angeles, Austin, New York, and San Diego. Each of these metros has a considerable concentration of the creative class. Rentfrow's research suggests that there is a psychological dimension to creative cities. People don't simply move to cities where they can find the best opportunities, the most fulfilling work, or the best school systems for their children. Creative, open-to-experience people seek out dense, urban centers where they can be themselves and find the creative stimulation that their work requires.

The most successful places put all 3T's together, explaining why cities that have deep reservoirs of technology and world-class universities fail to grow. In many cases, they are not sufficiently tolerant and open to attract and retain top creative talent. The interdependence of the 3T's also explains why some lifestyle meccas that lack a technology base fail to make the grade. Each of the 3T's is a necessary condition for prosperity but they are insufficient on their own. For real innovation and sustained economic growth, all three must be on offer.

Table 29.2 shows the leading metros as measured by my composite Creativity Index, including San Francisco, Boston, Seattle, San Diego, Washington, DC, and San Jose of large metros, and of smaller metros especially college towns such as Boulder, CO; Ann Arbor, MI; Corvallis, OR; Durham, NC; Ithaca, NY; Burlington, VT; and Madison, WI.

In addition to the 3T's, creative cities benefit from a fourth factor I call "quality of place" (Florida, 2002, 2012). You can think of it as a fourth T, reflecting the unique "territorial assets" of a place. We can call it "town" for short. It refers to the unique set of characteristics that define a place and make it attractive. Generally, quality of place encompasses three key dimensions:

- What's there? Does the combination of the built and the natural environment provide an inspiring setting for pursuit of creativity?
- Who's there? Are the people who live there diverse and do their interactions provide cues that anyone can make a life in that community?
- What's going on? How vibrant is the street life? Are there lots of galleries, restaurants, and stimulating things to do?

A key element of quality of place is authenticity, which comes from several aspects of a community – historic architecture, established neighborhoods, a distinctive music scene, or a specific set of cultural attributes. It is the opposite of generic; a place that is full of big box stores and chain restaurants and entertainment venues is seen as inauthentic – not only do these venues look pretty much the same but they offer the same menu of experiences a person could have anywhere else.

A Gallup survey (Knight Foundation, 2010) of tens of thousands of people across America found that there are three main factors that attach people to the

Table 29.2 *Top-ten metros on the creativity index (from Florida, 2012)*

Rank	Large Metros (over 1 million people)	Creativity Index	Small and Medium Size Metros (less than 1 million people)	Creativity Index
1	San Francisco–Oakland– Fremont, CA	0.970	Boulder, CO	0.981
2	Boston–Cambridge–Quincy, MA–NH	0.968	Ann Arbor, MI	0.961
3	Seattle–Tacoma–Bellevue, WA	0.961	Corvallis, OR	0.959
4	San Diego–Carlsbad–San Marcos. CA	0.961	Durham, NC	0.953
5	Washington–Arlington–Alexandria, DC–VA–MD–WV	0.947	Trenton–Ewing, NJ	0.945
6	San Jose–Sunnyvale–Santa Clara, CA	0.933	Ithaca, NY	0.937
7	Portland–Vancouver–Beaverton, OR–WA	0.930	Worcester, MA	0.922
8	Hartford–West Hartford–East Hartford, CT	0.916	Burlington–South Burlington, VT	0.918
9	Austin–Round Rock, TX	0.916	Tucson, AZ	0.909
10	Minneapolis–St. Paul–Bloomington, MN–WI	0.915	Madison, WI	0.907

places they live. The key findings are so interesting that they are worth quoting at length.

> While the economy is obviously the subject of much attention, the study has found that perceptions of the local economy do not have a very strong relationship to resident attachment. Instead, attachment is most closely related to how accepting a community is of diversity, its wealth of social offerings, and its aesthetics. This is not to say that jobs and housing aren't important. Residents must be able to meet their basic needs in a community in order to stay. However, when it comes to forming an emotional connection with the community, there are other community factors which often are not considered when thinking about economic development. These community factors seem to matter more when it comes to attaching residents to their community. (Knight Foundation, 2011, cited in Florida, 2012, p. 302)

Quality of place can be thought of in terms of a hierarchy, similar to that of Abraham Maslow's famous hierarchy of needs (Maslow, 1943). Many traditional urban development experts say what people and industries need from cities are the "basics" of safe streets, good jobs, and good schools. All of those things matter, of course, but just as we ultimately want more from our lives than the mere basics of bodily subsistence, we also desire more than that from our communities.

But How Do You Build a Creative City?

There is no silver bullet but the traditional repertoire of urban economic development experts is no longer a viable option. Good schools, a family-friendly environment, or an environment that's teeming with restaurants and bars just aren't enough. Nor are downtown arts centers, leafy suburbs ringed by high-tech industrial parks, or upscale shopping malls. Similarly, luring companies across state and national borders with precious public funds is a fool's errand. Trying to be the next Silicon Somewhere seldom pays off.

Generally speaking, it's the small things that have the greatest impacts. Top-down mega-projects such as giant stadiums, convention centers, and, these days, casinos, are almost always boondoggles; they never bring the jobs and spillover effects that are promised. What makes an enduring difference in a city's quality of place are small, low-cost, community-initiated, bottom-up improvements such as parks, bike paths, and other neighborhood-scaled amenities.

I like to say cities need a "people climate" as much as, and perhaps even more than, they need a business climate (Florida, 2002, 2012). A people climate is a general strategy aimed at attracting and retaining talent, especially, but not limited to, creative talent. Openness costs nothing whereas companies and sports teams can pull up and leave with a moment's notice when another city comes up with a better offer. Conversely, investments in amenities such as urban parks last for generations and benefit a broad swath of the population.

There is no one-size-fits-all model for a successful people climate. Building a creative community is an organic process that cannot be controlled in a top-down manner. What's needed are the right conditions in which to plant the right seeds. After that, get out of the way and let things take their course.

So why are so many communities unable to leverage the considerable creative assets they have? It's not that they don't want to grow. In most cases, their leaders are doing everything they think they should to spur innovation and high-tech growth. But, most of the time, they either can't or won't do the things required to create an environment or habitat that is attractive to the creative class. They pay lip service to the need to attract talent but dedicate their resources to subsidizing downtown malls and convention centers and recruiting corporate call centers to fill their new corporate parks. Or they try to reinvent themselves as facsimiles of quirkiness and charm, erasing their old, authentic neighborhoods and replacing them with Disney-fied imitations of gaslight districts, driving real creativity and the creative class away. Jane Jacobs had a handy name for leaders like those. She called them "the squelchers" – overly controlling types who believe that they know what's best for a city. Squelchers like to use the word "no" and prefer to respond to new initiatives or ideas with comments such as, "That's not how we do things here," "That will never fly," or "Why don't you just move someplace else?" (Jacobs, personal conversation, 2004).

Despite their innovative prowess, there are undeniable downsides to today's successful creative cities. As the back-to-the-city movement has brought educated, younger Whites back into their urban cores, many minority and lower-income residents have been displaced. Mere gentrification has escalated into "plutocratization" (Kuper, 2013), as some of the most innovative urban neighborhoods are turned into deadened trophy districts for the globe-trotting super-rich, their high-end real-estate nothing more than piggy banks and tax shelters for their wealth. "Middle-class people can barely afford to live here anymore," the Talking Heads front man David Byrne wrote of his beloved New York, "So forget about emerging artists, musicians, actors, dancers, writers, journalists and small business people. Bit by bit, the resources that keep the city vibrant are being eliminated" (Byrne, 2013).

Great creative cities like New York, London, Paris, Los Angeles, and San Francisco have not lost their creative edge yet. Indeed, New York, London, and Los Angeles continue to have outsize concentrations of artists, musicians, designers, writers, and other creatives. These cities have added a growing number of high-tech startups to their mix, as the talent that drives these companies has gravitated away from sterile suburban campuses to more dense, diverse urban locations. And Greater San Francisco remains the world's leading destination for high-tech startups and innovation, eclipsing even the nearby Silicon Valley to its south.

That said, concern is growing that younger creatives may be priced out of these cities, as Byrne's remarks attest, if these trends continue. As Jane Jacobs once told me, "When a place gets boring even the rich people leave."

The intergenerational consequences of rising housing prices in expensive creative cities are reflected in the fact that even economically advantaged people in those cities increasingly believe and fear their own children will never be able to afford the price of entry. My own MBA students tell me that they will not be able to afford a single-family home in Toronto without financial help from the proverbial "bank of mom and dad."

But blue-collar and service workers, along with the poor and disadvantaged, face the direst consequences of rising housing prices and economic displacement in expensive creative-class cities. This can be seen in Table 29.3, which shows the amount of money the members of the three major classes – the advantaged creative class and the less advantaged working and service classes – have left over after paying for housing. The average creative-class worker in San Jose has a whopping $80,503 left over after paying for housing, but the average blue-collar worker has just $23,109 left over, and the average service-class worker ends up with just $14,372. In San Francisco, the average creative-class worker has $71,741 left over compared with $26,920 and $16,806 for his working- and service-class peers. In New York, the average creative-class worker in New York pockets $71,245 compared with just $27,343 for the average blue-collar workers and $17,861 for the average service-class worker.

As a result, the members of the less advantaged classes are either forced into marginal, underserved neighborhoods or out to the exurban peripheries. Ultimately, this is unsustainable for these cities. It is next to impossible to maintain a functional city when teachers, nurses, hospital workers, police officers, firefighters, and restaurant and service workers can no longer afford to live within reasonable commuting distance of their workplaces.

Table 29.3 *Money left over after paying for housing (from Florida, 2017; based on data from the Bureau of Labor Statistics and on housing costs from the US Census)*

	Average Worker	Creative Class	Service Class	Working Class
Metros with the Most Left Over				
San Jose	$48,566	$80,503	$14,372	$23,109
San Francisco	$45,200	$71,741	$16,806	$26,920
Washington, DC	$43,308	$70,030	$13,925	$21,539
Boston	$42,858	$66,871	$16,206	$25,233
New York	$42,120	$71,245	$17,861	$27,343
Metros with the Least Left Over				
Orlando	$25,774	$50,002	$12,903	$21,173
Las Vegas	$26,194	$53,137	$14,394	$27,103
Riverside, CA	$27,296	$54,191	$13,501	$20,777
Miami	$27,482	$53,809	$14,099	$20,452
Virginia Beach Norfolk	$28,448	$51,601	$13,284	$22,939

Stark divides also cut across cities. Large superstar cities such as New York, London, and Los Angeles and leading technology and knowledge hubs such as the San Francisco Bay Area boast wildly disproportionate shares of the world's leading high-value industries, high-tech innovation and startups, and top talent. Just six metro areas – the San Francisco Bay Area, New York, Boston, Washington, DC, San Diego, and London – attract nearly half of all high-tech venture capital investment across the entire world (Florida & King, 2016, p. 20). The rise of "winner-take-all urbanism" has driven a wedge between the winners and the much broader ranks of the also-rans, who have lost their economic footing as a result of globalization, deindustrialization, and other factors – a phenomenon than I have dubbed "The New Urban Crisis" (Florida, 2017).

Creative cities are increasingly divided cities. My own research documents the striking correlation between creativity – whether measured by their creative class share or other metrics, such as my creativity index – and both inequality and segregation. As Table 29.4 shows, the super-star cities of New York and Los Angeles and the leading creative tech hub of San Francisco, not to mention Boston, Houston, Philadelphia, Dallas, Chicago, and Birmingham, number among America's most unequal and economically segregated places.

In 2008, Bill Bishop documented the sorting of Americans not just by political beliefs and cultural preferences but also by socioeconomic class – a phenomenon he dubbed "the big sort" (Bishop, 2008). That big sort has become an even bigger sort today, as the geographic divide between rich and poor Americans worsens. Between 1980 and 2010, income segregation grew in twenty-seven of the country's thirty largest metros (Taylor & Fry, 2012). By 2009, more than 85 percent of people living in American cities and metro areas lived in areas that were more economically segregated than they were in 1970 (Watson, 2009). The share of families who live in either all-poor or all-rich neighborhoods more than doubled between 1970 and 2012, increasing from roughly 15 percent to nearly 34 percent (Reardon & Bischoff, 2016).

There is another even more vexing kind of inequality – spatial inequality. The rich and the poor increasingly occupy entirely different worlds. At the center of the bigger sort is the decline of the American middle class and their sturdy middle-class neighborhoods that defined the American Dream. The share of American families living in middle-class neighborhoods fell from nearly two-thirds (65 percent) in 1970 to less than half (40 percent) in 2012 (Reardon & Bischoff, 2016). Moreover, between 2000 and 2014, the middle-class share of the population shrank in a whopping 203 of 229 US metros (Pew Research Center, 2016). The middle class is smallest in dense, diverse, knowledge-based metros, features of economically vibrancy, while they are largest in whiter metros where there is a larger share of the working class and higher levels of political conservatism, features of economic decline. Furthermore, metros with the largest shares of the middle classes in 2000 saw the largest decline in their shares of the middle classes by 2014. Most distressing, middle-class numbers are smallest in economically vibrant places and largest in declining ones (Florida, 2017).

Creative cities are thriving but an increasingly smaller share of their populations participates in the bounty. Many more cities and metros are struggling to stay in place, or are falling further behind. Mayors, urban leaders, and city residents are being forced to confront a new crisis that is borne as much of urban success as it is of failure.

In many ways, the election of Donald Trump represents the backlash against the urban creative class and its cities. Clinton took leading creative-class metros by a wide margin, while Trump took smaller metros and rural areas (Florida, 2016a, 2016b).

Clinton beat Trump with 55 percent compared to 40 percent of the vote in metros with more than a million people and won eight of the ten largest metros. These metros accounted for more than half the vote and generate two-thirds of America's economic output. Clinton took huge shares of the vote in the Bay Area creative-class hubs of San Francisco (76.7 percent) and San Jose (72.9 percent). And she carried more than two-thirds of the vote in Los Angeles. She also did very well in the densely populated metros of the BosWash Corridor, taking more than two-thirds of the vote in Washington, DC, and more than 60 percent in Boston, New York and Philadelphia. She carried more than 60 percent of the vote in Chicago, Miami, and Seattle as well.

Trump took the rest. He won metros with between 500,000 and a million people by 48 percent, compared with 46 percent for Clinton; those with 250,000 to 500,000 people by 52 percent, versus 43 percent for Clinton; and those with under 250,000 people by 57 percent, versus 38 percent for Clinton. He won in Birmingham, Oklahoma City, Jacksonville, Nashville, Dallas, and Charlotte in the Sunbelt and Cincinnati, Grand Rapids, Indianapolis, and Pittsburgh in the Rustbelt.

Table 29.4 *The connection between creativity and inequality (top-ten metros with the highest inequality compared with their creative class) (from Florida, 2017)*

Rank	Metro	Composite Inequality Index	Creative Class Share (%)
1	New York–Northern New Jersey–Long Island, NY–NJ–PA	0.979	35.8
2	Los Angeles–Long Beach–Santa Ana, CA	0.962	34.1
3	San Francisco–Oakland–Fremont, CA	0.919	39.4
4	Houston–Sugar Land–Baytown, TX	0.909	33.0
5	Charlotte–Gastonia–Concord, NC–SC	0.882	33.6
6	Philadelphia–Camden–Wilmington, PA–NJ–DE–MD	0.872	34.6
7	Dallas–Fort Worth–Arlington, TX	0.861	34.3
8	Boston–Cambridge–Quincy, MA–NH	0.858	41.6
9	Chicago–Naperville–Joliet, IL–IN–WI	0.853	35.1
10	Birmingham–Hoover, AL	0.852	33.1

Clinton support was concentrated in larger, denser metros with greater shares of the creative class, college graduates, and high-tech industries, while Trump support was concentrated in smaller, more sprawling, working-class metros.

The average Clinton metro was home to almost 1.4 million people, more than three times the size of the average Trump metro, which is about 420,000. And outside of metropolitan areas, Trump beat Clinton 61 percent to 33 percent in micropolitan areas and by 67 percent compared with 29 percent in rural areas.

Ultimately, America is divided between advantaged creative cities and the rest. The residents of these creative cities not only do better economically but are better traveled, better connected to the global economy, and more open to diversity. Perhaps because the work of the creative metros centers on knowledge, creativity, and abstract thinking, their residents tend to be more open to the notion that government can help improve the economy, better the environment, provide essential services (such as healthcare), and protect the fundamental rights of disadvantaged or discriminated-against groups.

Those who live outside these places see creative-class centers as elitist and coddled by government. They are well aware of the growing gap between the metro haves and have-nots and know they are losing ground. They'd like to somehow stop the forces of change that are leaving them behind and bring back the good old days when they, and their more traditional vision of America, were on top.

In my 2002 edition of *The Rise of the Creative Class*, I urged the creative class to grow up and to evolve from an amorphous group of me-oriented, self-interested, and self-directed individuals to a class with a true moral and social responsibility for overcoming our social and economic divides and building more cohesive cities and a more inclusive society:

> Affluent Creative Class people who move into racially, ethnically or economically diverse neighborhoods cannot simply assume that their presence automatically "revitalizes" these places. For many Working Class and Service Class residents, it doesn't. Instead, all it usually does is raise their rents and perhaps create more low-end service jobs for waiters, housecleaners and the like. While the classes may be living in close physical proximity, they do not intermix in any meaningful way. They might as well be occupying separate universes. Such neighborhoods and communities must become proving grounds for the idea that people of all types and backgrounds can truly live and work together. It needs to happen at the community level and spread from there across the nation as a whole if we are to achieve the social cohesion and economic vitality on which long-run prosperity depends. (Florida, 2002, p. 325)

This is even more the case today as our divides have deepened and amplified since then.

Richer, safer, cleaner, and healthier than ever before, cities are also ground zero for mounting inequality, segregation, and poverty. Driven by creativity, the power of cities is staggering. But the urban revival has been spiky and winner-take-all; for every urban neighborhood that has hand to struggle with gentrification and new wealth, many more have been left behind. While the clustering force has driven human progress for centuries, is is a double-edged sword.

That said, there is much to be optimistic about. Our clustering together in communities has driven each step of human progress up until now, and cities remain our best vehicles for identifying and solving our deepest social and economic problems. The way forward is more, not less urbanism.

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30 Creativity's Role in Everyday Life

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When asked about creativity, most people would mention creative giants such as Frank Lloyd Wright, Sylvia Plath, or Pablo Picasso or landmark creative works such as Fallingwater, *The Colossus*, or *Guernica*. Yet these domain-changing examples of Big-C creativity are just the tip of the iceberg of human creativity. For every work like Fallingwater, there are a million grown-ups-stay-away clubhouses constructed from cardboard boxes. For every poem in *The Colossus*, there are millions of poems by maudlin teens who "just can't even." For every "Blue Period" piece mounted on a museum wall, there are untold millions of "finger paint periods" taped to refrigerators.

This vast bulk of the creativity iceberg – people's countless creative hobbies, goals, products, and fleeting ideas – has not traditionally been the concern of major theories of creativity, which emphasize creative accomplishments that are publicly recognized, domain-changing, and often revolutionary (e.g., Csikszentmihalyi, 1988; Gardner, 1993; Sawyer, 2006; Simonton, 2004). But even the most revolutionary idea started somewhere, and that place probably wasn't a world-famous museum or performance hall. Instead, both landmark creative works and common creative acts are usually situated in their creators' complex, idiosyncratic, and utterly ordinary environments (Tanggaard, 2015): bouncing around ideas in a café, letting the mind wander while walking through the woods, or doodling on a sketch pad kept by the toilet.

This chapter explores creativity in everyday life. We describe the two main strands of thought in this area: studies of ordinary *mini-c* (personally meaningful creative insights) and *little-c* creativity (creative acts by non-experts; Beghetto & Kaufman, 2007), and studies of the situated ecology of all levels of creativity. After reviewing these strands, we place them in the context of the rapidly growing use of ecological assessment methods, which allow researchers to study psychological events as they happen in the real world. Our review considers some issues for the growing use of ecological assessment and then describes some lines of research that illustrate the insights they can give into what creativity looks like in people's everyday environments.

Two Senses of Creativity in Everyday Life

Everyday Creativity in the Four C Model

When creativity researchers talk about creativity in everyday life, they usually mean one of two things. The first sense is the study of "little-c creativity": the creative passions and pursuits of noneminent creators from all ages and walks of life. Eminent, domain-changing creative works deserve the attention they get but they represent the tip of creativity iceberg. For each Big-C, eminent work, there are countless common insights, ideas, and innovations that don't lead to domain-changing creative products. These everyday creative acts and ideas are the submerged bulk of the iceberg. The poems and songs and cupcake recipes of noneminent creators might not be publicly acclaimed and domain-changing but they represent the vast bulk of humanity's creative activity.

The Four C model (Kaufman & Beghetto, 2009) provides a fruitful framework for clarifying what the smaller forms of creativity look like (see Kaufman & Glăveanu, Chapter 2, this volume). This model distinguishes four ordered classes of creativity: *Big-C, Pro-c, little-c*, and *mini-c. Big-C* and *Pro-c* refer to eminent and professional-level creative accomplishments, respectively. Big-C and Pro-c accomplishments are public, significant achievements that require expertise within a specific domain. Big-C accomplishments are eminent works that define or change a creative domain, whereas Pro-c accomplishments are significant works by practitioners in a domain that contribute to its growth but are not eminent within the domain.

Moving down the Four C spectrum, *little-c* creativity, sometimes also referred to as *everyday creativity*, is something that is practiced by virtually everyone, not only people who possess the technical skills or expert knowledge required for Pro-c and Big-C creativity. Little-c creativity, in the Four C model, must meet the common "novel and appropriate" criteria for creative works but the novelty refers to the creator herself, not for the domain at large (Weisberg, 2006). Little-c creativity thus often results in novel products that are nevertheless variations on existing themes in a domain. As a result, little-c creativity covers a vast range of actions, from writing a song, making a new grill seasoning, refinishing a coffee table in a new color, and using scrapbook supplies to craft a perky-yet-menacing "Paws Off My Greek Yogurt" sign for the shared workplace fridge.

Mini-c creativity, the last category in the Four C model, involves "the novel and personally meaningful interpretation of experiences, actions, and events" (Beghetto & Kaufman, 2007, p. 73). This concept strikes us as the most fertile and intriguing concept in the Four C model. Mini-c creativity captures the small acts of insight, wit, mental restructuring, imagination, and improvisation in daily life. The range of examples is vast, from recognizing an opportunity to improvise during a class discussion (Beghetto & Kaufman, 2007), creating imaginary stories while daydreaming, thinking about how something from one's past recasts the meaning of something that just happened, and introducing funny quips into conversations. These mini-c ideas might not be public or result in a tangible creative product but they reflect the creation of new ideas and knowledge.

The concept of mini-c implies that creativity is inherent in human thought: When we construe patterns, have insights, and introduce variety instead of sameness into our actions, we're exercising creativity. Tanggaard's (2015) pathways model of creativity develops this general stance by proposing that "the conduct of life in itself can be a creative act" (p. 181). The creative pathways model emphasizes the actions and decisions we make in everyday life as we interact with other people and the environment. Situations in our lives are not always predictable, and the choices we face are not always obvious, so we must use some measure of improvisation to navigate our daily lives. These improvisations could be observed by studying the interactions between people or between people and objects. The pathways approach emphasizes that mini-c creativity is always *situated*: it happens in an environment and is shaped by the situation's structure and affordances. Although most of these creative pathways may be classified as mini-c insights, many might qualify as little-c creative acts, such as diffusing a tense or dangerous situation with an unanticipated but effective action (Richards, 2007) or using inventive turns of phrase in a conversation with friends (Pachucki, Lena, & Tepper, 2010). In short, this first sense of everyday creativity – little-c and mini-c creative products, acts, and ideas – implies that a typical day is stuffed with creativity, if not inherently creative (Bateson, 1999; Tanggaard, 2015).

The Situated Ecology of Creativity

Another sense of creativity in everyday life is the ecological study of creativity: what it looks like and how it unfolds in natural environments. This tradition seeks to study creativity as it happens, where it happens. It thus emphasizes the essentially situated and contextual quality of creativity. Ecological studies of creativity, for example, study how scientists develop theories and experiments in their frumpy research labs (Dunbar, 1997), how garden designers think through design problems in their studios (Pringle & Sowden, 2017), and how architecture students experience flow and motivation while grinding away at their studio desks (Fullagar & Kelloway, 2009).

An ecological approach to creativity seeks to get up close to creativity as it happens, so it isn't committed to any particular C in the Four C model. Some ecological studies have observed eminent and professional creators, such as how accomplished scientists develop research ideas (Dunbar, 1997) or how professional garden designers mesh top-down and bottom-up modes of thinking (Pringle & Sowden, 2017). Other studies, however, look at the natural ecology of little-c and mini-c creativity, such as improvisation in everyday social interactions (Tanggaard, 2015), observational studies of children's pretend play (Russ, 2013), and classroom studies of creative teaching and learning (Beghetto & Kaufman, 2016).

The ecological approach has an essentially situated and transactional view of creativity. In these models, creativity doesn't simply happen – it happens somewhere, and that *where* is essential to understanding the creative process. People's environments are wide-ranging – a shabby preschool with plastic baskets of broken crayons, a high-tech lecture hall, a jail cell with a small golf pencil and a few books of poetry – and these environments spark, shape, and constrain what people can do (Glăveanu, 2010; Tanggaard, 2015). At the same time, people also often pick which environments to enter and shape the environment to suit their goals (Allport, 1958). Creativity is thus situated (it happens somewhere) and transactional (it emerges from negotiating an environment).

How Can We Measure Everyday Creativity?

For researchers interested in studying mini-c and little-c creativity, how can it be measured? One common approach is to use self-report instruments that ask people to describe their own creative behaviors and hobbies. Some of these measures, such as the Creative Behavior Inventory (Hocevar, 1979; revised version in Dollinger, 2003) and the Biographical Inventory of Creative Behaviors (Batey, 2007), present people with a range of creative hobbies and activities from different domains and ask them to select the ones they engage in. Inventories using this "activity list" approach have been widely used and have good psychometric properties (Silvia et al., 2012).

But there are some problems with using activity lists to measure everyday creativity. First, people who receive high scores are people who report engaging in creative activities in a variety of domains. Someone who dabbles in jewelry making, poetry writing, and cupcake decorating would get a higher score than someone who is passionately devoted only to jewelry making. Breadth of creative engagement across many domains is rewarded, and these measures largely ignore deeper creative engagement in one or a few domains. These activity lists are also self-report measures, which are susceptible to exaggeration and recall bias.

Second, these activity-list measures aren't all-encompassing. People have a wide variety of interests, creative or otherwise, so it is unlikely that a list of common creative activities can capture the diversity of people's creative engagement. People with offbeat creative hobbies, such as subversive cross stitching (Jackson, 2015) or choreographing a modern belly-dance troupe, won't be captured on the typical self-report list. One potential solution is to ask people what hobbies and activities they participate in. Wolfradt and Pretz (2001), for example, asked people to list their hobbies, which were then rated for creativity by trained raters, who considered activities that require active engagement (e.g., drawing) to be more creative than passive activities (e.g., watching television). This approach will capture uncommon and quirky creative activities.

Ecological Momentary Assessment

Many other approaches have been used, such as semi-structured interviews, observational studies, and a range of qualitative methods (see Richards, 2007; Tanggaard, 2015). One particular method, however, stands out: *ecological momentary assessment* (EMA). EMA is a technique used to assess psychological variables in people's everyday, naturalistic, environments. The method thus combines the quantitative emphasis of traditional self-report assessment with the situated, contextual emphasis of ecological approaches to creativity. When participants are brought into the lab and asked to be creative on a task, they're trying to be creative while sitting in an unfamiliar lab room surrounded by strangers. Such artificial environments do not resemble the environments that we often choose to create in. EMA allows researchers to assess creativity as it happens within the environments that it naturally happens.

EMA in creativity research has typically taken one of two forms: *daily diaries* or *experience sampling*. A daily diary approach typically has participants answer a series of self-report questions once a day about what they did and how they felt throughout that day (Gunthert & Wenze, 2012). Since participants are doing this only once a day, daily diary surveys tend to ask more questions per day and to last for weeks or months. An experience-sampling approach, on the other hand, typically signals participants at random points during the day to answer questions about what they were doing and thinking when they were signaled. As a tradeoff for the number of surveys sent to people, these questionnaires tend to be shorter than those used in daily diaries, and experience sampling studies last days rather than weeks or months.

EMA techniques have many virtues for studying everyday creativity. First, we are able to study creativity as it naturally happens. As previously stated, everyday creativity is not something we can completely understand from lab-based studies – we must consider the environmental influences on this process (Hennessey, 2015). A typical day is fluid and complex. Bringing people into the lab and asking them about what they do in their normal environments isn't likely to illuminate how complex situations influence creativity.

Second, EMA assesses people as close to the events as is practical, so people don't need to reflect back over long time intervals to report about what they typically do. There are discrepancies between EMA and retrospective measurements for many phenomena (e.g., musical imagery, Cotter & Silvia, 2017; quality of life, Maes et al., 2015; activities in daily life, Sonnenberg et al., 2012). Oftentimes, there are aspects of an experience that slip under the attentional radar, such as the moment-to-moment fluctuation in emotions that are not recalled as accurately using retrospective measures (Reis, 2012; Schwarz, 2012). The more salient features, such as overall frequency of engagement in creative activities, may be accurately recalled in retrospective measures but the fluctuating aspects of the environment are less likely to be memorable. Although the differences between retrospective and in-the-moment reports have not been tested in regard to creativity in everyday life, it seems likely that EMA may be best equipped to examine everyday creativity in everyday environments.

Additionally, there is some evidence that people are not well equipped to report retrospectively on irregular or infrequent activities. Sonnenberg and colleagues (2012) investigated how much time people spent on various activities using both experience sampling and retrospective reports. For activities they engaged in frequently and on a scheduled, regular basis, such as hours spent working, people gave similar reports using experience sampling and retrospective surveys; for irregular activities not on an external schedule, such as hours spent doing leisure activities, experience sampling and retrospective reports did not match up as well. For many people, everyday creativity would likely occur irregularly rather than on a fixed external schedule.

Third, many experiences vary within a person across time, and retrospective measures obscure this within-person variability. When we assess experiences multiple times, we are able to observe this within-person variability, which is interesting in its own right (Fleeson, 2004). If there are aspects of creativity in daily life that are highly variable, we miss out on information when we use retrospective measures to ask people about their typical or average creative experiences. With EMA techniques, however, we are able to capture this information through maintaining the diversity of experiences rather than asking for an aggregate response (Schwarz, 2012; Silvia, Cotter, & Christensen, 2017).

Finally, EMA allows for longitudinal measurement of the creative process and progress toward a creative goal over short time scales, which is impractical with traditional survey or inventory measures of everyday creativity. For example, Benedek and colleagues (2017) recently used daily diaries to track the progress of a creative project – a short film or video for an art competition – and project-related behaviors and feelings over the course of two weeks. The visual artists reflected on the status of their creative project each evening and completed the survey. This longitudinal design allowed the researchers to examine trajectories of emotions, thoughts, and creative progress across the two weeks.

What Have We Learned About Creativity in Everyday Life?

Although there has been work examining little-c creativity using creativity inventories and other retrospective measures, we will focus on work that has assessed everyday creativity in everyday life using EMA techniques. Although there hasn't been much creativity research using EMA techniques, the method is becoming increasingly popular, and the few studies that have been done show that it is fruitful and feasible to use these approaches in creativity research.

How Often Do People Pursue Creative Projects?

One basic question EMA can illuminate is how often people work on creative projects during a typical day. Silvia and colleagues (2014) asked college students "Are you doing something creative?" several times throughout the day for one week using participants' personal phones. On average, people were doing something they felt was creative 22 percent of the time. Later studies have reported similar levels of engagement in creative activities. Other samples have reported doing something creative on 43 percent of the studied days (Karwowski et al., 2017, Study 2) or being "a little" creative on most days (Conner & Silvia, 2015), and middle-aged adults report frequent creative engagement (33 percent of the time; Karwowski et al., 2017, Study 1).

People are regularly creative in their everyday lives but are there some people who tend to be creative more or less frequently? One of the consistent findings in creativity research is the association between creativity and openness to experience (Oleynick et al., 2017). Consistent with past work, people higher in openness to experience engage in creative activities more frequently in their daily lives (Conner & Silvia, 2015; Karwowski et al., 2017; Silvia et al., 2014). Conscientiousness, agreeableness, and low neuroticism have also been associated with doing more creative activities in daily life (Karwowski et al., 2017). Additionally, college major matters – students majoring in the arts were very frequently creative (39 percent of the time) but students not concentrating in the arts were still frequently engaged in creative activities (19 percent of the time; Silvia et al., 2014).

Inner Experience and Daily Creativity

How do inner experiences, like moods, emotions, and flow states, relate to creativity? The links between affect and creativity have been studied intensively using experimental, developmental, and cross-sectional correlational methods (Baas, De Dreu, & Nijstad, 2008; Russ, 1993; see Baas, Chapter 12, this volume), but how does affect relate to creativity in the moment, in the time and place where someone is working on a creative goal? Silvia and colleagues (2014) examined both positive and negative moods many times per day and found that feeling happy or active at a given survey signal was associated with doing something creative at that survey signal. The findings thus broadly supported experimental research, which has found that positive, active states are most strongly linked to creative thought (Baas et al., 2008).

Conner and Silvia (2015) measured a range of positive and negative emotions at differing activation states (e.g., measuring positive affect across a range of activation levels, such as *energetic*, *happy*, and *relaxed*). At the within-person level, both positive and negative emotional states predicted being creative on that day. Positive emotion at all three activation levels was positively associated with being creative – the strongest predictor was high activation positive emotional states (feeling enthusiastic, excited, and energetic). Negative emotional states also were associated with being creative but negatively – doing something creative was less likely on days characterized by high levels of negative emotion. These associations were weaker than those with positive states. At the between-person level, positive emotions at all activation levels and high activation negative emotions (feeling angry, hostile, and irritable) were positively correlated with creativity. Consistent with Richards' (2007) view of creativity, the findings from Silvia and colleagues (2014) and Conner and Silvia (2015) suggest that creativity is more closely associated with positive psychological functioning rather than supporting the stereotypical layperson's view that everyday creativity must come from a place of pain and suffering.

To further clarify creativity's association with these positive states, Conner, DeYoung, and Silvia (2018) investigated whether everyday creativity increases people's well-being using the same data set as Conner and Silvia (2015). Specifically, they examined how being creative on one day carried over to measures of well-being (positive affect, negative affect, and flourishing) on the following day. In addition to the emotional state items used in the prior study, flourishing was measured by items about feelings of purpose and meaning in life, engagement, and social connectedness. Being creative on day one predicted increases in positive affect and, more strongly, increased flourishing on the following day. Even after controlling for being creative on day two, creativity on day one was still able to predict increases in high activation positive emotional states and flourishing. This was not a reciprocal relationship, however –

positive affect and flourishing did not predict being creative on the following day. Interestingly, personality factors did not moderate these relationships – everyday creativity is beneficial to a range of people, not just a select group or disposition. So, it seems that in a sample of young adults, everyday creativity increases well-being.

Other studies have examined *flow*, a rewarding state in which people feel fully absorbed in what they are doing (Csikszentmihalyi, 1990). Interestingly for our purposes, flow research has long ties to creativity (e.g., Csikszentmihalyi, 1996; Perry, 1999) and to experience sampling methods. Many of the early innovations in experience sample research were developed in the context of flow research (e.g., Csikszentmihalyi, 1975; Csikszentmihalyi & Figurski, 1982; Csikszentmihalyi & LeFevre, 1989).

In a study of flow, Fullagar and Kelloway (2009) used experience sampling to measure flow in a sample of architecture students working on projects in their studio space. They found that flow experience was highly variable: only 25 percent of the variance was at the between-person level, so flow was much more of a state concept than a trait. Furthermore, situational features associated with flow were feelings of high autonomy for the creative project and believing that the task required a range of different skills. Flow was thus encouraged by creative projects involving choice and diverse skills. Finally, flow was associated with active, positive emotions, further bolstering the other EMA studies of creativity and mood (Conner et al., 2018; Silvia et al., 2014). This study thus illustrates that flow is a dynamic concept that varies from situation to situation and identifies some features of the projects that encourage it (cf. Perry, 1999).

How Do Creative Projects Unfold?

In addition to capturing everyday instances of creativity, EMA can be used to follow the progress of a creative project and examine the creative process over time. Benedek and colleagues (2017) followed a group of professional visual artists over the course of two weeks as they completed a video entry for a competition. Over the course of the two weeks, the artists completed daily diaries: They reported how complete their project was and then described their affect and work style when working on the project. Although each creative project unfolded differently, Benedek and colleagues found that people generally felt positively and lost sense of time when working on their projects. Progress on the creative projects was associated with enjoying the work, deliberately choosing to spend time on the project, and focusing on the details of the project. Feeling anxious and a sense of "walking in a dense fog" hindered progress toward a finished product. Participants in this study were Pro-c visual artists, and future research should examine the creative process in people who have more casual creative interests and hobbies.

Imagination in Daily Life

In addition to tangible products that everyday creativity produces, people often experience mini-c creativity internally. Daydreaming and mind-wandering often receive negative reputations as being distracting failures of mental control and attention (McMillan, Kaufman, & Singer, 2013; Seli et al., 2016) but these mental processes can be willfully and intentionally guided (Seli et al., 2016) and produce personally interesting insights and creations. One view suggests that positive constructive daydreaming – consisting of creative thought and other forms of imagination – is essential for healthy mental functioning (McMillan et al., 2013). People get personal meaning through reflecting on their experiences and gain insight through simulating future events, all of which would qualify much of this mental activity as mini-c creativity. Constructs such as these have not traditionally been associated as being creative processes but taking a fresh perspective on daydreaming and spontaneous thought could take the study of everyday creativity in interesting new directions.

One example of this reframing can be applied to inner music – the experience of hearing music in one's mind that isn't playing in the environment (Beaty et al., 2013). People do intentionally initiate inner music during their everyday lives (Cotter, Christensen, & Silvia, in press) and this experience can serve a number of functions. Musicians will use musical imagery to rehearse and simulate upcoming performances (Bailes, 2006; Gregg, Clark, & Hall, 2008) and inner music likely plays a role in musical composition as well. Both of these functions can easily be connected to creativity – with this mental simulation, musicians can play around with new ideas before applying them to an actual performance or composition. But all inner music is something that people are creating in their minds – although the music may not be their own, they are self-generating this experience in the absence of external stimuli. Musical imagery is just one example of private, internal instances of mini-c creativity.

Mini-c creativity has not received much attention in the imagination literature, and these internal processes, such as daydreaming, mind-wandering, and other related processes, may be a place to start. In asking about the content and qualities of these mental experiences, we may be able to further understand mini-c creativity and include all four Cs in current research practices.

Conclusion

In this chapter, we proposed that the label *everyday creativity* has two distinct senses: the study of mini-c and little-c creators and their work, and the ecological study of creativity in natural environments. These two approaches overlap and we suggested that interest in each has been growing as research methods for studying psychological processes in vivo have become more practical and widespread. The growth of EMA methods looks like a significant trend in recent creativity research and we reviewed some recent lines of research with EMA methods to illustrate the kinds of questions they can explore. If the science of creativity examines creativity where and when it happens, whether it is a group of preschool children in a music class or a renowned sculptor in her studio, we think it will uncover new insights into people's essentially creative natures.

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Manifestations of Creativity

31 Creative Genius

Dean Keith Simonton

Creativity can assume many guises. There's the creativity that appears in everyday problem-solving: how to revise a favorite recipe when one required spice is absent from the kitchen cabinet; how to plan a surprise party for a special someone when it requires that every one assemble simultaneously at an exotic locale; or how to reorganize office operations to reduce expenditures by 20 percent while still maintaining productivity and morale. The solutions to these problems may yield a memorable cake, event, or organization chart but any influence is most often transient and delimited. The ad hoc recipe may not yield a prizewinning cake, the event may not set a new trend in celebrations, and the new office structure may only work for the specific personnel at a particular point in time.

In contrast, creativity can sometimes be of such importance that its effects endure for decades, centuries, even millennia. This is the magnitude of creativity seen in the epic poem *Iliad*, the ceiling frescoes of the Vatican's Sistine Chapel, the philosophical treatise *Discourse on the Method*, the scientific monograph *Principia Mathematica*, the Symphony No. 5 in C Minor, Op. 67, or the novel *War and Peace*. So monumental are these creative products that they have earned their creators immortal fame. Not just the products but the names of their authors have left a lasting mark on history – names such as Homer, Michelangelo, Descartes, Newton, Beethoven, and Tolstoy.

This latter degree of creativity is sometimes styled Big-C creativity, to be distinguished from little-c creativity mentioned in the first paragraph (Simonton, 2013b). However, the expression Big-C creativity can be also applied to cases that are not nearly so outstanding. Anyone creative enough to publish a poem in a major literary magazine, have an application approved by the US Patent Office, publish a highly cited scientific article in a top-tier journal, or write the score to a mainstream feature film might be said to exhibit lower levels of Big-C creativity. In other words, the latter label might be attached to all creators who generated an identifiable product without necessarily rendering the person highly eminent (cf. "pro-c" creativity in Kaufman & Beghetto, 2009). So when we talk about the creativity at the highest level we are really talking about **Boldface-C** creativity – the creativity of those who have left a mark on human civilization.

It's easy to provide a crude operational definition of this grade of creativity. It's called the "Google test." Pick a given *creative* individual and then use Google.com to search the creator's *name*. If you get thousands of clearly relevant internet sites – perhaps including a link to a corresponding Wikipedia article – the person has passed the preliminary exam. If the links include at least one site dedicated specifically to that individual, then Google certification attains the highest level of confidence. To illustrate, consider Hildegard von Bingen, the twelfth-century abbess, philosopher, scientist, physician, artist, poet, and composer: Can she be considered a **Boldface-C** creator? The answer, as any reader can verify, is yes. Hundreds of thousands of hits plus her very own Wikipedia entry and dedicated website.[1]

Most often these highly eminent creators are recognized as creative geniuses. That is, creative geniuses become highly eminent because they have contributed at least one product widely viewed as masterwork in an established domain of creative achievement. Because these domains are quite varied, we must begin by discussing the diverse *varieties* of creative genius (cf. Sternberg & Bridges, 2014). The next topic concerns the psychological *correlates* – both dispositional and developmental – of creative achievement in these diverse domains. The last subject turns to *grades* of creative genius. Even among **Boldface-C** creators there exists variation in the extent of creative accomplishment. Finally, this chapter concludes by discussing the *processes* by which creative geniuses arrive at their history-making ideas.

Before continuing, I have to specify some restrictions in the scope of this chapter's coverage. Creative genius is such an attractive topic that it has enlisted researchers who favor a diversity of theoretical and methodological approaches (Simonton, 1999a). More than a century ago, for example, psychoanalysts initiated the practice of conducting single-case diagnoses of historical creators, a research paradigm that actively continues to the present day. A classic example is Sigmund Freud's (1910/1964) psychoanalysis of Leonardo da Vinci (Elms, 1988). Although psychobiographies have expanded well beyond the limitations of psychoanalytic theory (Schultz, 2014), their exclusive reliance on qualitative and idiographic methods raises issues of both scientific replicability and generalizability (Simonton, 1999a). These drawbacks also hold for single-case qualitative studies of scientists' notebooks, such as Gruber's (1974) well-known work on Charles Darwin's network of enterprises (see also Tweney, 1989). Nonetheless, it is worth mentioning a recent movement toward single-case empirical studies that are both quantitative and nomothetically driven (cf. Simonton, 1999a). Examples include inquiries into the creative process in Thomas Edison and Pablo Picasso (Damian & Simonton, 2011; Simonton, 2015; Weisberg, 2014). Whether this trend continues remain to be seen. In any event, the current literature review concentrates on research results emerging from investigations that are empirical, quantitative, multiple-case, and nomothetic.[2] Of course, this very same fourfold emphasis tends to be characteristic of creativity research in general. Just the cases radically differ in eminence.

[1] See www.hildegard.org

[2] The same criteria caused the omission of Gardner's (1993) comparative work, which studies seven creative geniuses in the context of his theory of multiple intelligences (Gardner, 1983; see also Gardner, 1998). For a detailed analysis of this work in the context of the larger literature on creative genius, see Simonton (2006).

Varieties

If a creative genius is someone who becomes eminent by making a contribution to a major domain of creative achievement, what are these domains? The ancient Greeks were perhaps the first to address this question. The answer took the form of the Muses who were thought to inspire each creative genius. Traditionally, there was a Muse responsible for heroic or epic poetry (Calliope), lyric and love poetry (Erato), sacred poetry (Polyhymnia or Polymnia), tragedy (Melpomene), comedy (Thalia), music (Euterpe), dance (Terpsichore), history (Clio), and astronomy (Urania). Presumably, other forms of creativity, such as philosophy or the visual arts, required no Muse! Perhaps pure logic or technique sufficed.

Modern researchers have tried to identify the main domains of achievement according to those forms that have attracted the highest levels of creativity in a given civilization or civilizations. Francis Galton's (1869) *Hereditary Genius* included chapters on scientists, creative writers, poets (as a separate group), painters, and composers. Catharine Cox's (1926) *Early Mental Traits of Three Hundred Geniuses* classified her creators as scientists, philosophers, informative creative writers (essayists, critics, and historians), imaginative creative writers (poets, dramatists, and novelists), artists (painters and sculptors), and composers. Alfred Kroeber's (1944) *Configuration of Culture Growth* grouped geniuses from the major world civilizations into the fields of philosophy, science, philology, literature, drama (as a separate group, too), sculpture, painting, and music. More recently, Charles Murray's (2003) *Human Accomplishment* classified a worldwide sample of eminent creators into the domains of science, mathematics, medicine, technology, philosophy, literature, art, and music (cf. Murray, 2014).

Although there seems to be some agreement on certain core domains – especially the broad categories of science, philosophy, literature, music, and the visual arts – it is important to recognize that specific non-Western civilizations will often include forms of creativity that are not particularly well appreciated in Western civilization. For instance, Chinese civilization includes the highly regarded categories of calligraphers and artisans (Simonton, 1988a), Japanese civilization the highly honored categories of ceramicists and sword makers (Simonton, 1997b), and Islamic civilization the highly valued categories of jurisprudents and mystics (Simonton, 2018c). This point should be remembered when researchers try to compare the relative creativity of civilizations or cultures (e.g., Galton, 1869; Murray, 2003). Lots of creativity is channeled into areas that are overlooked because of ethnocentric blinders. A parallel oversight can cause problems in assessing the achievements of women creators as well.

Sometimes, too, alternative modes of creativity are dismissed because their products are too ephemeral. Examples might include choreography, fashion design, winemaking, and haute cuisine. Even if creators in these areas can become highly eminent in their own lifetime, that eminence dissipates quickly with the passage of time (cf. Runco et al., 2016; Whipple, 2004). Who besides an expert in the history of ballet even remembers the choreographer for the debut performance of

Tchaikovsky's *The Nutcracker*? In comparison, how many of my readers have heard of either Tchaikovsky or *The Nutcracker*?

Although many creators attain eminence in one and only one inclusive domain of creative achievement, it is clear that some can attain distinction in more than one. In addition to Hildegard von Bingen, such universal or omnibus creators include Omar Khayyám, Leonardo da Vinci, Blaise Pascal, Johann Wolfgang von Goethe, and Benjamin Franklin. But how common is such creative versatility? It turns out that it is fairly frequent (Simonton, 1976; White, 1931). This idea was most recently established in Cassandro's (1998) study of 2,102 creative geniuses. The creators were assessed on their versatility, defined by having achieved eminence in more than one domain or subdomain. Although 61 percent were not versatile by this definition, 15 percent were eminent in more than one subdomain within a domain (e.g., poetry and drama within literature), and fully 24 percent were eminent in more than one domain (e.g., literature and science). Hence, more than a third exhibited creative versatility of some kind at the Big-C level. Shakespeare was a creator in the first category of versatility (poet and dramatist) whereas Goethe was a creator in the second category (poet, dramatist, novelist, and natural scientist).

Creative geniuses who contribute to more than one domain or subdomain can be said to have "balanced portfolios." Their eminence does not depend on their contributions to any single domain. This is very fortunate. Although Goethe was proudest of his scientific work (most notably his *Theory of Colors*), it is manifest that his current reputation rests far more on his literary greatness.

Correlates

Why does someone choose to attain fame (and perhaps fortune) in one domain rather than another? Is it a matter of mere chance, or are there certain variables that are associated with the choice? Could Picasso just as well have grown up to become an Einstein and vice versa? Or was the creative growth of these two eminent individuals deflected toward divergent domains?

As it happens, the latter is the case. Specific factors tend to direct creativity toward particular domains of achievement. These factors fall into two categories: dispositional and developmental (Simonton, 2009).

Dispositional Correlates

Human beings vary on a large number of intellectual and personality variables. Some of these individual differences correlate with creative genius regardless of achievement domain. The most conspicuous example is the positive correlation with openness to experience, one of the Big Five Personality Factors (McCrae & Greenberg, 2014). Creative geniuses tend to exhibit wide interests, a breadth that often inspires the versatility already mentioned (Cassandro, 1998; Cassandro & Simonton, 2010; Simonton, 1976; White, 1931). It is difficult to create in a domain without first showing sufficient interest in that domain.

Nevertheless, other dispositional variables correlate with the domain of creative achievement. Perhaps the single most intriguing example is psychopathology. Since the time of Aristotle, people have speculated about the "mad genius." Although this possibility has provoked considerable controversy, there seems to be some grain of truth to the association (Kaufman, 2014; Kyaga, 2015; Simonton, 2014b). For example, creative achievement appears to be positively correlated with elevated scores on the clinical scales of the Minnesota Multiphasic Personality Inventory (Barron, 1963) as well as the psychoticism scale of the Eysenck Personality Questionnaire (Acar & Runco, 2012; Eysenck, 1995; cf. Grosul & Feist, 2014). Indeed, highly creative people apparently exhibit a "shared vulnerability" with the mentally ill insofar as both groups display exceptional cognitive disinhibition (Carson, 2014). The creative are fortunate to possess other cognitive resources, most notably high general intelligence, that convert a potential liability to an asset. As William James (1902) expressed it more than a century ago, "when a superior intellect and a psychopathic temperament coalesce . . . in the same individual, we have the best possible condition for the kind of effective genius that gets into the biographical dictionaries" (pp. 23–24).

Even so, it is also the case that any inclinations toward mental illness are contingent on the domain of creative achievement. According to Ludwig (1998), the frequency and magnitude of psychopathology typical of a domain corresponds to the nature of the creativity in the domain: Creators in domains that "require more logical, objective, and formal forms of expression tend be more emotionally stable than those in . . . [domains] that require more intuitive, subjective, and emotive forms" (p. 93). Ludwig then showed that that this principle applied at multiple levels of "magnification," that is, the occurrence of mental illness exhibited the fractal pattern of "self-similarity." Consider the following four levels:

Level 1: Scientists have lower lifetime rates of mental illness than do artists (see also Damian & Simonton, 2015; Post, 1994; Raskin, 1936; Simonton, 2014c). Indeed, those rates can be considerably lower than found in the general population.

Level 2: (a) in the sciences, natural scientists have lower rates than do social scientists (see also Ludwig, 1995); and (b) in the arts, creators in the formal arts (e.g., architecture) have lower rates than those in the performing arts (e.g., music and dance) who in their turn have lower rates than those in the expressive arts (e.g., literature and the visual arts).

Level 3: Within a specific expressive art like literature, nonfiction writers display lower rates than do fiction writers who in their turn have lower rates than do poets (cf. Simonton & Song, 2009).

Level 4: Within any specific artistic domain (e.g., painting, sculpture, and photography), those who create in a formal style will exhibit lower rates than those creating in a symbolic style, and the latter exhibit yet lower rates than those creating in an emotive style. So of all varieties of creativity, poets writing in a highly emotionally expressive style should have the highest propensity for pathology (cf. Kaufman, 2000–2001, 2001; Martindale, 1972; Simonton & Song, 2009).

An analogous variety of Level 4 magnification can be found in the relation between psychopathology and scientific creativity in paradigmatic disciplines. In particular, scientists who display some degree of psychopathology are more likely to attain eminence as revolutionaries who reject the current paradigm, whereas scientists who exhibit no pathology are more prone to become famous for making contributions that preserve the current paradigm (Ko & Kim, 2008). "Defying the crowd" is not a strategy without risk (Sternberg, 2016).

I must stress that these differentiations can be applied to other dispositional characteristics besides psychopathology. Unfortunately, these contrasts tend to involve a subset of disciplines rather than the more comprehensive distinctions that Ludwig (1998) offered. In fact, most relevant investigations concentrate on contrasts among scientific disciplines. Even so, it is useful to contemplate the following two interdomain differences. First, Chambers (1964) found that creative psychologists were more likely to score higher than creative chemists on Factor M of the 16 Personality Factors (see also Cattell & Drevdahl, 1955). This means that chemists are less bohemian, introverted, unconventional, imaginative, and creative in thought and behavior relative to psychologists. Second, in Roe's (1953) study of sixty-four eminent scientists (using the Thematic Apperception Test), the social scientists (psychologists and anthropologists) were shown to be less factual, more emotional, and more rebellious than the physical scientists (physicists and chemists).

Interestingly, dispositional traits even divide subdisciplines of the same overall discipline (i.e., "Level 4" magnification). An example is Suedfeld's (1985) content analysis of addresses delivered by presidents of the American Psychological Association (APA). The speeches were scored on integrative complexity, a measure of how many divergent perspectives a person can take into consideration and whether the person can integrate these perspectives into a coherent viewpoint. Those APA presidents who were natural-science oriented (e.g., behaviorists) demonstrated lower levels of integrative complexity than those who were human-science oriented (e.g., humanistic psychologists). Admittedly, not all APA presidents were creative geniuses but at least some of them were.

Developmental Correlates

At least in part, dispositional traits must have some foundation in the early environmental experiences that shape creative development. Disposition is as much a function of nurture as nature if not more. It should come as no surprise, therefore, that highly eminent individuals who contribute to distinct domains of creative achievement also tend to differ in their developmental backgrounds (Damian & Simonton, 2014; Simonton, 2009). In a sense, the creators in each domain exhibit distinctive biographical profiles (Simonton, 1986).

This fact is immediately apparent in research on the family backgrounds of Nobel laureates (Berry, 1981). If we exclude the prizes for peace (because it does not represent a recognized form of creativity) and for physiology/medicine (because it is a very heterogeneous category), we find that 28 percent of the laureates in physics are most likely to have come from homes where the father was an academic professional. The corresponding figures for the chemistry and literature laureates are 17 percent and 6 percent, respectively. Even more striking are the differences in partial orphanhood – losing their fathers while still young. The figures are physics 2 percent, chemistry 11 percent, and literature 17 percent. The contrast in the family backgrounds of the physicists and creative writers is especially striking: 30 percent of the literature laureates "lost at least one parent through death or desertion or experienced the father's bankruptcy or impoverishment" whereas "the physicists . . . seem to have remarkably uneventful lives" (p. 387; see also Simonton, 1986; cf. Raskin, 1936).

Another study of over 300 twentieth-century eminent personalities found that fiction and nonfiction authors tended to come from unhappy home environments, whereas better home conditions produced scientists and philosophers (Simonton, 1986). In addition, the eminent scientists had the most formal education and artists and performers the least. A comparable investigation of an earlier sample of eminent scientists and creative writers showed that the former tended to have appreciably more formal education than the latter (see also Raskin, 1936). There is also some tentative evidence that creative artists, relative to creative scientists, are prone to have been exposed to a greater diversity of mentors (Simonton, 1984, 1992). Last but not least, eminent artists may be somewhat more likely to be nurtured by unstable and heterogeneous sociocultural systems than is the case for scientific creators (Simonton, 1975, 1997b). Sociocultural stability and homogeneity more favor the creative development of eminent scientists.

If we focus on contrasts among scientific domains we encounter such findings as (1) eminent psychologists, relative to chemists, were much more likely to have been rebellious toward their parents (Chambers, 1964; see also Roe, 1953) and (2) physical scientists showed early interests in mechanical and electrical gadgets while social scientists were more inclined toward literature and the classics, and often exhibited an early desire to become creative writers (Roe, 1953). These divergences continue into adulthood. Where 41 percent of eminent social scientists divorced at least once, only 15 percent of eminent biologists did so, and the corresponding figure for eminent physical scientists was a mere 5 percent (Roe, 1953).

Perhaps the most fascinating developmental correlate is a creator's ordinal position in the family. Galton (1874) was the first to document how firstborns are disproportionately represented among eminent scientists, and subsequent researchers have replicated this result (Eiduson, 1962; Roe, 1953; Terry, 1989). Indeed, the firstborn predominance appears particularly strong among eminent women psychologists (Simonton, 2008b, 2017b). At the same time, there is reason to believe that revolutionary scientists have a higher likelihood of having been laterborns (Sulloway, 1996). That's because laterborns are supposedly more rebellious, more open to new ideas, and less conforming to conventions (see also Sulloway, 2014). This difference is reflected in aesthetic forms of creative eminence as well. Whereas classical composers are more disposed to be firstborns (Schubert, Wagner, &

Schubert, 1977), creative writers are more inclined to be laterborns (Bliss, 1970).[3] Presumably creativity in the former domain is more formal and conventional than creativity in the latter domain.

This pattern of differences closely mirrors what we previously saw with respect to dispositional traits. It is possible to array various scientific and artistic disciplines along a single bipolar dimension (Simonton, 2009). At one pole are domains where creativity tends to be more logical, objective, formal, and conventional; at the other pole are domains where creativity tends to be more intuitive, subjective, emotive, and unconventional. This bipolar dimension then allows us to arrange all domains of creative achievement according to their respective dispositional and developmental traits. To illustrate, eminent creativity in domains near the former pole, like physics and chemistry, should be associated with a greater frequency of firstborns, lower psychopathology and parental loss, and higher levels of formal education, whereas eminent creativity in domains near the opposite pole, like fiction and poetry, should be associated with a greater frequency of laterborns, higher psychopathology and parental loss, and lower levels of formal education. Of course, these are mere tendencies that operate only on the average. These are statistical regularities rather than hard and fast rules. Nevertheless, the disposition and development of someone who attains eminence near one pole will often differ from the disposition and development of someone who attains eminence near the opposite pole.

Grades

Too often the term "genius" is applied as a dichotomous term. Either you have genius or you don't. This all-or-none usage is especially commonplace in psychometric definitions of genius. Thus, Terman (1925–1959) defined genius as someone who earned a score of 140 or higher on the Stanford–Binet Intelligence Scale (cf. Simonton, 2016b). This psychometric threshold even appears in the *American Heritage Dictionary* (1992) where a genius is "A person who has an exceptionally high intelligence quotient, typically above 140." Naturally, people might quibble about the precise cutoff. Some may put it as low as 130 whereas others might put it as high as 160. The decision is clearly arbitrary. Or, rather, the only guiding principle seems to be that the qualifying score has to be low enough to admit its advocate into the ranks of genius!

Yet when we turn to *creative* genius, it becomes more obvious that we must deal with a quantitative rather than qualitative attribute. This reality is apparent in the most favored definition of creativity, namely that it must produce an idea that is both (1) novel, original, or unique and (2) effective, adaptive, or functional (e.g., Runco & Jaeger, 2012; cf. Simonton, 2018b). So Einstein's general theory of relativity is highly creative because it was highly original (i.e., constituting a substantial break

[3] Although recent research on personality development suggests that birth order explains very little variance, the same research shows that birth order still has significant effects on personal development that can potentially support the contrasts cited here (Damian & Roberts, 2015). The operative principle is within-family sibling divergence (Sulloway, 2010).

with Newtonian physics) as well as highly effective (e.g., it solved a problem in Mercury's orbit that hitherto lacked any workable solution). It should be clear that these two components are continuous rather than discrete variables. Creative products, in particular, can vary in both originality and effectiveness. Moreover, the variation in these two dimensions does not have to go together. Some ideas may be highly original but ineffective or highly effective but completely unoriginal. The first of these outcomes is perhaps the most interesting. An illustration is Einstein's unified field theory: It was extremely original but it simply failed to work, yielding predictions that were manifestly false.

Given that creative genius is a quantitative rather than qualitative trait (i.e., even geniuses can vary in the amount of creativity they display), we should expect it to be associated with other quantitative variables. And it does. Below I provide examples that fall into three categories: achieved eminence, creative productivity, and grade predictors.

Achieved Eminence

Cattell (1903) was the first person to demonstrate empirically how much geniuses can differ in the attainment of fame. Using several standard reference works, he compiled a list of the 1,000 most eminent creators and leaders in Western civilization, where the 1,000 were ranked according to the amount of space they received. The top-ranked creative genius on the list (#2) was William Shakespeare, a big name that needs no introduction (first place went to a leader, namely Napoleon). And the bottom ranked? The nineteenth-century French historian, philologist, and critic named Claude Charles Fauriel, who came in 998th (the 999th and 1,000th were both leaders). I must confess that I had no idea who this person was until I wrote this paragraph. But Fauriel does pass the Google test, having dedicated websites in both English and French! So Shakespeare and Fauriel define the end points in eminence for creative geniuses in this distinguished sample (cf. Cox, 1926; Whipple, 2004).

One might object that such space measures do not represent the best way to assess the achievement of such geniuses. Certainly, one reason why Shakespeare is ranked so high is that it is easy to devote many lines to synopses of his plays and sonnets. Yet the extreme variation in achievement eminence appears if we use alternative operational definitions. An interesting illustration is to be found in Hart's (2000) book *The 100: A Ranking of the Most Influential Persons in History*. Here the author attempted to identify the top 100 in terms of worldwide influence and then rank them. In his (subjective) opinion, the highest ranked creative genius was Isaac Newton, who came in second place (after a leader, namely Muhammad), whereas Shakespeare was pushed down to 31st. The lowest ranked creative genius was Homer, who came in at 98th (99th and 100th were leaders). Because this was a top-100 rather than top-1,000 list, Homer has far better name recognition than Fauriel. The least influential scientist on Hart's list, at 82nd, is Gregory Pincus, the person credited with the first practical birth control pill.

Both Cattell (1903) and Hart (2000) differentiated creative geniuses along an ordinal scale. This practice actually underestimates the magnitude of the variation in achieved eminence. In the case of Cattell (1903), for example, a genius ranked #1 is as far from one ranked #2 as a genius ranked #999 is from one ranked #1,000. But if he had published the raw space measures – the number of lines or pages devoted to each individual, he would have obtained far different results. The gap between #1 and #2 would be far, far greater than that between #999 and #1000. That's because the cross-sectional distribution of eminence is extremely skewed (Martindale, 1995; Zusne, 1985). The overwhelming majority of creative geniuses are rather obscure and just a handful stick out, with only one or two situated at the apex of acclaim.

Martindale (1995) provided an excellent illustration with respect to the number of books devoted to 602 British poets identified as notable in a standard reference work. A total of 34,516 books were written, or an average 57 books apiece. However, 9,118 of these books, or fully 26 percent, are about William Shakespeare. The two leading runners-up are Milton at 1,280, or 4 percent, and Chaucer at 1,096, or 3 percent. At the bottom end, 134 poets, or 22 percent, were the subject of not a single book. Accordingly, if we ranked these poets, Shakespeare, Milton, and Chaucer would come in 1st, 2nd, and 3rd, whereas 134 poets would all be tied for last place. Although Shakespeare can be said to be over six times as famous as Milton by the book counts, his rank is only one score higher. At the other end, the 134 nonentities are all equally unknown. The only way to distinguish among them would be to adopt a more refined space measure. Instead of counting the number of monographs, we could count the number of lines each receives in encyclopedias or biographical dictionaries dedicated to English literature. A poet who ranked 602nd by this measure would probably represent a Big-C but regular-font creator. He or she might demarcate absolute zero on the **Boldface-C** temperature scale.

Creative Productivity

From a psychological perspective, there's something a bit odd about the above distribution. Ever since Galton (1869), researchers have been accustomed to believe that most psychological variables are normally distributed. Instead, eminence is often so skewed that the modal score rests at the very bottom of the distribution and the highest scores dwell at the end of an enormously long upper tail. Frequently there is no lower tail whatsoever! How can this be?

The answer gets back to what I said was a minimal requirement for Big-C creativity: the contribution of at least one creative product to a recognized domain. Although occasionally there exist one-hit wonders who make one and only one contribution (Kozbelt, 2008), it is rare for these creators to rise to the highest ranks. The reputation of Homer rests on more than his *Iliad*, Michelangelo on more than his Sistine Chapel frescoes, Descartes on more than the *Discourse on the Method*, Newton on more than the *Principia Mathematica*, Beethoven on more than the Fifth Symphony, and Tolstoy on more than *War and Peace*. Indeed, each has contributed additional creative products that alone would have ensured their place in the pantheon of **Boldface-C** creators. Try the *Odyssey*, the *Pietà*, the *Les passions de l'âme*, the *Opticks*, the Ninth Symphony, and *Anna Karenina*, respectively. These geniuses are far from one-hit wonders.

This brings me to one of the hallmarks of creative genius: productivity (Albert, 1975). Creators of the highest order tend to be extremely prolific, producing work after work after work. Besides maintaining an exceptional rate of output, they tend to initiate output at an unusually young age and not end their output until quite advanced in years (Simonton, 1997a). So phenomenal is their output that a relatively small number of creators tend to dominate their chosen domain. Typically, the top 10 percent in total lifetime output are responsible for about half of all contributions, whereas the bottom 50 percent in total lifetime output can only be credited with 15 percent or less of all contributions. To show how extraordinary this dominance can be, Thomas Edison held patents to over a thousand inventions, a record that he maintained until the twenty-first century (Simonton, 2015). Clearly a technological genius of the highest order!

Admittedly, the foregoing findings apply to total lifetime output regardless of the quality of that output. Might it not be possible that some individuals are nothing more than mass producers who generate one worthless work after another? And might it also be possible that other individuals are perfectionists who offer the world just a handful of masterpieces – all wheat and no chaff? Yes, both are possible, but both are also exceedingly rare (Simonton, 2004). The norm is for the creators who produce the most works to also produce the most masterworks. That means, in effect, that even the greatest creative geniuses will generate lesser, even mediocre products. In other words, output tends to be uneven, high-quality products rubbing shoulders with low-quality products. Einstein is generally viewed as one of the all-time superlative geniuses. Even so, his career by no means consisted of an uninterrupted series of successes. I already mentioned his biggest failure – the unified field theory. He also penned a large number of unsuccessful attacks on quantum theory. In fact, one of those critiques woefully failed because he neglected to take into consideration his own theory of relativity!

In any case, the cross-sectional distribution of high-impact contributions corresponds very closely to that of low-impact contributions (Simonton, 1997a). Because both distributions are highly skewed, with a small elite credited with most of the work, we obtain a partial explanation for the similarly skewed distribution of eminence. Highly prolific creators generate most of the work, good or bad, but obviously it is their best work that ensures their posthumous reputation (e.g., Simonton, 1977, 1991a, 1991b). I say that the explanation is only "partial" because the distribution of eminence is even more skewed than the distribution of productivity (Martindale, 1995). Other factors operate to stretch the upper tails of eminence well beyond what can be explicated by creative output alone. No doubt Einstein was the preeminent theoretical physicist of his day. But it is likely that his fame today relative to that of, say, Enrico Fermi or Niels Bohr, is out of proportion to their respective contributions. How many times have you seen a T-shirt or wall poster with the face of Fermi or Bohr?

Grade Predictors

We have just learned that the primary basis for variation in eminence is variation in lifetime output. Those who make more total contributions to their chosen domain are more likely to make more notable contributions, and it is on the latter that their eminence is largely founded. Hence, the next question is whether creative geniuses differ on other variables that predict how they vary in productivity and/or eminence. This question is particularly critical from a psychological perspective. One could argue that the individual differences in fame and output reflect the operation of sociological rather than psychological processes. For instance, sociologists have shown how the process of accumulative advantage – where the rich get richer and the poor get poorer – can produce skewed productivity distributions in the absence of any individual differences in talent or ability (e.g., Allison, Long, & Krauze, 1982; Allison & Stewart, 1974). But if we can identify predictors of genius grade that dwell inside individuals, then psychological explanations become more justified.

Fortunately, psychologists have in fact identified several variables that predict the level of creative achievement. Some of these variables – such as inclination toward some degree of psychopathology and ordinal position in the family – also differentially predict attainment according to domain (Simonton, 2009). Yet other predictors appear to be universal. Most conspicuously, creative genius does appear to be positively associated with general intelligence, as assessed by historiometric IQ. The correlation tends to be somewhere between 0.20 and 0.30 (Cox, 1926; Simonton, 1976, 1991c, 2008a; Simonton & Song, 2009; Walberg, Rasher, & Hase, 1978). It is almost unheard of for a creative genius to have an IQ below 120, and the overwhelming majority have IQs above 140.

But high general intelligence alone does not guarantee genius-grade creativity. The person must also tremendous energy, drive, persistence, and determination (Cox, 1926; Galton, 1869; Helmreich, Spence, & Pred, 1988; Simonton, 1991c). One reason why this is so crucial is because exceptional creative achievement requires an awesome amount of work. First, it takes about a decade of intensive study and practice to acquire the necessary domain-specific expertise (Ericsson, 2014). History-making creative achievements are not produced by amateurs or novices. Second, churning out product after product can be grueling business, especially when successes are punctuated by failures (e.g., Simonton, 2015). One cannot hope to produce path-breaking work if one is unwilling to take big risks, and sometimes such risks do not pay off.

Undoubtedly, to some extent the personal attributes of creative geniuses can be attributed to heredity. That attribution is justified because almost all traits have substantial heritability coefficients (Simonton, 1999b, 2008c, 2014a). In this sense, genius is inborn. Yet it is also the case that creative genius is made. The inventory of environmental experiences that contribute to creative development is also quite large. It includes family background factors, educational and training experiences, and early career opportunities, the specifics partly dependent on the domain of achievement. The significant point is that the most illustrious creative geniuses differ on a diversity of variables. This fact, in combination with the dispositional differences, implies that the magnitude of creativity displayed has a psychological foundation.

To be sure, given that so many psychological variables tend to be normally distributed, one might wonder how these variables can account for the skewed distributions of eminence and productivity. Although a number of explanations have been offered (Simonton, 1997a, 1999b), one has special interest here. If an outcome variable is the additive function of a large number of normally distributed variables, then that outcome variable will also have a normal distribution. But what if that outcome variable is a *multiplicative* function of those same normally distributed variables? In that case the outcome variable will display a highly skewed lognormal distribution (Simonton, 2003). This distribution can then explain the cross-sectional distribution in lifetime output. The creative geniuses found in the extreme upper tail are those who happen to register the highest on all of the predictor variables. The multiplicative manner in which those predictors are integrated serves to exaggerate their extremity. The upshot is an Albert Einstein, Jean-Paul Sartre, James Joyce, Pablo Picasso, or Igor Stravinsky.

Processes

Researchers often speak of the person, product, and process perspectives on creativity, but, so far, I have only treated the first two (cf. Simonton, 2003). So what are the thought processes by which creative geniuses arrive at their high-impact ideas? Does genius-level creativity merely involve the same mental operations as found in ordinary creativity but just applied to an acquired domain-specific expertise? For example, do geniuses also rely on divergent thinking, remote associations, primary process, or cognitive disinhibition? Or does boldfaced Big-C creativity function in mysterious ways, the genius enjoying unique access to flashes of insight unavailable to little-c creators? If the latter, does that mean that creative genius cannot be trained or practiced? Were the ancient Greeks right in supposing that creators had to wait patiently for inspiration from their favorite Muse? If their Muse failed them, were they out of luck?

Unhappily, creativity researchers are all over the map on this issue (for extensive review, see Simonton, 2012a). On the one hand, some investigators argue that (1) creative genius involves nothing more than exceptional domain-specific expertise (Ericsson, 2014) and (2) only ordinary thought processes are required to convert this expertise into extraordinary creative products (Weisberg, 2014). In this view, it is perfectly possible to program a computer to display genius-grade creativity using straightforward algorithms or heuristics (Cope, 2014; Langley et al., 1987). If genius can be so easily programmed, then anyone can become a genius!

On the other hand, some researchers have discerned the involvement of processes that are not always associated with everyday thinking. For instance, Ness (2013) scrutinized the thinking habits of sixteen geniuses, including such figures as Charles Darwin, Maria Montessori, Albert Einstein, Stanley Milgram, Thomas Edison, Marie Curie, Ernest Rutherford, and Paul Ehrlich. She found that their discoveries and inventions were founded on a large set of "tools," namely analogy, broadening perspective, changing point of view, dissecting the problem, finding the right question, frame shifting, juggling induction and deduction, observation, recombination and rearrangement, reversal, and the power of groups. On the basis of interviewing

Nobel laureates and studying their discoveries, Rothenberg (2015) identified three additional processes, namely Janusian, homospatial, and sep-con articulation thinking. And these lists do not even consider that creative genius often relies on behavioral procedures instead of cognitive processes. Examples include tinkering, play, experimentation, and exploration (Simonton, 2012b, 2015). Darwin's son reports his father's special fondness for "fool's experiments" in which he "was willing to test what would seem to most people not at all worth testing" (F. Darwin, 1892/1958, p. 101). For example, he once asked his son to serenade a mimosa with his bassoon to see whether plants respond to music!

What are we to make of these numerous, diverse, and sometimes inconsistent possibilities? Just throw up our hands in despair and then curse the intractable nature of creative genius? Or might each and every process and procedure merely represent a special case of a far more universal principle? By the same token, can that universal principle apply to all domains of creativity rather than just representing a domain-specific technique? The answer is a resounding *yes*! That principle contains two core concepts.

1. *All* forms of creativity are ultimately *combinatorial* (Simonton, 2010). New ideas or responses are generated as combinations of previous ideas or responses. For instance, Thagard (2012) systematically demonstrated that 100 top discoveries and 100 top inventions are combinatorial products of various types (see also Thagard & Stewart, 2011). Likewise, in the arts, even the greatest artistic masterpiece can be viewed as the combinatorial product of previous themes and techniques. This necessity has been firmly established in the case of Pablo Picasso's *Guernica*, for example (Damian & Simonton, 2011; Weisberg, 2004). The combinatorial nature of creativity has even been extended to classic problem-solving experiments, such as Maier's (1931, 1940) classic two-strings problem (Epstein, 2015; Simonton, 2017a). In any event, every so-called "creative" process or procedure mentioned earlier is just one particular way of generating new ideational or behavioral combinations.

2. *All* guises of creativity are necessarily *selectionist* (Cziko, 1995). Combinations must be generated without complete prior knowledge of whether they will actually prove useful or effective. Indeed, any combination that is already known to possess high utility in advance of its generation would have to count as routine or habitual rather than creative (for logical and mathematical proofs, see Simonton, 2013a, 2016a, 2018b). Hence, each generated combination must undergo a selection process or procedure to determine its actual usefulness or effectiveness, mandating what has been variously called "trial and error," "generate and test," "guess and check," "selection by consequences," "bold conjecture and refutation," or "blind variation and selective retention" (e.g., Bain, 1855/1977; Campbell, 1960; Popper, 1963; Skinner, 1981). For good or ill, the preferred term in my own theoretical and empirical research has been BVSR, the acronym for Campbell's (1960) Blind Variation and Selective Retention theory of creativity (Simonton, 2011, 2013a; see also Nickles, 2003).

Significantly, the selectionist component of creativity operates at two levels, the individual and the field of creators active in the same domain. The latter include the "peers" behind peer review (cf. Wray, 2010). According to

Csikszentmihalyi's (2014) systems theory, an idea generated at the individual level must be validated by the field before it can enter the domain proper as a genuine contribution. Until that domain-specific certification takes place, the idea can only count as little-c creativity, not Big-C creativity. In any case, by integrating combinatorial and selectionist concepts into a single comprehensive theory, we obtain a universal theory that transcends not just the creative domain but also the magnitude of creativity, incorporating both little-c and Big-C creativity, with the latter a special case of the former. Besides also accounting for all processes and procedures, the same theory has two additional advantages. First, the theory provides the basis for complex but rigorous mathematical and computational models that have so far survived extensive empirical tests (e.g., Simonton, 1997a, 2003, 2010). Second, the same theory supports a detailed interpretative framework for understanding specific exemplars of creative genius, such as the careers of Galileo Galilei and Thomas Edison (Simonton, 2012a, 2015). When it comes to identifying a single comprehensive and precise theory behind all creativity, genius or otherwise, there's really no current competition.

Conclusion

Because a whole book can easily be written on creative genius, this chapter has been forced to touch only on the highlights. Many important empirical results were largely ignored. For example, I have not delved into the complexities associated with the life-span development of creative genius from birth to death and everything between. Moreover, I have largely ignored the sociocultural aspects of creative genius, a topic touched upon in my earlier chapter on "Creativity's Role in Society" in this handbook (Simonton, Chapter 22, this volume).

Despite all of these extensive findings, it must still be acknowledged that many significant topics deserve far more research than they have so far received. Certainly, more work must be done on creative genius in samples other than "dead white males." What little work has been done on underrepresented groups, such as women and minorities, shows that creative genius may not always operate in the same way as majority-culture men (e.g., Damian & Simonton, 2015; Simonton, 2017b). In the same vein, even though creative genius appears in all of the world's civilizations (again see Simonton, Chapter 22, this volume), the bulk of the research concentrates on modern Western civilization. Naturally, part of the reason for this concentration may be methodological. Mainstream techniques, such as interviews and assessment, can only be applied to living participants. Yet many of the great creative geniuses of history are long deceased, such as Homer, Michelangelo, Descartes, Newton, Beethoven, and Tolstoy, who were mentioned at the outset of this chapter. And many other creative geniuses appeared in non-Western civilizations, such as the Islamic, Indian, Chinese, and Japanese (e.g., Simonton, 1988, 1997b, 2018c). For these individuals, different methods are required, such as historiometry, which can be used on truly transhistorical and cross-cultural samples (Simonton, in 2018a). Research using these broader samples is essential to determine the extent to which the phenomenon of creative genius operates the same way across all times and places (cf. Simonton & Ting, 2010).

In short, I hope that this chapter will require extensive revision when this handbook goes through its third edition!

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32 Creativity and Malevolence

Past, Present, and Future

David H. Cropley and Arthur J. Cropley

The Benevolence Bias in Creativity

Simon (2001) noted a propensity in "popular folklore" (p. 203) to ascribe positive labels – e.g., "inspired" and "imaginative" – to creative achievements. According to Henning (2005), creativity is based on "integrity, sincerity and trustworthiness" and is aimed at fostering "beauty," "self-respect," "love," "peace," and "education." In short, creativity is widely connected with finer feelings, a sense of beauty, and sublime thought (Tatarkiewicz, 2011). This positive view of creativity is not confined to North American/Western European societies. For example, according to Chan (2011), the Confucian conception of creativity requires a person to display moral goodness and harmony, and the person's actions must benefit society. McCann (2005) drew attention to the fact that among Indigenous Australians, as is also the case with the Maori people of New Zealand, First Nations in Canada, and Native Americans in the United States, creativity implies benefiting other members of the community.

In fact, one of the most striking things about discussions of creativity is that in educational, scientific, business/industrial, and political discussions it is almost universally treated as self-evidently good. This state of affairs reflects the historical development of the way creativity has been understood since ancient times. Although Plato referred to the "divine frenzy" (Wittkower & Wittkower, 1969, p. 98) and Aristotle to the "tincture of madness" (Langsdorf, 1900, p. 90), both wrote approvingly of creativity. As the Roman, Horace (2005 [ca. 19 BCE], lines 9–10) put it, in Ancient Rome artists enjoyed special license to do as they pleased. Admiration of creative individuals continued through the Renaissance: According to Kant (1790/1914), they are favorites of nature with an "*innate* mental predisposition" (p. 204) (emphasis added). In the nineteenth century, even though creativity was thought to be dangerously close to madness (e.g., Lombroso, 1895; for an overview of modern research, see Kaufman, 2014), it was admired. The Sputnik shock of 1957 extended this widespread public admiration. Creativity was hailed as the pathway to peace and prosperity, and in the United States was even called for by the National Defense Education Act of 1958.

However, this does not mean that creativity is universally welcome *in practice*. For example, A. J. Cropley (2012) reviewed the situation in Australia and concluded that in the case of education, despite the fact that recent policy documents issued by state governments call for the promotion of creativity in the schools, this is largely lip service. D. H. Cropley and Cropley (2015) complained that, in the corporate world, creativity is often ignored or rejected, with well-known cases of even major corporations such as Polaroid, Nokia, and Smith Corona going bankrupt because they were either unwilling, or unable, to introduce effective novelty. Historically, there is ample evidence of "official" rejection of creativity such as the treatment of Galileo by the Inquisition when he attempted to publish the heliocentric model of the solar system and was forbidden even to *think* about it or, in more modern times, dissenting thinkers in the Soviet Union being sent to the Gulag.

Nonetheless, the highly favorable understanding of creativity in scholarly discussions is clearly visible in the psychological literature. Kampylis and Valtanen (2010) examined forty-two modern definitions of creativity and no fewer than 120 terms typically associated with it (collocations) and concluded that almost all definitions are positive, while collocations are rarely negative. According to Csikszentmihalyi's (e.g., 1999) systems view of creativity, experts in a field use the term "creativity" to refer to things they regard as exceptionally good and worthy of admission to the canons of the field. As McIntyre (2006) put it, a creative product constitutes "a *valued* addition to the store of human knowledge" (p. 202, emphasis added). Thus, discussions of creativity are marked by what we call a "benevolence bias," and this bias has hampered the development of thinking about creativity and limited practical application of knowledge about it.

Malevolent Creativity

The Idea of the Dark Side

The most prominent modern breakaway from the influence of the benevolence bias – the idea that there might be a *dark side* to creativity – was explored directly by McLaren (1993). This developed further with the distinction between *positive* and *negative* creativity that Clark and James (1999) and also James, Clark, and Cropanzano (1999) made. Similar questions about the nature of creativity, for example issues related to morality, were tackled by Runco and Nemiro (2003). Various terms are used by researchers in this area to attempt to capture the essence of "bad" creativity. In addition to negative creativity, these include "cantankerous" creativity (Silvia et al., 2011, p. 687), "perverse" creativity (Salcedo-Albarán et al., 2009, p. 4), and "unbridled" creativity (Craft, Gardner, & Claxton, 2008, p. 169).

One aspect of the dark side of creativity involves the apparent inherently destructive effects of simply being creative for the Person. A. J. Cropley and Cropley (2009) described the case of the French mathematician Évariste Galois, who was expelled from secondary school despite being a brilliant and, as we now know, highly creative mathematics student. Galois wanted to learn, admired his mathematics teacher, and produced excellent work in math lessons, however, he was simply too creative to fit in. Gascon and Kaufman (2010), Averill and Nunley (2010), and Gabora and Holmes (2010) explored the problematic personal aspects of creativity in a more clinical manner and emphasized issues such as social alienation, neurosis, even suicide. Goncalo, Vincent, and Audia (2010) drew attention to a dark aspect of the creative Process: Past creativity may block further creativity. They gave the example of Art Fry, the inventor of the Post-It note, who is said to have both been permanently stereotyped as the "Post-It man" thereafter and to have himself seen all future problems as variants of the idea of making use of adhesives that do not stick.

Malevolent Creativity: The Past

The benevolence bias was challenged more specifically by D. H. Cropley (2005). He went beyond existing ideas of negative creativity, which acknowledged that the Products of effective novelty are not limited to benevolent ones and defined a form of creativity in which the *deliberate intent* is to cause harm. He referred to such creativity as "malevolent" creativity. Cropley pointed out that in the same way that creativity helps businesses meet the needs of customers and stay competitive, it can also help to do harm more effectively, even if those outcomes seem reprehensible to most people. One domain in which the malevolence of creativity is obvious is crime (e.g., D. H. Cropley & Cropley, 2013): Useful and effective novelty is employed to improve the benefits yielded by criminal behavior, regardless of the damage suffered by other people as a result. This fusion of creativity and criminal intent is most obvious in areas such as fraud but is also seen in some cases of theft or murder as well as in areas such as cybercrime, drug smuggling, people trafficking, or illegal exporting of high-tech products – what Ekblom and Tilley (2000) termed *resourceful* crime. The most striking and clearly malevolent contemporary manifestation of *malevolent* creativity is terrorism. Here, harm to other people is the core or the sole purpose of a particular creative product. It is its fundamental *intention*.

These questions began to receive systematic analysis by D. H. Cropley, Kaufman, and Cropley (2008), who expanded the discussion of the concept of malevolent, as opposed to merely negative, creativity. Following the interest generated by the 2008 paper and the commentaries on it (Eisenman, 2008; James & Drown, 2008; Spooner, 2008; Walczyk & Griffith-Ross, 2008), this new concept was explored in greater depth in an edited volume, *The dark side of creativity* (D. H. Cropley et al., 2010). One publication in particular (D. H. Cropley, 2010) set out a framework that helps, in particular, to understand the interaction of the Four P's in the context of malevolent creativity.

The theoretical framework of malevolent creativity developed further through work by James and Drown (2008), who challenged the proposition that either *malevolent* or *negative* creativity is relevant to counterterrorism. D. H. Cropley and Cropley (2011) explored the utility of the malevolent creativity concept to generalized law-breaking, while Gill, Horgan, and Lovelace (2011) began applying the concept specifically to instances of terrorism.

Malevolent Creativity: The Present

The theoretical framework for malevolent creativity developed mainly in the period 2005–2010. More recently, research has gone a step further and directly addressed malevolent creativity in an empirical way. For example, a paper by Lee and Dow (2011), explored relationships between personality and divergent thinking in a malevolent context. This was followed by a study of divergent thinking and dishonesty (Gino & Ariely, 2012) and an examination of creativity and integrity in the context of lying (Beaussart, Andrews, & Kaufman, 2013). Around the same time, attention turned to the exploration of particular application domains. A distinct thread of malevolent creativity research in the domain of terrorism has emerged through the work of Gill and colleagues (2013) and Asal and colleagues (2013), who began to build on the theoretical foundations of malevolent creativity and terrorism, exploring variables specific to malevolent creativity and terrorist organizations. D. H. Cropley and colleagues (2014), by contrast, continued seeking to understand the perception of malevolent creativity better, in particular looking for evidence to shed light on the benevolence bias.

Researchers are continuing to devote attention to developing a deeper understanding of the variables associated with malevolent creativity. Harris (2013) examined personal and situational factors and malevolent creativity, while Harris, Reiter-Palmon, and Ligon (2014) studied ethical concepts and problem construction in malevolent creativity. Kapoor (2015) discussed malevolent creativity and the so-called *dark triad* elements of personality, and Furnham (2015) carried out a more general examination of demographic and personal characteristics associated with positive and negative elements of creativity. A descriptive theme of the relationships between darker elements of personality (e.g., psychopathology) and creativity has continued with Dahmen-Wassenberg and colleagues (2016). Measurement also remains a theme of current research, seeking to operationalize the theoretical foundations of malevolent creativity, and recent studies such as Hao and colleagues (2016) and Kapoor and Khan (2016) have explored this, with varying degrees of success. A final element of the descriptive phase of malevolent creativity research, and one that seeks to create a bridge between theory and application, is the examination of a set of case studies of malevolent creativity across the domains such as art and science (Kapoor, Tagat, & Cropley, 2016). Some researchers have also examined areas with a peripheral link to malevolence. These include, for example, questions of pro- and antisocial motivation and creativity (Forgeard & Mecklenburg, 2013) and classroom creativity (Beghetto & Kaufman, 2014).

Studies seeking to establish cause and effect relationships around the periphery of malevolent creativity through (quasi)experimental methods began to emerge almost at the same time as descriptive studies. Walczyk and colleagues (2008), as well as Mayer and Mussweiler (2011), used different stimuli to explore the relationships between dishonesty, distrust, and creativity. More recently, Riley and Gabora (2012), in similar fashion, primed participants with photographs of threatening and non-threatening situations and examined differences in creativity in resulting short stories. Harris, Reiter-Palmon, and Kaufman (2013), by contrast, explicitly addressed *malevolently* creative responses to priming, finding a negative association between emotional intelligence and the malevolence of creative outputs. Gino and Wiltermuth (2014) conducted a series of experiments designed to explore the relationship between creativity and dishonesty. In particular, they were able to show that subjects who cheated on a task subsequently produced more creative outputs on other tasks and suggested that this is driven by an underlying link to a desire to break rules and challenge norms that is common both to creativity and to dishonesty. Harris and Reiter-Palmon (2015) found that heightened implicit aggression and reduced premeditation lead to higher levels of malevolent creativity, in particular in situations that *provoke* malevolent creativity. Finally, Gutworth, Cushenbery, and Hunter (2016) studied both contextual and individual factors as predictors of malevolent creativity, finding evidence that situational cues – provided in the context of problem-solving exercises – predict malevolent creativity even after controlling for differences in personality and cognitive ability.

The Future: Application of Malevolent Creativity Research

D. H. Cropley and Cropley (2013) focused particular attention on the practical application of malevolent creativity to the *prevention* of crime and terrorism. Although essentially inductive and nonempirical in nature, this work asked how a knowledge of malevolent creativity, its antecedents, and the causal relationships between the person, the environment, and cognitive processes could be harnessed for two purposes: first, to diminish the malevolent creativity of criminals and terrorists and, second, to enhance the creative ability of police and other organizations responsible for combating crime and terrorism. This work further recognized that *application* research must turn its attention to representative samples (e.g., real criminals as the subjects of research) and must address some of the challenges of practical application – for example, the fact that the subjects of interest (criminals) are not under the control of researchers or interested parties (see also D. H. Cropley, 2017).

Despite these practical challenges, malevolent creativity research has begun to move into a phase of *applied* research. A simple example is the exploration of video games and malevolent creativity (D. H. Cropley, 2015). A frequent and general cause for concern is that video games might foster a range of antisocial, or even dangerous, behaviors in children. By extension, this could include malevolent creativity. Is there a risk that video games could enhance an individual's willingness or ability to generate harmful novelty (i.e., malevolent creativity)? Cropley explored this question, proposing a set of conditions that any video game would need to satisfy in order to be a candidate for fostering malevolent creativity.

Perhaps the strongest application domain of malevolent creativity that has developed since 2015 is counterterrorism, reflecting the impact of the September 11 terrorist attacks on thinking. Hofmann (2016) presents an example of the application of an ex post facto approach to the study of cause and effect in terrorist groups. In this specific case, the primary focus was on the impact of *charismatic leadership* on the selection of targets and the success of terrorist actions. While not directly related to malevolent creativity, this study demonstrates a highly applied approach with clear potential for application in studies of criminal and terrorist creativity. Fischbacher-Smith (2016) represents another example of a bridge between inductive theory-building and the emergence of applied research in and around the domain of malevolent creativity. Incorporating a variety of concepts, including malevolent creativity, the author not only sets out a theoretical framework specific to counter-terrorism applications but also formulates hypotheses specific to this application domain.

Horgan (2017) is conspicuous in particular for the support he provides to the claims made in this chapter, namely that psychology has a great deal to offer the study of terrorism. Indeed, in his words, "we cannot escape the fact that psychology has largely ignored the terrorist" (p. 200). At the same time, he notes "the immensely valuable and welcome application of industrial/organizational (i.e., "workplace") psychology to issues of . . . malevolent creativity" (p. 202). Recent studies such as McBain, Cropley, and Kavanagh (2017) and Hadi (2017) continue to answer this call. The former found evidence that the *environment* – i.e., the context – surrounding the production of malevolent creativity may be more influential than personality in determining the success of malevolently creative products, while the latter has explored the relationship between adverse childhood experiences, criminal thinking, and creativity. Thus, while Horgan (2017) laments that "Neither psychological nor other research has revealed qualities unique to those who become involved in terrorism, or the existence of singular pathways into (and out of) terrorism" (p. 200) there is a growing body of work in malevolent creativity that seeks to address this very question.

Emerging Insights

Resisting the effects of the benevolence bias makes it possible to look at creativity in a new way and delivers new insights. These, in turn, reveal new issues and questions that would otherwise remain unexplored because the benevolence bias would make it impossible even to conceptualize the problem. Some examples of aspects of creativity that can only even be imagined by accepting that it has a malevolent side, and for which remedies are needed, are outlined in the sections "The Victims-of-Creativity Effect," "Volition in Creativity: Supply-Side Creativity," and "Creativity Decay." The descriptions that follow are merely inductive in nature – they describe the phenomena in question and give an idea of the variables involved but do not extend to deductive, experimental, cause-and-effect analyses. In the case of malevolent creativity, the need for the next step – *application* of new insights – is particularly urgent because by its very nature malevolent creativity is a bad thing, in fact so bad that many people deny its existence.

The malevolent creativity concept makes reexamination of all the central pillars of knowledge about creativity necessary. If creativity, in its most general sense, results from the interaction of elements of the P of Person, the cognitive processes the person employs (P of Process) and the environment in which the person acts (P of Press), and leads to novel and effective products (P of Product), then what does malevolence mean for this framework? Key questions include: What elements of the person – psychopathology, for example – might steer creativity toward malevolence?

What cognitive processes – divergent thinking, for example – might play a role in developing novel and harmful solutions? What environments might be conducive not only to creativity but to malevolent creativity? How do the qualities of a creative product – especially novelty – add value to malevolent outcomes? In some ways, this debate echoes the one about domain-generality and domain-specificity in creativity (see, for example, Kaufman, Glaveanu, & Baer, 2017). Are there qualities or processes that are unique to malevolent creativity? Indeed, is malevolence – such as in crime and terror – a domain of creativity at all?

The Victims-of-Creativity Effect

Singer (2010, p. 178) distinguished between effects of creativity that apply to only a single person or a small group and those affecting a large number of people, a high proportion of the population, or even everybody. Sternberg (2010, p. 318) extended this two-dimensional approach (effects on only a few vs. on many) by discussing *three* dimensions: *intrapersonal* effects (effects for one person only – usually the person generating the creativity), *interpersonal* effects (effects on other people as well) and *extrapersonal* effects (effects on an entire context or setting such as a city or country). In the case of engineering, bridges that collapse, engineering projects that pollute the ground water or poison the atmosphere, or even super weapons intended to bring rapid and lasting peace that, nonetheless, expose the world to terrifying threats of mass destruction are examples of the more general, extrapersonal kind of dark creativity.

Jasper (2010) made a vital point in this regard by arguing that, since functional creativity has to be relevant and effective, *it always brings benefits to someone* (the person or persons for whom it is effective) but this means disadvantages for somebody else. For example, the engineers who conceived of the steam locomotive greatly improved nineteenth-century life but destroyed the livelihood of stagecoach builders and coach drivers. In fact, Hilton (2010, p. 134) stressed that creativity "naturally" leads to *both good and bad* – to put it in a simple way, *somebody always gets the short end of the stick*. The problem is the *distribution* of the benefits. If one person gets the advantages while another gets the disadvantages, then the creativity is positive for one side but negative for the other. Hilton concluded that the good or evil of creativity lies in the *balance* of the two elements (who gets how much good and who suffers how much harm). Hilton's analysis suggests that a realistic practical application of this insight may lie not in trying to eliminate negative consequences, since this may be impossible, but in applying correctives that "tip the balance."

Volition in Creativity: Supply-Side Creativity

D. H. Cropley (2010) broadened the study of cause and effect relationships in malevolent creativity by examining not only the intention to do evil (malevolent intention) but also the intention to do good (benevolent intention), that is, the more general dimension of *volition*. He developed a taxonomy of malevolence/benevolence in creativity that encompasses three aspects: Product, Press, and Volition. He introduced (2010, p. 369) ideas such as "failed benevolence" or even "failed malevolence" and perhaps more interesting "resilient benevolence" and "resilient malevolence." The latter refers to an intention to do harm that succeeds, despite an actively unsupportive environment (Press) – as some terrorist attacks have done, thus displaying a high level of resilient malevolence.

D. H. Cropley and Cropley (2015, pp. 32ff.) argued that volition is an overlooked causal factor in the study of creativity. They suggested a two-dimensional classification system involving *product-related volition* as one dimension (high or low level of intention to produce a product – whether malevolent or benevolent – rather than simply being creative or feeling creative or listening to the inner creative voice) and *communication-related volition* as the other (ranging from no intention at all of "going public" with a product to public awareness being paramount). For example, in the extreme case of purely spiritual creativity in the sense of Rothman (2014) – who rejected the idea of products in creativity outright and argued that it is a state of being, not doing – product-related volition is zero (there is absolutely no intention of producing a product of any kind) and, of course, communication-related volition is also zero (there is no intention of making any product public). At the other extreme is creativity generated with the explicit intention of producing a product (product-related volition is high) and a strong intention of making this product public (communication-related volition is also high). All other combinations are conceivable (e.g., high product volition but low communication volition). Volition may have been neglected in the past because of the unconscious persistence of the view that creativity comes when it chooses to, so that volition is irrelevant.

Discussion of volition facilitates consideration of what might be called "supply-side" creativity (high product volition paired with high communication volition; the creative individual creates a product for public consumption and attempts to "sell" it), as against "demand-side creativity" (the creative individual works to satisfy existing needs, for example by solving an existing problem). Cropley (2010) pointed out that supply-side creativity may actually be forced to struggle against the resistance of the environmental Press (i.e., to demonstrate resilience). The popular stereotype of penniless artists freezing in garrets in Paris, while producing whatever their creative spirit drives them to create and hoping that the world will buy it, is a romantic image of extreme supply-side creativity. However, Deresiewicz (2015) complained that artists are now becoming entrepreneurs, producing what the buyers want (i.e., demand-side creativity). Malevolent creativity can be seen as the prototypical example of supply-side creativity, with the creativity of terrorism representing the pinnacle of malevolent creativity (terrorists produce novel products that most people do not want and impose the products on their environment).

Creativity Decay

D. H. Cropley, Cropley, and Kaufman (2008, p. 109) described an aspect of malevolent creativity they called "creativity decay": the inverse relationship between public awareness of a novel product and the product's ability to profit from its surprisingness. In most cases, the malevolent creativity of criminals depends for its success on their creativity *not* becoming public – at least initially – so that, for them, high product volition is accompanied by low communication volition. An obvious example is financial scams, where it is important that the fact that they are *scams* must be kept hidden. In the case of terrorists, however, making the product public and awareness of the malevolent intentions of the perpetrators are absolutely essential; otherwise it would not be terrorism but, for example, espionage or sabotage. Terrorists thus find themselves in the paradoxical situation that they depend on working in secret (if antiterrorist organizations were aware of the terrorists' intentions they would block them), while also depending on the widest possible awareness of their actions in order to evoke terror. Thus, for terrorists, the problem of handling creativity decay takes a quite different form than for most other criminals. In fact, consideration of the role of communication volition may offer a way of distinguishing between the malevolent creativity of terrorists and that of other criminals.

Conclusions

Creativity research is often dogged by myths and misconceptions (e.g., Hong, Part, & Rowell, 2017). Where creativity research is held back by the notion that creativity is a special gift enjoyed by only a chosen few and is always good, we define a *benevolence bias*. However, since approximately 2010, the concept of malevolent creativity has emerged to challenge this preconception. Creativity is not the exclusive domain of artists, musicians, entrepreneurs, engineers, and scientists – all seeking to harness the beneficial effective novelty. Rather, it is also possible to be creative for deliberately harmful purposes. This may range from fraud and theft, through to terrorism, as demonstrated by the September 11 attacks.

Malevolent creativity research has addressed a variety of questions: How do individuals perceive the relationship between harmful outcomes and creative outcomes. Is there a recognizable profile of the malevolent and creative individual? What role does the environment play in helping or hindering malevolent creativity? However, as Horgan (2017) suggests, there are still many questions to be answered and many opportunities too for creativity researchers in this domain.

The study of malevolent creativity also opens up entirely new perspectives, such as the problem that there are victims of even benevolent creativity, and has major implications for defense against malevolent creativity. A traditional focus of creativity in a broadly *educational* setting concerns the development and enhancement of individual divergent thinking and the personal qualities that accompany this. However, malevolent creativity raises the prospect of designing *interventions* the purpose of which is to *inhibit* creativity, or accelerate the decay of novelty to interfere with criminal creativity, or shift the balance of harm. These are also not merely abstract questions – in the face of increasing incidences of internet fraud, and digital crime, and in an environment of ongoing terrorism, finding ways to combat malevolent creativity is literally a matter of life and death. Malevolent creativity research therefore must move as quickly as possible to the application of theory and descriptive findings and explore causal questions of *how* and *why*.

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33 Creativity and Aesthetics

Pablo P. L. Tinio

Introduction

Creativity and aesthetics are inherently related, and this is apparent in our everyday interactions with many created aspects of our world: the museum visitor having a profound engagement with the sculpture created by an artist; the listener with the musician's song; the reader with the poem; and the teacher with a child's drawing. As these examples show, where the creative process ends, the aesthetic experience begins. The psychology of aesthetics is a field that focuses on "the study of our experiences of the visual arts, music, literature, film, performances, architecture, and design; our experiences of beauty and ugliness; our preferences and dislikes; and our everyday perception of things in our world" (Tinio & Smith, 2014, p. 3). In this chapter, I provide a brief overview of psychology of aesthetics as a field of study and describe the various ways in which aesthetics is linked to creativity.

The inception of the field of psychology of aesthetics is attributed to the early work of Gustav Theodor Fechner (1876). Fechner's first formal aesthetics study involved two paintings of the Madonna by Holbein the Younger. During Fechner's time, there was an ongoing debate as to which of the two paintings was actually by Holbein, and Fechner had asked visitors of an exhibition displaying both paintings which of the two they preferred. Fechner believed that preference would indicate authenticity. The results of Fechner's study were inconclusive. However, the study was monumental because it is considered the first empirical examination of aesthetic preference and it touched on – perhaps implicitly – the direct connection between creativity and aesthetics, between art making and art viewing, and that visitors' preferences would somehow reflect the recognition of the marks on canvas made by Holbein himself.

In his work, Fechner (1876) often took both creativity and aesthetics into account. In fact, two of the primary methods he used to study people's aesthetic reactions were the "method of choice" and the "method of production." Fechner's study of the Madonna paintings is an illustration of the method of choice (i.e., preference). The method of production involves tasks in which people create stimuli, such as simple shapes like triangles, which are then assessed for certain physical characteristics such as their sizes and pleasantness.

Scholarship focusing on the link between creativity and aesthetics, as addressed in the early years of psychological aesthetics research, would largely disappear during the twentieth century with creativity research and aesthetics research being done independently of one another (Vartanian, 2014). As a consequence, the fields of creativity and aesthetics have had quite different trajectories. Theories and empirical findings from the two fields have rarely been synthesized, even when in everyday life (as shown in the examples above), creativity and aesthetics are often clearly related – one is the beginning and the other the end. Below, I will describe the many ways in which the two sides are related beginning with the application to aesthetics of one of the most well-known conceptualizations of creativity, Rhodes' (1961) Four P's of creativity.

The Four P's of Creativity (and Aesthetics)

Rhodes (1961) conceptualized creativity in terms of four P's: *product, process, person*, and *press* (also referred to as place, context, or environment). Product refers to the artifact, idea, or any other outcome of a creative effort. In creativity and aesthetics research alike, the *product* has been the most studied of the Four P's, and visual artworks have been the type most commonly studied. In creativity, *process* involves the means by which creative products are produced and could include cognitive processes such as problem construction, idea generation, and idea evaluation (e.g., Mumford et al., 1991). The corresponding process in aesthetics is related to the perceptual and cognitive processing of artworks, including their composition, style, and meaning. In aesthetics, *person* refers to the characteristics of the art perceivers and could include their knowledge, personality traits, motivations, and cultural background as well as their life histories. Finally, in aesthetics, *press* refers to aspects of the art viewing context that could directly influence the aesthetic experience of art. Press could involve physical features of the museum space or broader influences such as social and cultural aspects of the art experience. In this chapter, I will use the Four P's as a framework for presenting an overview of psychology of aesthetics and, in so doing, I will also show that creativity's process, product, person, and press have their counterparts in aesthetics.

Process

Our interactions with artworks involve specific cognitive processes and behaviors that are described by formal models of aesthetic processing. Most of these models are comprised of distinct stages of processing that begin with the initial encounter with an object initially classified as an artwork based on its visual properties (e.g., a rectangular canvas depicting a person or scene) or based on the context the object is in (e.g., in an art museum or gallery). The artwork goes through a series of information-processing stages that result in various outcomes, such as judgments regarding whether the artwork is interesting, pleasant, or beautiful. Visually, artworks are often physically no different than any other object. Consider *readymades*, or ordinary objects or arrangements of objects that are formally presented as artworks. The most famous example of a readymade is Marcel Duchamp's piece, *Fountain* (1917), a porcelain urinal that he submitted to an exhibition of the Society of Independent Artists in New York in 1917. Although the piece was rejected, its very submission to the exhibition as an art piece challenged the practices of art institutions at that time and who decides what could be exhibited as art or not. As can be seen in the models of aesthetic processing in the following paragraphs, most objects – whether considered to be art or not – share the same early processing stages. What defines art processing is the later stages that involve an art perceiver's knowledge, interpretation, and judgment of the art object.

One of the most frequently cited models of aesthetic processing is Leder and colleagues' (2004; Leder & Nadal, 2014) *Information Processing Model of Aesthetic Appreciation and Aesthetic Judgments*. According to the model, aesthetic experiences begin with the *pre-classification* of an object as art. The low-level visual features are then analyzed automatically and without conscious awareness during the *perceptual analyses* stage. These features could include the artwork's symmetry, contour, and contrast. During the next stage of *implicit memory integration*, the artwork's prototypicality and familiarity are processed. Next, conscious deliberation regarding the artwork's content (e.g., it depicts a face, landscape, or nothing at all) and style (e.g., Impressionist, Cubist, or Abstract Expressionist) occurs during the *explicit classification* stage. During the following stage of *cognitive mastering*, there is an attempt to understand and interpret the artwork based on its content, specific visual characteristics, and underlying concepts. In essence, the cognitive mastering stage involves a process of meaning-making or problem-solving, which leads into the final stage of *evaluation*, during which an understanding of the artwork, satisfaction with the aesthetic experience, or a general sense of ambiguity could be experienced. The model describes two outputs: an aesthetic judgment (e.g., how much the viewer likes the artwork) and an aesthetic emotion (e.g., the happiness and pleasure from understanding the artwork or displeasure from feeling a lack of understanding). Although the model is stage-like, there are continuous feedback loops among the stages of the model.

Chatterjee (2004) proposed a similar model that is also stage-like, but with emphasis on the neural foundation of visual aesthetics. As with Leder and colleagues' model, Chatterjee describes the aesthetic experience as beginning with the processing of low-level visual features such as shape and color. Intermediate processing follows and involves the grouping of disparate visual elements. Next, the content of the artwork is extracted, which is then followed by a judgment regarding the artwork as well as an emotional response. According to Chatterjee, early and intermediate processing of art is no different than the processing of other objects. What distinguishes the aesthetic response to art is the later processes that involve the viewer's subjective knowledge.

The models by Leder and colleagues (2004) and Chatterjee (2004) were proposed during a time when psychological aesthetics scholars were beginning to develop a neurobiological account of the aesthetic experience. During this time, the distinct subfield of *neuroaesthetics* (Zeki, 1999) was emerging. Neuroaesthetics attempts to ground aesthetic experiences in terms of neuroscience. Thus, the neural bases of processes related to visual perception, memory, aesthetic judgments, and emotions are taken into account (Chatterjee, 2011). Chatterjee and Vartanian's (2014) recent model, *The Aesthetic Triad*, extends previous models by situating components of the aesthetic experience within three primary neural systems. The sensory-motor system underlies visual perception and engagement of the motor system. The emotion-valuation system is involved in, for example, pleasure and preference judgments as well as emotional responses to artworks. Finally, the meaning-knowledge system involves the contribution of knowledge to the aesthetic experiences as well as the interpretation of an artwork and meaning derived from it. According to Chatterjee and Vartanian, the three primary systems contribute to and interact during aesthetic experiences, although the extent to which each system contributes varies depending on factors such as the characteristics of the object under consideration.

The above-mentioned three models (e.g., Leder et al., 2004) share a common underlying structure of aesthetic processing: the progression from low-level to high-level processing. As will be shown in the following section, this common structure becomes a significant feature when art viewing is linked directly to art making. Although this link between art making and art viewing is apparent, scholarship on creativity and aesthetics has been conducted in relative isolation from each other. This disconnect is addressed in the Mirror Model of Art (Tinio, 2013), which attempts to directly link and mirror (in reverse order) the stages of art creation with the stages of art reception.

The Mirror Model (Tinio, 2013) describes artistic creation in terms of three stages that reflect the progression from the initial idea or motivation driving the creation of a work to its completion: *initialization, expansion and adaptation*, and *finalizing*. As an illustration, the creation of a painting begins with an idea conceived by a creator. The idea is then initially translated into a rough sketch on canvas of the main visual elements that will be included in the painting (initialization stage). Creating this *underdrawing* is a common practice in painting (Locher, 2010) and related fields, such as architecture. In the next stage, layers of paint are added, thus developing and expanding on the initial idea and underdrawing (expansion and adaptation stage). The third stage involves finalizing the work by adding additional layers as well as performing various refinements and the addition of finishing touches (finalizing stage).

Informed by the above-mentioned frameworks of aesthetic processing of art (Chatterjee, 2004; Leder et al., 2004), the Mirror Model directly relates these art making stages to three broad stages of aesthetic processing such that the last stages of art making correspond to the initial stages of aesthetic processing, and vice versa. Specifically, the processing of low-level visual features corresponds to the finalizing stage of art making during which the artist would have added the last layers of materials such as color and varnish (Level 1 correspondence). Memory-based processing corresponds to the expansion stage of art-making, when the artist has built on and expanded the underdrawing, thus establishing the main contents of the work (Level 2 correspondence). Finally, aesthetic judgments and meaning-making correspond to the first stage of art making during which the artist realized and developed the idea that motivated and steered the creation of the work (Level 3 correspondence). The Mirror Model therefore accounts for the entire course of art making and art viewing while linking specific sets of processes that define the two sides of the art experience – creativity and aesthetics (Tinio, 2013).

Product

The creative process typically results in the production of an idea or object. Although an aesthetic experience could involve any type of object, artworks are considered to be the prototypical aesthetic object. In fact, aesthetics research since Fechner (1876) has been most commonly directed to studying how specific features of artworks (especially visual artworks) influence the way that the artworks are perceived and evaluated.

As described by models of aesthetic processing (e.g., Leder et al., 2004), visual features are initially processed automatically and they influence the outcomes of subsequent processing stages. Artworks, such as drawings, paintings, and sculptures, are extremely complex visual objects composed of numerous visual features that combine to achieve certain effects, such as to depict a person, place, thing, or to express an artistic concept. To study the effects of one, or several, visual features on the aesthetic experience thus poses as an enormous challenge to researchers. However, rigorous methods that have been able to isolate a visual feature while holding other features constant have led to important and reliable findings. We will focus on the following features: line and contour, contrast, symmetry, and composition of elements and visual balance.

Line and Contour

The effects of contour are related to the more general effects of line and shape. In paintings, lines delineate the edges of depicted objects such as people, objects in a scene, and features of a landscape. The human visual system is optimized for processing lines efficiently, and studies have shown that visual information conveyed by lines underlies our ability to quickly recognize objects in our environment (e.g., Biederman, 1987; Marr, 1982). Lines therefore make for efficient compositional devices, as exemplified by Pablo Picasso's drawings of animals and faces using one continuous line. These drawings are examples of minimalistic and simple yet refined use of line to depict objects.

A line's contour is an important aesthetic property. People tend to prefer objects with curved contours to those with sharp or rectilinear contours (Bar & Neta, 2006; Leder, Tinio, & Bar, 2011). People also find curved contours more beautiful and pleasant (Vartanian et al., 2013). Objects with curved contours elicit more positive emotions overall than objects with sharp or rectilinear contours (e.g., Dazkir & Read, 2012). Curved contours have also been shown to be associated with positive and safety-related words and sharp contours with negative and danger-related words

(Palumbo, Ruta, & Bertamini, 2015). The positive effects of curved contours have even been demonstrated across different cultures as shown by a recent study by Gómez-Puerto and colleagues (2018), who found the contour preference in people from Oaxaca in Mexico, Bawku in Ghana, and Mallorca in Spain. This cross-cultural finding, considered alongside evidence of a preference for curved objects that are presented using very short presentation durations (indicating automatic processing, e.g., Bar & Neta, 2006), suggests that the preference might be a hard-wired behavioral response to the environment – one that contains sharp objects that must be perceived and avoided – that generalizes to neutral stimuli such as aesthetic objects.

Contrast

Lines and the shapes they create allow us to recognize objects in our environment. One of the challenges the human visual system must overcome for object recognition to occur efficiently and accurately is how to separate one object from other objects or how to visually isolate an object from a scene (Tinio & Leder, 2013). This is achieved by identifying areas of high contrast within a scene or image. The boundaries that define objects, such as the outlines of a face, are high contrast areas, as are facial features themselves, such as dark eyebrows or hair on beige skin, or the dark, central part of the eye (iris) on a white area (sclera). Contrast is therefore a basic visual feature that allows us to navigate our environment, but it is also a fundamental feature affecting the aesthetic experience of art. Consider artists' use of the *chiaroscuro* method, a play on light and shade, to produce certain moods or to draw attention to specific areas of their works. Another example is Ansel Adams' selective manipulation of contrast to highlight objects in his now classic black-and-white photographs.

In general, stimuli that are high in visual contrast are preferred over their lower contrast counterparts. The strong impact that contrast has on aesthetic judgments was demonstrated by Tinio, Leder, and Strasser (2010). Participants in that study provided preference judgments for images of natural (e.g., a mountainous landscape) and human-made (e.g., a cityscape) scenes, and, overall, they preferred the images of natural scenes, a typical finding that has been shown in numerous studies (e.g., Tinio & Leder, 2009). However, when images of human-made scenes with high contrast and images of natural scenes with low contrast were compared, there was a reversal in preferences.

The positive effects of contrast on aesthetic judgments could be explained by the concept of *processing fluency*. Reber, Schwarz, and Winkielman (2004) showed that the more fluently (i.e., easily) an object could be processed, the more likely it would be judged positively. Thus, high contrast stimuli are aesthetically judged more positively because they are easier to process (Reber, Winkielman, & Schwarz, 1998). One of the defining characteristics of Ansel Adams' black-and-white images is their wide range of tones; in other words, there is a great range between the lightest lights and the darkest dark areas of his images. Applying the fluency concept, Adams' images are popular and well-liked because their contrast levels allow for fluent processing – his use of contrast results in the main objects in each image being visually emphasized, and the entire images themselves have high resolution and clarity. They are easy on the eyes.

Symmetry

Another visual feature, symmetry, has a positive influence on aesthetic judgments. The type of symmetry that has been studied most is bilateral or mirror symmetry, in which adjacent sides (left to right, top to bottom, or any pair of adjacent areas) have the same number, type, and configuration of elements – the two sides are mirror reflections of each other. Symmetry is ever-present in the biological and physical worlds: in human faces and bodies as well as in various flora and fauna. It is also present in many aspects of human-made environments, such as buildings and design and consumer products. Symmetry's omnipresence suggests that it is a fundamental organizing principle in our world.

Regarding human bodies and faces, there is an abundance of evidence that symmetrical faces and bodies are considered more attractive than their less symmetrical counterparts (e.g., Cardenas & Harris, 2006). The dominant explanation for this effect is an evolutionary one; symmetrical bodies and faces signal good health and reproductive fitness (e.g., Thornhill & Gangestad, 2006). Considered another way, malnutrition, parasites, disease, and physical injury could lead to asymmetry. For example, compound bone fractures often do not heal to their original shape or position, and diseases such as rickets, which often come from malnutrition, could cause bone fractures and physical deformities.

Processing fluency is another possible explanation for people's positive responses to symmetry, with the human visual system having evolved to process symmetrical stimuli more efficiently than asymmetrical stimuli. As with contrast, things that are easier to process are judged more positively (Reber et al., 2004). Indeed, symmetrical stimuli are detected faster than asymmetrical stimuli, and there is evidence that they are also detected pre-attentively (Locher & Wagemans, 1993).

A third possible explanation for the positive bias toward symmetry was proposed by Ramachandran and Seckel (2014), who also directly link our response to symmetry with art perception. They assert that symmetry is visually salient, and the response to symmetry seems universal because symmetry is everywhere especially in living things, and symmetry detection "serves as an early-art system, drawing your attention. And drawing and sustaining attention is the first minimum criterion for art, although hardly sufficient" (p. 381). Ramachandran and Seckel include symmetry in their universal laws of aesthetics.

Symmetry is a means of organizing an artwork and balancing the elements that comprise it, and the history of art is replete with examples of explicit use of symmetry. According to Kreitler and Kreitler (1972), "Since symmetry is a quality of good gestalts, there should be little wonder that it dominates so many of the early art products and paintings of former cultures from Sumer to Latin America and from ancient Persia and Greece to the beginnings of the medieval period" (p. 104). However, there are instances when the breaking of symmetry might be used to elicit specific reactions from viewers. Modern art, such as Cubist paintings, with its focus on novelty and expression of concepts, as opposed to accuracy of depiction, is such an example.

Composition

Visual features like contour and symmetry help to determine the overall layout or composition of the elements of an artwork. Unlike these individual features, however, composition involves the visual relationships among these features as well as all of the other elements (e.g., shapes and depicted objects) that make up an artwork. Composition is often discussed in terms of the visual balance of the elements within the pictorial frame of an image. The Gestalt psychologist Rudolf Arnheim (1974, 1982) developed a psychological theory of composition that referred to the balancing point of elements around the center of the pictorial frame. This center, according to Arnheim, does not necessarily have to be located within the physical center of the frame (i.e., a central point to which lines from the picture edge are equidistant) but could be located on any of the main axes of the image – horizontal, vertical, or diagonals. What is important is that the weights of the individual elements are visually balanced around this geometric center of mass.

Although the geometric visual center of an artwork is fundamental to how the work will be viewed, composition goes beyond the center and also involves the more global organizational structure of artworks. Artworks are defined by their composition as much as the content that they depict and the underlying concept that they express. Artists therefore exert great efforts to achieve optimal composition. Modern artists such as Mondrian, whose well-known abstract paintings consisted of straight vertical and horizontal lines, rectangles, and minimal use of color, exemplify this intense focus on composition. Mondrian painstakingly organized these elements into a balanced compositional structure (McManus, Cheema, & Stoker, 1993). According to Arnheim (1974), “Seen in the intended upright position, a late Mondrian painting displays no more weight at the bottom than at the top. But turn it upside down, and the picture will look top-heavy” (pp. 31).

Composition is a delicate matter and the subtlest of changes in the placement of elements could have a significant impact on the structure of the whole. Artists such as Mondrian were meticulous in this regard as to achieve a composition that is just right. The question that beckons is how viewers of artworks perceive composition? Where and how does the viewer pick up where the artist left off, a dynamic that speaks to the correspondence between creativity and aesthetics?

Locher (2003) conducted a study that looked at whether viewers would be able to perceive the *visual rightness* (Carpenter & Graham, 1971) of representational and abstract paintings. Two versions of each painting were created: a version in which one or two elements were repositioned to create a slight disruption to the composition and a version in which one or two elements were repositioned to produce a more severe disruption. Locher hypothesized that if the original paintings indeed have the best possible composition – that they are *visually right* – participants should be able to distinguish them from the altered versions, a hypothesis that was confirmed. Although participants were not able to distinguish the originals from the slightly altered versions, they were able to distinguish them from the more severely perturbed versions.

Composition is also related to the physical orientation of an artwork. Orientation is a straightforward affair with regard to representational artworks such as paintings of landscapes, objects, or people – the sky is up, the ground is down, and so on. For abstract artworks, such as Jackson Pollack's drip paintings or Mark Rothko's color field paintings, orientation is less obvious as these artworks could be presented vertically, horizontally, diagonally, or any other orientation in between. But artists are rarely ambiguous with how their works should be oriented, and viewers themselves seem to be sensitive to the "right" orientation as intended by the artists. Latto, Brain, and Kelly (2000) demonstrated this when they showed participants Mondrian paintings in their intended orientation along with versions of the same paintings in seven other orientations. Participants preferred the paintings in their original orientations to their corresponding versions presented in another orientation. The authors concluded that the rotations of the originals changed the balance of the paintings.

The results of the research on composition presented above (e.g., Locher, 2003) indicate two points about composition. The first point is that composition is a delicate attribute of artworks. Artists strive to create optimal structures that visually balance the different elements in their works, including depicted objects, lines, shapes, and color as well as the relative sizes and distances of these elements within the entire picture frame. The second point regarding composition is that art viewers themselves are able to perceive the optimal, visually right compositions and presentation orientation that the artists intended for their work. This latter point provides additional evidence for the correspondence between art making and art viewing.

Person

Research on specific characteristics of artworks, such as their composition, has dominated the field. However, person-related factors are equally influential in their influence on the aesthetic experience of art. Person-related factors in art could be considered from the point of view of the artist or the viewer. For a discussion of factors related to the artist, see Pelowski, Leder, and Tinio (2017). In this section, we will discuss how aspects of the viewer's personality and the amount of knowledge a person has about art influence his or her aesthetic experience.

Personality

A common approach to studying the relationship between personality and the aesthetic experience is to have people complete a personality assessment and provide preference ratings for a set of artworks that vary in content, type, style, and other dimensions. The Big Five personality measures (Costa & McCrae, 1992) are the most common types of instruments used in these studies, and they measure five personality factors: *conscientiousness*, *agreeableness*, *neuroticism*, *extraversion*, and *openness to experience*. In addition, researchers have also often measured *tolerance for ambiguity* and *sensation-seeking*.

Of the Big Five, openness to experience is arguably the most strongly associated with engagement with the arts and with aesthetic preference (see also Feist, Chapter 17, this volume). Openness to experience refers to the extent to which a person is imaginative and intellectually curious as well as open to, and seeks out, new thoughts, ideas, and experiences. This characteristic of personality is associated with a general liking for art (Furnham & Avison, 1997; Furnham & Walker, 2001). Openness to experience is also positively associated with art interest (belief about one's creativity and artistic capacity, and experiences studying and practicing art), art knowledge (knowing different styles of art), and art activities (visiting art galleries and art shops as well as buying pictures; Furnham & Chamorro-Premuzic, 2004). Openness to experience is also strongly correlated with the more general constructs of aesthetic activities (engagement with the visual arts, classical music, and literature), aesthetic inclusivity (having a broad view of what could be considered art), emotion and understanding (thinking that one should understand the emotions of the artist and background information of an artwork to appreciate it), aesthetic relativism (belief that one's education and upbringing influence aesthetic appreciation of art), and aesthetic quality (view that skill is needed to create art and that artistic talent is innate; McManus & Furnham, 2006). Openness to experience is thus associated with overall aesthetic engagement and interest as well as art participation.

Openness to experience has also been shown to be associated with preference for specific types of art. Especially noteworthy is the finding that people who are high on this trait tend to prefer artworks that are less conventional and that many people find unappealing. Examples of such artworks include abstract art by artists such as Mark Rothko, Barnett Newman, and Josef Albers, and pop art by Andy Warhol, David Hockney, and Roy Lichtenstein (Furnham & Walker, 2001). People with high openness to experience also prefer less known art styles and genres, avant-garde art, and artworks representing styles that can be difficult to process such as Cubist works (Chamorro-Premuzic et al., 2009). People high in openness to experience prefer art in general more than those low on the trait; however, this difference is greatest when measuring preferences for abstract art (Feist & Brady, 2004). Moreover, people high in openness to experience tend to prefer works that are complex both in composition and in number of elements (Chamorro-Premuzic et al., 2010). Research on the relationship among the other Big Five factors and art engagement and preference have been mixed (Swami & Furnham, 2014).

There are other personality-related factors associated with preferences for less conventional types of art. For example, sensation seekers (those who desire intense and complex experiences and will take risks for such experiences; Zuckerman, 1979) tend to prefer abstract art – especially works that are complex, such as those by Jackson Pollock and Marcel Duchamp – to representational art (Furnham & Bunyan, 1988). They also prefer pop art (Furnham & Walker, 2001) and surreal art (Furnham & Avison, 1997) to more traditional art. Finally, tolerance for ambiguity is also related to art preference and those who score highly on this trait tend to prefer nontraditional art, although to a lesser extent than those with high scores on openness to experience and sensation seeking. Taken together, openness to experience, sensation seeking, and tolerance for ambiguity are personality traits that are associated with aesthetic preferences for art that are typically complex and unconventional.

Art Knowledge

Like personality traits, art knowledge and expertise could significantly influence the aesthetic experience of art. In contrast to visual features of artworks, which are considered bottom-up factors and are processed largely automatically and early in the aesthetic experience, art knowledge is considered a *top-down* factor that guides higher-order cognitive processes such as identifying an artwork's style as well as interpreting, understanding, and judging the work.

Knowledge about art is acquired through formal education (e.g., taking art history or studio classes) or informal yet extensive experiences reading about, creating, and viewing art in galleries and museums. Smith and Smith (2006) accounted for the many different ways in which art knowledge could be acquired through their concept of *aesthetic fluency*, which refers to the amount of knowledge that a person has about art and how such knowledge is obtained. The development of aesthetic fluency is similar to the development of vocabulary, in that it involves an accumulation of knowledge from various experiences with art. Smith and Smith developed the aesthetic fluency scale to measure a person's level of aesthetic fluency, much in the same way as a vocabulary test measures the size of someone's vocabulary. The scale includes the names of five artists and five art terms, which are rated on a five-point scale from "I have never heard of this artist or term" to "I can talk intelligently about this artist or idea in art." They found that aesthetic fluency is most strongly influenced by how frequently a person goes to museums and, to a lesser extent, age and art history education.

To illustrate the importance of art knowledge on the aesthetic experience, consider an art museum visitor with very little knowledge of art. This visitor might walk into a museum with no plan as to what he will see and no expectations about the outcome of his visit. Another museum visitor who has a great deal of knowledge about art and extensive experience visiting museums might walk into the museum with preconceived ideas about what she would like to achieve during her visit. She would like to see her old favorites from the permanent collection after which she proceeds to a special exhibition that she has read about in an art magazine but knows very little about. She expects to learn as much as she can about the artworks.

These are two very different visitors because they have very different levels of art knowledge and because they have different sets of expectations that they bring with them the moment they step into the museum (Pekarik & Schreiber, 2012; Tinio, 2017). There is even neuroscientific evidence that links art expertise with neural efficiency during the processing of art (Panga et al., 2013). Different amounts and types of art knowledge will ultimately lead to two experiences that are entirely different. Even at the basic level of how people view art, there is a difference between less and more knowledgeable viewers (Massaro et al., 2012). Those who are highly knowledgeable about art take a more global approach to looking at art, focusing not only on the content of the work but also on its overall compositional structure and the spatial relationships among the various elements. In contrast, those who are less knowledgeable tend to focus on the objects that are depicted (Cupchik & Gebotys, 1988; Nodine, Locher, & Krupinski, 1993).

The attentional focus on depicted content by viewers with less art knowledge has parallels with how they make sense of and evaluate abstract artworks, which are visually and conceptually more difficult to engage with than representational artworks. This group prefers representational works more than abstract works (e.g., Hekkert & van Wieringen, 1996; Rawlings, 2003) and often base such preferences on the feelings generated by the artworks, as opposed to their formal elements (Winston & Cupchik, 1992). Furthermore, those who are more knowledgeable find abstract artworks less confusing and more interesting (Silvia, 2013). The amount of knowledge one has about art therefore influences all aspects of the art experience from basic looking behaviors and expectations regarding the aesthetic experience of art to how the meaning of an artwork is derived and, ultimately, how it is evaluated.

Press

The artwork, combined with its physical and conceptual characteristics, person-related factors, and the processes associated with the aesthetic experience, forms three of the four main aspects of the aesthetic experience of art: process, product, and person. The fourth is the context in which an artwork is experienced. In creativity research, *press* refers to the contextual, social, and cultural factors affecting creativity. We will adopt this term to refer to the influence of these same factors on the aesthetic experience.

Most research in the psychology of aesthetics has been conducted in a laboratory with researchers presenting reproductions of artworks to participants (usually college students) who may or may not have any interest in or knowledge about art. Much has been gained from such studies and, because of the experimental control that they permit, laboratory studies will continue to be a most important means for studying aesthetic responses to art. This approach, however, presents a major conundrum: The bulk of knowledge in the field comes from laboratory studies but the majority of theories and models of aesthetics refer to art viewers looking at real art in real contexts. The assumption then is that findings from the laboratory will generalize well to the real world of art, an issue that scholars have recently started to examine empirically (Pelowski et al., 2017). There are two main ideas to bear in mind when considering the context of art viewing and its influence on the aesthetic experience: differences between genuine artworks and their reproductions and differences between the laboratory and the museum.

Genuine Artworks and Reproductions

Original artworks and their reproductions differ considerably in many respects. The former are often larger, richer in color, more nuanced in tones, and bearing the texture from brushstrokes and other physical marks that evidence the touch of their creators. Furthermore, originals are rare, one-of-a-kind objects that are often highly valued. Original paintings are considered more interesting and are liked more than their corresponding reproductions (slide-projected or digital formats; Locher, Smith, & Smith, 2001). Similarly, original photographs presented in the museum are looked at longer as well as liked more and rated as more interesting than their corresponding reproductions (Brieber et al., 2014).

Compared with reproductions, original artworks are also considered more valuable and as conveying the artist's touch (a type of contagion effect), a result of an artist's "unique creative performance" (Newman & Bloom, 2012, p. 568). Freedberg and Gallese (2007) suggest that artists' physical marks on an artwork activate in the viewer corresponding areas of the brain, and Taylor, Witt, and Grimaldi (2012) demonstrated empirically that art viewers physically mirrored the implied motion of brushstrokes in the paintings they were viewing, and that this mirroring occurred automatically. Similarly, Leder, Bär, and Topolinski (2012) showed that viewers who made hand movements that were consistent with the style of paintings that they were viewing (such as stippling hand movements for pointillist paintings) liked the paintings more than paintings that did not match the hand movements.

Aesthetic Experiences in Museums vs. Laboratories

Genuine artworks, then, have important physical characteristics that differentiate them clearly from reproductions. However, the physical context in which artworks are displayed presents additional factors that influence aesthetic experiences. The prototypical context associated with art viewing is the museum. Museums are special spaces in their own right: they are typically located in bustling city and town centers or in picturesque areas of the countryside; the buildings themselves are often historical ones that have been converted to specifically house the museums' collections or built specifically for the purpose; and the gallery spaces afford certain behaviors from its occupants – often seriousness, at times reverence, rarely playfulness, but almost always some level of formality (Pelowski et al., 2017).

The unique space of the museum imparts certain qualities on artworks, qualities that are largely absent in reproductions presented in the laboratory. Artworks in the museum produce more intense aesthetic experiences than their corresponding reproductions (Specker, Tinio, & van Elk, 2017). For artworks that are considered ambiguous, viewing time is higher in the museum than in the laboratory, which suggests that the museum environment fosters a slower approach to resolving ambiguities in artworks (Brieber, et al., 2014). This difference in viewing time is especially important as time spent viewing individual artworks – including masterpieces by Cezanne, Rembrandt, Raphael, Picasso, van Gogh, and Matisse – in museums is, on average, about 27 seconds (Smith & Smith, 2001; Smith, Smith, & Tinio, 2017), and this includes time spent reading the labels presented alongside the artworks. In addition, artworks presented in a museum are liked more and rated as more positive, interesting, and arousing than the same original artworks presented in the laboratory (Brieber, Nadal, & Leder, 2015). Finally, artworks encountered in the museum are more likely to be remembered, likely because of the many cues – such as the spatial layout and other physical features – in the museum that are not available in the laboratory (Brieber et al., 2015) and because of the higher level of visual details available in genuine artworks (Specker et al., 2017).

Another important feature of the museum that has largely been overlooked by aesthetics researchers involves the actual format of presentation. In essence, artworks are rarely presented in isolation. They are typically included as part of an exhibition or, at the very least, presented near other artworks. Their locations within the galleries are purposefully curated. Smith (2014) argues that aesthetic experiences in museums are due to the net effect of all of the artworks that a person encounters, and it is this totality, not individual artworks themselves, that is most important when considering the aesthetic experience of art in museums, an outcome that he calls the *museum effect*. This is an aspect of the aesthetic experience that needs further investigation and has yet to be taken into account adequately by models of aesthetic processing.

Conclusion

We have examined the four main aspects of the aesthetic experience of art: the product, process, person, and press. Regarding the product, the artwork that results from the creative process becomes the object of attention during an aesthetic encounter. The psychology of aesthetics field was founded on Fechner's (1876) study of people's aesthetic evaluations of two creative products, the two Madonna paintings. More than a century's worth of research after Fechner has produced a great deal of knowledge about how an artwork's inherent features influence how the work is perceived, interpreted, and evaluated. New methods for digitally manipulating stimuli and for objectively measuring various properties of artworks, such as their image statistics (e.g., Redies, 2007), are certain to provide us with deeper understanding of the objects of aesthetic experience.

Concerning the process, the perceptual and cognitive processes associated with aesthetic experiences of art involve a progression from the automatic processing of visual features (e.g., contrast and contour) of an artwork, the identification of depicted objects, and the classification of its style to making sense of its meaning and the concept behind the work and its eventual aesthetic judgment. Regarding aesthetic judgments, new models and updates to older models (e.g., Chatterjee & Vartanian, 2014) are beginning to go beyond the typically discussed responses of pleasure, liking, and interest and to more complex and unusual aesthetic responses, such as disgust, anger, confusion, crying, and awe (e.g., Nusbaum & Silvia, 2014; Silvia, 2009). The burgeoning subarea of neuroaesthetics, and the powerful methodologies that it provides (e.g., brain imaging technologies), has the potential for more nuanced and objective examination of these different responses.

Regarding the person, in addition to perceivers' art knowledge and experiences and their personality characteristics, other person-related factors affecting the aesthetic experience of art need to be further explored in future research. These factors include the effects of people's current emotional states going into an aesthetic encounter as well as their goals, motivations, and expectations regarding the encounter. Other factors include the art perceiver's culture and beliefs, the effects of which we know very little.

Finally, concerning press, new methods have allowed for more nuanced examination of aesthetic experiences in genuine contexts. Mobile eye tracking, for example, allows for detailed measurements of where and how people move about in museums, what artworks they look at and for how long, and on which areas and features of the artworks they focus their attention (e.g., Brieber et al., 2014). The future of aesthetics offers a lot of promise.

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34 Imagination Is the Seed of Creativity

Rebecca J. M. Gotlieb, Elizabeth Hyde, Mary Helen Immordino-Yang, and Scott Barry Kaufman

Imagination does not become great until human beings, given the courage and strength, use it to create.

— Maria Montessori (1948, p. 21)

Across domains and levels of sophistication of creativity, there is one fundamental skill that makes creativity possible. Without imagination, there can be no creativity. This chapter explores cognitive and affective processes common to both imagination and creativity, advancing the argument that the former enables the latter in conjunction with other personal factors such as expertise, personality, and motivation, as well as environmental support (S. B. Kaufman & Gregoire, 2015; Seligman, Forgeard, & Kaufman, 2016; Sternberg & Lubart, 1991).

Imagination refers broadly to the human capacity to construct a mental representation of that which is not currently present to the senses (Markman, Klein, & Suhr, 2009; Seligman et al., 2016). We engage in imaginative thought both intentionally and unintentionally and both solitarily and collectively. Across social-emotional and temporal domains, there are a number of forms of imaginative thought, including perspective-taking, identity construction, constructive internal reflection, thinking informed by an understanding of multiple cultures, pretend play, prospection, memory construction, counterfactual thinking, and mind-wandering (Abraham, 2016; Runco & Pina, 2013). Many forms of imagination – especially imagination about people, including oneself, across time and space – draw heavily on the brain's default mode network, a network composed of several brain regions along the midline of the brain in the frontal and parietal lobes, including the medial prefrontal cortex, medial parietal cortex, lateral parietal cortex, and regions within the medial and lateral temporal cortex (Andrews-Hanna, Smallwood, & Spreng, 2014; Immordino-Yang, Christodoulou, & Singh, 2012; Raichle & Snyder, 2007; Schacter, Addis, & Buckner, 2007; Spreng & Andrews-Hana, 2015; Tamir & Mitchell, 2011). Other forms of imagination that involve visualizing physical objects or physical space are thought to recruit more heavily the brain's executive attention network and dorsal attention network, a network involving communication between the frontal eye fields and the intraparietal sulcus (Andrews-Hanna et al., 2014; Jack et al., 2013). An understanding of the brain networks that support imaginative thought can help elucidate the confines of the imagination construct. Regardless of the specific large-scale brain network interactions involved with specific forms of imagination, we see a unifying theme across all of these imaginative cognitive and emotional processes – the capacity to see in one's mind what is not present – which serves as a critical foundation for creative thinking.

Like imagination, creativity involves thinking about content that is removed from the here and now. It can be a messy process characterized by the harmonizing of seemingly contradictory ways of thinking or being (S. B. Kaufman & Gregoire, 2015). Like imagination, creativity in the social domain is thought to be supported by the default mode network (Beaty, Benedek et al., 2014) because of its role in the development of "originality" – or the mental representation of novel ideas (Jung et al., 2013). The executive attention network, on the other hand, is important for making plans and keeping track of strategies employed while pursuing a creative goal. People exhibit creativity in big and small ways; we can engage in creativity that is personally meaningful and useful in our everyday lives or creativity that helps us learn new ideas and concepts. Some individuals pursue creative endeavors professionally, even producing works that change thoughts and behaviors of groups and society (J. C. Kaufman & Beghetto, 2009; S. B. Kaufman & Gregoire, 2015). Creativity is rarer than imagination, as it demands both usefulness and a good sense of the audience – knowing when to be original and when to conform to societal conventions (Seligman et al., 2016). It also requires enough domain-specific knowledge to gauge how well received one's idea will be by a given audience (Sternberg & Lubart, 1999). Therefore, researchers have proposed that the creative process be divided into two main phases: the generation phase, through which imagination enables the relatively unconstrained invention of ideas, and the exploration phase, in which those ideas are evaluated and refined (Finke, Ward, & Smith, 1992). It is apparent, however, that creativity depends on imagination and so is essential for it. We turn now to exploring specific cases of the imagination–creativity relationship.

Social-Emotional Imagination

Social-emotional imagination is the ability to conceive of multiple possible cognitive and affective perspectives and courses of actions and to skillfully reflect about each of these and their ties to one's own value and understanding of the world (Gotlieb, Hyde et al., 2016). It is composed of several specific imaginative skills, including perspective-taking, identity construction, constructive internal reflection (Immordino-Yang et al., 2012), and cultural awareness (Gotlieb, Hyde et al., 2016; Gotlieb, Jahner et al., 2016). Social-emotional imagination also involves or is related to meaning-making, narrative construction, pretend play, planning, self-regulation, and moral decision-making. Each of these processes is made possible by imagination, and each also has the potential to support people in exhibiting creativity.

Individuals who frequently and deeply engage in social-emotional imaginative thought may demonstrate their creativity by being leaders in advocating for just social policies, pioneering entrance into domains others have not previously entered, and applying solutions to problems from one social context to another. The creative vision of Martin Luther King, Jr. and the bravery of Sally Ride (a physicist who became the first American woman astronaut to fly in space) may have stemmed from skilled social-emotional imaginative abilities. The creativity of those adept in social-emotional imagination may also manifest in smaller ways, such as by being able to put others at ease, helping a group of individuals coalesce, or being able to find something to admire in most people.

Pretend Play: The Genesis of Social-Emotional Imagination

Before people develop social-emotional imaginative abilities in perspective-taking, identity construction, constructive internal reflection, or cultural awareness, they develop precursor imaginative abilities. Pretend play, which is "the acting out of stories which involve multiple perspectives and the playful manipulation of ideas and emotions" (S. B. Kaufman, 2012, para. 1; see also Russ & Doernberg, Chapter 28, this volume), is recognized as an essential contributor to children's social and emotional development and may represent an early form of social-emotional imagination. There are several processes that combine to make pretend play, such as divergent thinking, associative thinking, insight and problem-solving, narrative development, emotional expression, joy in pretending, and integration of affect (i.e., appropriately expressing emotion within a storyline; Russ, 2014). In addition to pretend play with peers, even when children use toys to construct narratives or characters alone, they can cultivate social skills through the representation of multiple points of view and practiced communication (Hughes, 1999). Participating in make-believe games supports children's capacities for self-regulation, delay of gratification, civility, and empathy (Berk, Mann, & Ogan, 2006; Hirsh-Pasek et al., 2009).

Through the development of these skills, pretend play may support creativity. Many experts regard play as a natural form of creativity for children between the ages of two and a half and ten (Fein, 1987). Children who have or have had imaginary friends tend to score more highly on measures of creativity (e.g., on the "unusual uses" test and on a measure of involvement in creative hobbies) than do children who report never having had an imaginary friend (Hoff, 2005). Central to appreciating its role in laying the groundwork for creativity is the notion that through pretend play, children practice, manipulate, and deeply engage with images, ideas, fantasy, and affect (Russ, 2014). This is especially true of the role-playing form of pretend play, through which they learn to hold multiple representations in mind and to flexibly switch between them. This process provides children with experience in the aforementioned generation phase of creativity by allowing them to practice designing fantastical characters and plots (Sachet & Mottweiler, 2013). However, it may also help them build skills relevant to the exploration phase of creativity, which is dedicated to the evaluation and refinement of unconstrained, imaginative thought. For instance, if by engaging in role-play, children improve their understanding of others' mental states, that very understanding could help them discern which of their ideas others would consider novel and original. Thus, social understanding would mediate the relationship between pretend play and creativity (Runco, 2006; Sachet & Mottweiler, 2013). Another important mediator in the relationship between pretend play and creativity is affect. In particular, Russ, Robins, and Christiano (1999) found that the affect children display through pretend play can furnish them with a wide range of associations that they can later draw on when engaging in problem-solving and divergent thinking (i.e., a free-flowing manner of generating multiple related ideas or solutions to a problem). Children learning to experience, regulate, and fluidly alternate across a broad range of emotions through engagement in pretend play can strengthen affective processes supportive of adult creativity.

Perspective-Taking

Empathic perspective-taking, one aspect of the social-emotional imagination, is the ability to imagine what another person thinks or feels or to imagine oneself as another person (Batson, 2009). Affective perspective-taking is inherently an act of imagination in that it requires simulating another person's experiences. It is known to be supported by several regions within the aforementioned default mode network, as well as by some regions outside of the default mode network that are associated with visceral feelings (Fan et al., 2011; Lamm, Decety, & Singer, 2011; Schurz et al., 2014).

Perspective-taking may facilitate a number of social functions that support creativity. For example, if we take the perspective of the person to whom we are relaying a story, we may be able to tell the story in a way that is clearer to that person and that will require him to surmise less information on his own. In so doing, we can increase the listener's enjoyment of the story (Cooney, Gilbert, & Wilson, 2017). As such, this act of perspective-taking may facilitate fluid conversing, which can be an act of creativity in that two people are working together to create a novel shared experience that they find valuable in some way (e.g., serving an important social function, establishing a collaboration that later results in a tangible creative product). When individuals learn about ideas expecting to have to teach them to others, and thus encode the content while imagining what others would think or need to know to understand the idea, they learn the content more thoroughly and can communicate it more effectively than if they had learned the content without expecting to teach it (Chang, Berger, & Chang, 1981; Fiorella & Mayer, 2014; Nestojko et al., 2014). That is, drawing on perspective-taking skills while processing information helps us learn the information in a way that is longer-lasting and useful.

Perspective-taking also increases cooperation among individuals and reduces negative misinterpretations of others' behaviors (Rumble, Van Lange, & Parks, 2010). The ability to cooperate and alter one's own ideas in light of others' recommendations may support the generation of creative insights (Sawyer, 2007, 2017). Relatedly, perspective-taking can improve the outcome of a negotiation such that each party finds a previously undiscovered and mutually beneficial outcome (Galinsky et al., 2008). Teams with greater diversity, including diversity of perspectives, tend to be more creative, and engaging in more perspective-taking helps people work more effectively with people who are different from them (Hoever et al., 2012; Galinsky & Moskowitz, 2000). For example, when Italian elementary school children were asked to think of all the uses of an object that they could – a classic task used to measure creativity – they generated a greater number of uses when they had previously worked on an unrelated task in a team with an immigrant to Italy than when they had worked on the unrelated tasks with only Italian-born peers. Moreover, the creativity benefits of diverse teams were greatest when participants focused on the similarities between people, rather than the differences (Vezzali et al., 2016).

Notably, the aforementioned benefits of perspective-taking support creative thought that happens in groups (e.g., Sawyer, 2007, 2017), and yet solitude is extremely important for creativity. Indeed, many creative geniuses (e.g., Proust) demand that they work alone (S. B. Kaufman & Gregoire, 2015). Yet, even for creative work that an individual produces alone, perspective-taking abilities may be helpful. For example, fiction writers have greater empathy and perspective-taking abilities than the general population (Taylor, Hodges, & Kohányi, 2003). Further, fiction writers who have published their work or who earn some income from their writing, as compared with those who have not published and do not earn any income from their writing, are more likely to state that the fictional characters they create have thoughts and feelings separate from their own (Taylor et al., 2003). Similarly, actors, individuals who are creative in performance art, are better able to read the emotions and imagine the thoughts of others than are nonactors (Goldstein, Wu, & Winner, 2009). Perspective-taking training among young children has been associated with enhanced divergent thinking (Doron, 2017).

Flexible Identity Construction

Another aspect of social-emotional imagination that supports creativity is the flexibility with which people construct their identity. *Flexible identity construction* requires maintaining a sense of one's core self while also conceiving broadly of and skillfully moving between the many aspects of one's identity. It also involves developing and utilizing strategies to refine an aspect of one's identity or to become a hoped-for future self (Gotlieb, Hyde et al., 2016). Both the acts of conceiving of an array of identities that one currently possesses and envisioning possible identities one might possess in the future require imagination. This process of identity construction calls for an individual to reflect about how her different actions and relations can be combined or disentangled to make her who she perceives herself to be and who she might be in the future.

By calling to mind aspects of identity that are associated with success in an array of environments, individuals make it possible to demonstrate creativity in more domains. Further, they may be willing to put themselves in a greater diversity of circumstances, which could provide fodder for creative thinking. Conceiving of one's identity as multifaceted can make it easier to connect with a greater range of individuals because it is easier to find a shared aspect of identity. Consequently, the exposure to more individuals and ideas that a broadly construed identity can facilitate may spur creativity (Kang & Bodenhausen, 2015). Individuals can also switch among varied aspects of their own identities (e.g., an individual can shift to see herself as a woman, mother, scientist, marathon runner, etc.) to assume the ones that are most helpful or appropriate for the task at hand (Kang & Bodenhausen, 2015). In instances when an aspect of one's identity is threatened, if the individual focuses on nonthreatened or positively stereotyped aspects of her identity or core values, she is typically buffered from the adverse performance effects of the identity threat (Gresky et al., 2005; Rydell & Boucher, 2009; Rydell, McConnell, & Beilock, 2009; Taillandier-Schmitt, Esnard, & Mokounkolo, 2012). For example, when a woman is taking a math test, if instead of focusing on her identity as a woman, she focuses on (1) her identity as a college student, which is an identity that is positively stereotyped for success in math, (2) the fact that there are a large number of aspects of identity that she possesses besides her gender identity, or (3) some of the traits or characteristics that she possesses that are most important to her (e.g., humorous, sensitive, loyal), she may not show the suppressed performance on the math task that is typical of people experiencing stereotype-threat.

While the benefits of the aforementioned stereotype threat-reducing strategies have mostly been examined relative to performance on convergent thinking tasks (e.g., solving multiple-choice math problems), it is conceivable that these benefits would also support divergent thinking and creative expression. For example, as women and racial and ethnic minorities gain popularity as mainstream artists in fields from which they have historically been excluded or underrepresented, the ability to draw on the similarities they have to others in their field (e.g., in being exceptionally talented at their art) may help them overcome hurdles to entry associated with being one of the first of a particular identity group to enter that field. Flexible identity construction may reduce stereotype threat effects on people's ability to demonstrate their creativity. It is also the case that assessing people's creative abilities may be a way to measure students' potential and ability without inducing stereotype threat effects (J. C. Kaufman, 2006). Thus, including creative assessments in the college admission review process, for example, might be a fairer way to assess diverse students (J. C. Kaufman, 2010). Having a more diverse student body entering college may, in turn, expand the possible identities that these youth and members of their community ascribe to themselves or conceive of as possible.

Constructive Internal Reflection

The way in which we learn to construct our identity is through reflection about who we are and what our lives mean. *Constructive internal reflection* is the ability to connect complex ideas and think about one's own values and beliefs and the social meaning of one's quotidian encounters in order to guide actions and thoughts (Immordino-Yang et al., 2012). To engage in this deep reflection, people likely need uninterrupted and relaxed time with their thoughts. Like other aspects of social-emotional imagination, constructive internal reflection occurs when the default mode network is active and is unlikely to occur when attention is focused outward (Immordino-Yang et al., 2012). Constructive internal reflection is a skill that can facilitate creativity in the social realm, such as in generating novel solutions to and actions against societal inequalities, or simply cleverly navigating an awkward or emotionally charged encounter with a friend or co-worker.

Constructive internal reflection helps us make meaning of our lives and guides moral actions. For example, adults who express greater concern for advancing the health and well-being of future generations are more likely to construct their own life story as one in which, disturbed by others' suffering and guided by a strong sense of morality, they worked to improve one negative situation after another in order to make the future better for other people (McAdams & Guo, 2015). In the midst of difficult circumstances, people are less likely to see their personal narrative as one of transforming hardship into triumph (Dunlop, Guo, & McAdams, 2016). And yet, even in devastating circumstances, when people interact with others and carry out kind deeds that benefit others, they are better able to make meaning of their lives and maintain a sense of purpose (Frankl, 1946). The ability to find a way to altruistically help other people even while facing tremendous personal struggles is an example of creative thinking about how to direct one's energy. Similarly, when people feel inspired by others' virtuous actions, as compared to inspired or impressed by their skillful actions, they are more likely to think about implications of that person's story for their own life purpose. They often spontaneously describe wondering how they can use their life to better serve others or how they should be more grateful for the good fortune they have (Immordino-Yang, 2011; Immordino-Yang et al., 2009). That is, the act of imagining and making meaning of alternative situations and life stories can inspire creativity in leading a life of service.

Polycultural Thinking

The final core component of social-emotional imagination that we will discuss here is *polycultural thinking*, or thinking informed by an awareness of multiple interacting cultures (Morris, Chiu, & Liu, 2015). Polycultural thinking is a form of cultural awareness that can be developed among people who live and interact with others from a variety of cultures and who often themselves belong to more than one cultural group. It can promote creativity by providing an individual with multiple frames through which to think about problems. Evidence suggests that just one year of positive and meaningful interactions with diverse peers – which may stimulate polycultural thinking – can improve students' problem-solving, complex thinking, and leadership skills, as well as their concern for the common good (Hurtado, 2005). One study of multiracial adolescents compared those adolescents who identify as multicultural with those who identify with only one of their groups. The adolescents who identified as belonging to more than one racial group showed greater self-esteem, positive affect, and participation in community (Binning et al., 2009). This may suggest that capitalizing on polycultural thinking or ways of being supports psychological well-being and civic engagement. As culture shapes the way we understand the physical, social, and emotional dimensions of our world (Immordino-Yang & Gotlieb, 2017; Immordino-Yang, Yang, & Damasio, 2014; Oyserman & Lee, 2008; Shweder & Bourne, 1982), then having a larger repertoire of cultural frames may facilitate skills for viewing and experiencing the world in a greater variety of ways, which in turn may allow us to generate new and useful ideas. Creative innovation typically arises from the unexpected rearrangement of products and ideas that already exist. The cultural experiences and lenses that individuals possess impact the products that they might rearrange and the way in which they might do so (Glăveanu, 2010). Consider, for example, that numerous novelists, poets, social scientists, and visual artists have characterized their multicultural or multiracial identities and experiences as a driving force and a source of ideas in their work (O'Hearn, 2008).

Temporal Imagination

Beyond the social-emotional imagination, another form of imagination that supports creativity is the *temporal imagination*, which is characterized by one's ability to engage in mental time travel. Mental time travel is being aware of subjective time and oneself in relation to it or reconstructing and reasoning about the past and envisioning possible futures (Tulving, 1985, 2002). Temporal imagination includes such processes as prospection, episodic memory construction, counterfactual thinking, and mind-wandering. Like social-emotional imagination, many forms of temporal imagination are subserved by the default mode network (Østby et al., 2012; Spreng & Grady, 2010; Tamir & Mitchell, 2011). Many aspects of temporal imagination are indeed quite social in nature; however, they are characterized by being about imagination across time.

Individuals with strong temporal imaginations may be visionaries able to predict trends ahead of others (e.g., Tetlock & Gardner, 2016) or they may demonstrate creativity in their ability to write engrossing works of fiction. Esteemed author and Nobel Prize winner Toni Morrison's ability to tell historical stories set across time periods and through a range of brilliant characters' perspectives may be the result of vivid temporal imagination. Paul Farmer, through his work as co-founder of Partners in Health and numerous efforts to provide healthcare and to cure diseases in developing countries, may similarly possess exceptional temporal imaginative abilities. His ability to see a country's future health trajectory and imagine alternatives and ways to bring about those alternatives is an example of harnessing temporal imaginative abilities toward creative (i.e., novel and useful) ends. Although these individuals demonstrate exceptional temporal imagination, temporal imagination can be valuable for all of us in, for example, deriving greater meaning in life (Waytz, Hershfield, & Tamir, 2015).

Prospection

Gilbert and Wilson (2007) define prospection as the "ability to 'pre-experience' the future by simulating it in our minds" (p. 1352). These mental simulations include *navigational* (i.e., moving through physical space), *social* (i.e., speculating about others' minds, similar to perspective-taking discussed above), *intellectual* (i.e., evaluating new ideas), and *memorial* (i.e., recalling and reasoning about the past; Buckner & Carroll, 2007). The first three categories represent hypothetical simulations of future events, while the fourth allows one to run through counterfactual alternatives to events that have already occurred (Seligman et al., 2013). In recent years, researchers have tied these forms of mental simulation and self-projection to neural activity in the default mode network. The internally directed cognition that the default mode network supports facilitates imagination in that it allows the individual to conduct simulations based on personal experiences using both episodic memories of the past and prospective representations of the future (Buckner, Andrews-Hanna, & Schacter, 2008).

Construal-level theory allows us to appreciate the role of prospection in supporting creativity. This theory stipulates that temporal distance – or the perceived proximity of an event in time – affects an individual's mental representations of future events and thus their responses to them (Trope & Liberman, 2003). In particular, the farther away an imagined event is from the present, the more likely it will be "construed" in terms of abstract, general, and decontextualized features, rather than in more concrete, specific, and contextual detail (Förster, Friedman, & Liberman, 2004). Relatedly, Liberman and Trope (1998) asked participants to imagine engaging in a range of activities (e.g., reading a science fiction book) either the following day or the following year and to describe the activities. As predicted, descriptions of the near future "tomorrow" events elicited low-level, concrete descriptions, such as "I read a book by flipping the pages," whereas descriptions of reading "next year" elicited high-level, abstract descriptions, such as "I broaden my horizons by reading a book."

These findings suggest that more distant future perspectives – those enabled by prospection – promote abstract representations. Creativity and insight problem-solving, in turn, are known to benefit from abstract thinking (Finke, 1995; Förster et al., 2004; Ward, 1995). Similarly, research has shown that temporal distance can influence the breadth of object categorization. For example, in a study by Liberman, Sagristano, and Trope (2002), participants were asked to imagine an event (e.g., a camping trip) either for the upcoming weekend or for several months later and to organize thirty-eight objects intended for the event (e.g., tent, toothbrush) into however many exhaustive and mutually exclusive groups they saw fit. Those who completed the task with the belief that the trip was farther in the future used fewer, more eclectic categories than those who envisioned it as being just around the corner. These findings, too, provide evidence of how prospection, particularly that which projects thinkers months and years into the future, can serve creativity by helping them become open to broader categorizations and unlikely connections between objects and ideas.

Memory Construction

One might think that remembering the past is merely an act of recall. However, emerging research suggests that memory construction underlies imaginative thinking because humans are not able to "play back" the past like a movie reel but instead must cobble together a likely rendering of past events based on educated, imagined guesses (Schacter, 1996). Those who engage in more vivid memory construction may be able to think more creatively because they conjure more real-world details and experiences when thinking about current challenges, which may yield more realistic solutions to those challenges. They may be better at using their past actions to guide current and future behavior, which could support creativity by making it more likely that individuals will seek experiences they have not had previously.

Recent studies compared people provided with training in recalling details of an event (e.g., guided mental-imagery exercises) and a control group who were asked general questions about the event but not supported in remembering it better. Both younger and older adult participants in the recall-training condition significantly outperformed participants in the control condition on a subsequent, unrelated divergent thinking task, and they generated more new and creative ideas (Madore, Addis, & Schacter, 2015; Madore, Jing, & Schacter, 2016). This effect may occur because supporting people in remembering past events encourages them to focus on details. Activating this detail-orientation may also be helpful for creative thinking tasks that similarly require an attention to specifics. Episodic memory, which is itself imaginative, may support creativity by promoting a focus on specificity and detail.

Counterfactual Thinking

Counterfactual thinking is a specific case of temporal imagination that combines both prospection and memory when individuals entertain thoughts of what might-have-been (Roese & Olson, 2014). When people engage in counterfactual thinking about their own life or the lives of other people, the default mode network is involved (De Brigard et al., 2015). Specifically, people tend only to simulate what-if experiences in rich detail when they are proximal or similar to one's current experience in that they occur close in time, are physically nearby, likely to happen, or are relevant to close others (De Brigard et al., 2015; Liberman & Trope, 2008; Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2003). Individuals also run distal simulations – those dedicated to imagining events that seem far away in terms of time and distance and that are unlikely to occur or that involve the minds of strangers. However, the mental representations of such events are generally abstract and simplified by comparison. Tamir and Mitchell (2011) found that two regions of the default mode network – the medial prefrontal cortex and retrosplenial cortex – were more active when fMRI study participants were asked to think about proximal rather than distal events, regardless of whether the perceived "distance" between the current and imagined experience was spatial, temporal, social, or hypothetical.

This ability to simulate counterfactual experiences – to imagine alternatives for how past events could have unfolded – in different levels of detail also "may contribute to the uniquely human capacity for considering novel and hypothetical outcomes at arbitrary points in the future," according to Mitchell and colleagues (2011, p. 863). Thus, "what-if" thinking about the past may support future creativity both through the practice of entertaining other possibilities and by allowing the thinker to detach from the present and more flexibly imagine himself in different circumstances that may be more conducive to creativity. For example, individuals who are more skilled at counterfactual thinking are also more easily able to self-restrain (Mischel, 2014) and to delay gratification in the service of later reward

(Mischel, Shoda, & Rodriguez, 1989), which could support one's ability to persist through the many obstacles a creative pursuit can present. One possible explanation for the relation between counterfactual thinking and self-restraint is that, as people experience counterfactual emotions such as regret or relief, they may become motivated to make more adaptive choices going forward (O'Connor et al., 2015). It is important to keep in mind, however, that imagination can be used for both positive–constructive ends as well as for potentially selfish purposes. Similarly, while creativity is widely regarded as being associated with desirable personal attributes and outcomes, it may also have a more malevolent side (e.g., being related to a lack of integrity) (Beaussart, Andrews, & Kaufman, 2013; Cropley, Kaufman, & Cropley, 2008). For instance, those who more frequently engage in counterfactual thinking may also be more skilled at lying and more likely to expect others to lie (Briazu et al., 2017). Indeed, both counterfactual thinking and lying require imagining possible alternatives. Nevertheless, lying can be an act of creativity in that individuals typically generate a new "truth" to help achieve some goal they have involving the person to whom they are lying.

Whether counterfactual thinking is used to support benevolent or malevolent ends, it is a useful skill. It can, however, cease to be useful when people struggle to disentangle factual and counterfactual thinking. People who cannot discern what information is fact and what information is plausible but inaccurate may act based on wrong information. The issue of assessing what is true and what is an "alternative fact" received intense political and media attention preceding and following the 2016 US presidential election. This inappropriate application of counterfactual thinking has had and will continue to have deleterious implications for how we are governed.

Mind-Wandering

Mind-wandering – or the experience of having one's attention shift away from the objective world and its related perceptual input and toward internal reflection – often involves temporally imaginative thoughts (McMillan, Kaufman, & Singer, 2013). Notably, mind-wandering can also be atemporal (Jackson, Weinstein, & Balota, 2013). The default mode network is active when individuals mind-wander (Jung et al., 2013). Generally, mind-wandering is positively correlated with creativity (Preiss et al., 2016) but not all kinds of mind-wandering promote creativity, and some kinds of mind-wandering – such as negative rumination – can be maladaptive (Nolen-Hoeksema, 2000). However, the kind of mind-wandering known as "positive constructive daydreaming," which is characterized by "playful, wishful imagery, and planful, creative thought" (McMillan et al., 2013, p. 1), can serve four adaptive functions: future planning, creative incubation and problem-solving, attentional cycling (when an individual can flexibly switch between various informational streams), and dishabituation (which improves learning since an individual is taking short, recuperative mental breaks from externally demanding tasks; Schooler et al., 2011).

In a series of studies investigating the temporal dimensions of mind-wandering, Smallwood and colleagues (2011) demonstrated the adaptive benefits of "prospective daydreaming." It allows individuals to connect past and future selves, to devise long-term plans, and it can also serve as a wellspring of creative inspiration. In a later study, Smallwood, Ruby, and Singer (2013) explored how mind-wandering related to self-control as measured by delay discounting of distant rewards. They found self-generated thought engages processes associated with the effective management of long-term goals. In other words, as discussed above, those who are better able to imagine the future can recruit that ability to resist current temptations and to take steps toward achieving their goals, including those focused on creative achievement (Baird, Smallwood, & Schooler, 2011; S. B. Kaufman & Duckworth, 2015; Mooneyham & Schooler, 2013). When given the opportunity to mind-wander, individuals engage in more creative problem-solving (Baird et al., 2012).

Imagination and the Default Mode Network Are Not the Whole Story

One basic premise we wish to reemphasize is that imagination is necessary but not sufficient for creativity. As such, creativity must draw on skills, knowledge of the context, motivation, and a variety of traits other than imagination. In this same vein, if creativity goes beyond imagination, it is likely subserved by more than just the default mode network. Indeed, meaningful creativity draws on imaginative abilities, executive control abilities, and flexible task switching, and is supported by the default mode network, salience network, and the brain's executive attention network (Beaty et al., 2015; Beaty, Silvia et al., 2014; Bonnelle et al., 2012). Although the default mode network and executive attention network are typically at odds with one another – when one is activated, the other tends to be deactivated – creative thinking is unique in that it requires these networks to work in concert with one another (Beaty et al., 2015; Zabelina & Andrews-Hanna, 2016). The salience network (which includes the anterior cingulate cortex, presupplementary motor area, and anterior insula) facilitates the flexible switching between these other large-scale brain networks (e.g., Andrews-Hanna et al., 2014; Bonnelle et al., 2012).

While a traditionally emphasized function of the executive attention network is to home in on relevant stimuli from an individual's external environment, the aforementioned research findings reveal that the executive attention network can also play a role in selecting meaningful associations that emerge from the inner stream of thought supported by default mode network activity, as well as in suppressing the more prepotent responses that are likely to be uncreative (see Beaty, Silvia et al., 2014). For instance, Kam and colleagues (2013) found that the executive attention network can work in tandem with the default mode network to identify the most relevant ideas that arise from engaging in intentional episodic memory retrieval and processing. This has important implications when considering potential sources of creative inspiration. The types of imagination reviewed here (e.g., social-emotional and temporal) primarily draw on the default mode network – albeit with enhancement from flexible toggling between the default mode network and the executive attention network.

Bearing Creative Fruits from the Seeds of Imagination

Without imaginative thinking there can be no creativity, and, yet, imaginative abilities alone will not ensure creativity. Individuals need enriching environments to provide fodder for their imaginative thought to produce creativity. As Lev Vygotsky said,

> If we want to build a relatively strong foundation for a child's creativity, what we must do is broaden the experiences we provide him with. All else being equal, the more a child sees, hears, and experiences, the more he knows and assimilates, the more elements of reality he will have in his experience, and the more productive will be the operation of his imagination. (1931/2004, p. 15)

We also need to create supportive environments that reward students engaging in imaginative thought and demonstrating their creativity. For example, some types of feedback about creative works can leave students feeling mortified and unlikely to maintain high creative aspirations for themselves (Beghetto & Dilley, 2016). On the other hand, students who persistently and passionately pursue their creative interests and are praised for doing so are likely to continue to work hard toward their creative goals and achieve beyond what might be expected of them based on ability alone (S.B. Kaufman & Duckworth, 2015). To capitalize on individuals' imaginative capacities, we need to cultivate environments in which students can periodically disengage from external stimuli and take time to look inward, reflect, and make novel connections (Immordino-Yang et al., 2012). Students need to be given structured opportunities to reflect, and they need to be taught how to do so productively (Gotlieb, Jahner et al., 2016; Immordino-Yang et al., 2012). Although the role of imagination in creativity is critical and clear, in order for either process to unfold optimally and appropriately people need to be in an environment that supports them.

In addition to the environment, there are several characteristics of an individual that affect the extent to which he or she is imaginative and the likelihood that his or her imagination will yield creative fruits. In their extensive review paper, Barron and Harrington (1981) identified the main characteristics supportive of creativity, including broad interests, attraction to complexity, independence of judgment, autonomy, intuition, self-confidence, comfort with ambiguity, propensity for risk-taking, curiosity, and high valuation of aesthetic experiences. More recently, Oleynick and colleagues (2017), reviewing the literature on the personality trait of Openness/Intellect, labeled it "the core of the creative personality" (p. 9). This construct, like the other four comprising the Big Five model, contains two major subfactors as indicated by its compound name – *openness* and *intellect* – which show discriminant validity (DeYoung, Quilty, & Peterson, 2007). Openness reflects cognitive engagement with aesthetic, sensory, and affective information in perception and fantasy, whereas intellect reflects cognitive engagement with abstract and semantic information through reasoning (S. B. Kaufman et al., 2015). While the *openness* and *intellect* facets can be parsed in order to differentially predict achievement in the arts (i.e., music and theater/film) and sciences (i.e., research discoveries and inventions) respectively, taken together as a single personality trait, they correlate more positively and consistently with all domains of creativity than do conscientiousness, extraversion, agreeableness, or neuroticism (J. C. Kaufman et al., 2010).

In order to better understand the strong association between openness/intellect and creativity, we can examine some of the cognitive processes common to both. Latent inhibition, for instance, is the ability to ignore presumably irrelevant stimuli and inconsequential events in one's environment (Lubow, 1989). While excessively decreased latent inhibition is a feature of psychosis (Lubow et al., 1992), in more mild variants, it can benefit original thinking (Carson, 2011). Work by Carson, Peterson, and Higgins (2003) and Peterson, Smith, and Carson (2002) suggests latent inhibition correlates with both openness/intellect and creativity in psychologically healthy individuals because, as they contemplate the pertinence of a wider range of perceptual input, they are more likely to generate the kinds of novel associations that inspire creativity (see also Carson, Chapter 14, this volume). Similarly, implicit learning – or learning of complex information that occurs outside of conscious awareness – is another cognitive process that may enable those scoring high in openness/intellect to detect unlikely connections within their surroundings, thereby fueling creativity (S. B. Kaufman et al., 2010). Divergent thinking is often considered an aspect of creativity and is supported by openness/intellect (McCrae, 1987). Divergent thinking tasks, such as those asking participants to come up with as many uses for a brick as possible, are scored for originality (i.e., how common a response is across participants). The ability of those high in openness/intellect to generate original ideas is successfully captured on divergent thinking tasks, which can be predictive of creativity both inside and outside of the laboratory (S. B. Kaufman et al., 2015).

Motivation is a critically important personal factor that ensures these general tests of creativity translate into creative achievement in the real world. Again, this attribute aligns with the openness/intellect trait, which represents a motivation to explore the world through perception and reason based in curiosity and on the expectation of informational reward (DeYoung, 2013; Oleynick et al., 2017). Extending beyond the mere drive to navigate one's existing inner and outer worlds, individuals high in openness/intellect can go one step further by developing their creative ideas into something tangible, whether that be a piece of art or a scientific invention. To this end, inspiration, which is associated with both openness and creativity (Oleynick et al., 2014; Thrash et al., 2010), can play an important role in spurring individuals to transform hypotheticals into actual products. It is evident that the openness/intellect trait interacts with imaginative capacities to result in observable and measurable creative output.

Creative individuals are also characterized by their adaptability and proclivity to mix seemingly incompatible emotional and attentional states, such as calmness and euphoria, or deep focus and spontaneity, depending on the demands of the task in question (S. B. Kaufman, 2015). Furthermore, "affective engagement" – or the extent to which individuals are open to experiencing the full spectrum of their emotions – is a better predictor of lifetime creative achievement than is IQ (S. B. Kaufman, 2013, 2015). People who report that they rely on their emotions and empathic abilities to make decisions also report having a greater number of creative accomplishments in the arts than individuals who do not rely on their emotions to as great an extent (S. B. Kaufman, 2013). Relatedly, Fong (2006) has studied the effects of "emotional ambivalence" – or the simultaneous experience of positive and negative emotions – on creativity. Her findings suggest that when individuals experience emotions that do not usually coexist (e.g., feeling both excitement and frustration about a product launch), it can serve as a signal they are in an unusual environment, which can then increase sensitivity to unusual associations, which can, in turn, foster creativity.

Conclusion: Future Directions for Research on the Imagination–Creativity Relationship

The study of imagination and the study of creativity contribute to one another. While imagination helps us understand the mechanism by which we are able to be creative, creativity is a chief reason why imaginative thinking is important and valuable. Thus, studying these two constructs together may enrich our appreciation of each. As we continue to build an integrative understanding of the relationship between imagination and creativity, and the biological, mental, and cultural factors that support each, we believe that some of the most important questions for neuroscientists and psychologists to investigate are:

- What is the mechanism by which the mental experience of imaginative thought translates into the culturally relative demonstration of creativity? How does variability among individuals in proclivity for engaging in imaginative thought impact the imagination–creativity relationship? How might this relationship be impacted by variability among cultures in terms of what is considered novel and useful?
- How might an understanding of the different networks (especially the default mode network executive attention network, and salience network) that subserve different processes involved in imaginative thought and creativity support our understanding of how these diverse skills are related to one another?
- How does imagination differ across domains? How might an understanding of domain-specific imaginative abilities help us understand varying profiles of creative talent and differences in creativity across different fields?
- How might we support individuals in more frequently and successfully harnessing their imaginative abilities toward creative ends? How might we create educational and cultural institutions that teach individuals skills and inspire motivation to turn imagination into creativity? How will society change as youths are supported in transforming their imagination into creativity?

We have argued that imagination is the seed that may ultimately produce the rare fruit of creativity. If this is so, it is also the case that cultural context is the wind and angle of the sunlight affecting the direction in which the imagination tree grows. Environmental support for creativity and personality traits (e.g., openness to experiences) are the fertile soil that determines the extent to which the tree has the needed nutrient to grow. The default mode network and other networks in the brain are the xylem and phloem tissue setting biological constraints on how the tree produces fruit. Research related to the above question will advance our ability to produce imagination trees that bear the sweet fruit of creativity.

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35 What Is and What Can Be

The Scope and Possibilities of Creativity and Creativity Research

James C. Kaufman, Vlad P. Glăveanu, and Robert J. Sternberg

It's been a long journey from the introduction to the conclusion of this volume. Creativity is a multifaceted construct that has been with us since the beginning of our species (Kozbelt, Chapter 6, this volume). Debates about its nature and roots have continued through much of recorded time (Glăveanu & Kaufman, Chapter 1, this volume). As a field of scientific study, creativity had some moments of interest in the early twentieth century (Chassell, 1916; Hutchinson, 1931) but did not become a topic of regular interest until Guilford's (1950) presidential address to the American Psychological Association. Guilford's Structure of Intellect model (1950, 1967) introduced many creativity-relevant concepts, perhaps most notably divergent thinking (Runco & Acar, Chapter 11, this volume). Since the early days of creativity scholarship in the 1950s and 1960s, both the scope of creativity as a phenomenon and the scope of creativity theory and research have become wider and more complex.

The Scope of Creativity

The field of creativity has spread out in many different directions over the last several decades. We have tried to reflect these many perspectives and nuances throughout the book. The Four P model (Rhodes, 1961) continues to be a solid framework with its distinction between the Person, Process, Product, and Press (environmental factors). Starting with the creative person, there are still numerous components to be studied. Indeed, the study of the creative personality (Feist, Chapter 17, this volume) is its own area. In addition, there are biological perspectives, rooted in genetics (Barbot & Eff, Chapter 7, this volume) and neuroscience (Vartanian, Chapter 8, this volume). There are cognitive perspectives (Ward & Kolomyts, Chapter 9, this volume) that can cover everything from cognitive control (Benedek & Jauk, Chapter 10, this volume) to how intelligence relates to creativity (Sternberg, Kaufman, & Roberts, Chapter 16, this volume) to one's self-beliefs (Karwowski, Lebuda, & Beghetto, Chapter 19, this volume). Some perspectives consider affective dimensions, including creativity's relationship to mood (Baas, Chapter 12, this volume), emotions (Ivcevic & Hoffman, Chapter 13, this volume), mental illness (Carson, Chapter 14, this volume), and positive mental health (Forgeard, Chapter 15, this volume).

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The creative process is present in many theories of creativity (Kaufman & Glăveanu, Chapter 2, this volume). There are many possible motivational factors that underlie creativity (Hennessey, Chapter 18, this volume); it can also be sparked by imagination (Gotlieb, Hyde, Immordino-Yang, & S. Kaufman, Chapter 34, this volume) and play (Russ & Doernberg, Chapter 28, this volume). For many of us, this process is part of our everyday lives (Cotter, Christensen, & Silvia, Chapter 30, this volume). Our engagement with the creative process evolves over our lifetimes (Hui, He, & Wong, Chapter 4, this volume) and understanding it is crucial for enhancing our own creativity (Sternberg, Chapter 5, this volume).

The creative product is the result of the creative person engaging in the creative process and it is the key to most creativity assessments (Plucker, Makel, & Qian, Chapter 3, this volume). Very high-level products can result in the creator being considered a genius (Simonton, Chapter 31, this volume). The way that other people react to artistic products is part of the genesis of aesthetics (Tinio, Chapter 33, this volume). Not all creative products have positive impacts on the world; indeed, some can lead to malevolent outcomes (Cropley & Cropley, Chapter 32, this volume).

The concept of the creative press (or environment) has been an area of growing attention in recent years; indeed, a sociocultural perspective on the Four P's expands the original framework to be the Five A's (Glăveanu, 2013), with the person becoming the actor, the process becoming the action, the product becoming the artifact, and the press being split between audience and affordances (i.e., resources). Creativity does not occur in a vacuum. In real life, much creativity emerges from groups (Sawyer, Chapter 26, this volume) and interacts with society (Simonton, Chapter 22, this volume). Even if creating alone, one's immediate physical environment can make a large difference (Dul, Chapter 23, this volume).

Another key variable is culture (Lubart, Glăveanu, de Vries, Camargo, & Storme, Chapter 20, this volume), with Eastern versus Western perspectives the most often studied (Niu, Chapter 21, this volume). Culture does not need to be at the level of the nation; cities vary in ways that can enhance or hurt creativity (Florida, Chapter 29, this volume). Culture also can be interpreted in many other ways. It can refer to organizational culture (Reiter-Palmon, Mitchell, & Royston, Chapter 24, this volume), where the quality of the leader has a big impact (Mumford, Martin, Elliott, & McIntosh, Chapter 25, this volume). It can also mean a school classroom (Beghetto, Chapter 27, this volume).

Positive, Neutral, and Negative Creativity

Obviously, no handbook can cover every possible topic. However, if you've read these chapters, you have a strong handle on the current state of creativity scholarship. What advances or directions can be anticipated or desired in the future? In these times of both promise and turmoil, creativity can be a tool used for positive, neutral, or negative outcomes.

Building off of the ideas of both malevolent creativity (Cropley, Kaufman, & Cropley, 2008) and negative creativity (James, Clark, & Cropanzano, 1999; James &

Taylor, 2010), Sternberg (in press) discusses three types of creativity: positive, negative, and neutral. *Positive creativity* is the generation of an idea or product that is both novel and useful or effective in some way but that also serves a positive, constructive function for the domain or field in which it is useful or effective. Conversely, *negative creativity* is the generation of an idea or product that is both novel and useful or effective in some way but that also serves a negative, destructive function for the domain or field in which it is useful or effective. *Neutral creativity* is the generation of an idea or product that is both novel and useful or effective in some way, and that serves neither a positive nor negative function for the domain or field in which it is useful or effective. An idea or product can be positively creative at one time or in one place and yet negatively creative at another time or in another place. Negative creativity is sometimes distinguished from malevolent creativity, where not only the outcome but also the intention is negative (Cropley et al., 2008). However, sometimes "the road to hell is paved with good intentions." That is, seriously negative outcomes can occur even when scientists or others are trying to do beneficial work.

Because creativity takes place in a social context, positive, negative, and neutral creativity must also be viewed in context. Thus, we need to ask whether a contribution is positive, negative, or neutral in the short or long term (temporal context) and whether it is positive, negative, or neutral globally or merely locally (spatial context). For example, standardized tests in general may be useful locally in a given time and place but when their use is overextended, their usefulness may decrease (Sternberg, 2004). That is, a test score that has one meaning in wealthy suburbs of New York City may carry an entirely different meaning in rural Kenyan villages (Sternberg, 2014). Tests that meant one thing when most of the test-takers were upper-class white males, back in the early 1900s, may mean something else when many of the test-takers are from economically disadvantaged immigrant or other backgrounds where the native language of the test-taker is other than English (A. Kaufman, 2009; Sternberg, 2014).

Pursuing these concepts, we would argue that in science as well as in society as a whole, we have too often valued creativity without considering whether it is positive or negative (or neutral). In science, we can get so caught up in achieving eminence or merely the next step on a promotion ladder that we fail to consider whether the creativity we are exhibiting is truly positive. Is it forwarding science or merely our own eminence, career advancement, bank account, or whatever? Indeed, we so easily can get on a scientific treadmill (or an artistic, literary, musical, or other one) that we do not make the time to think about the uses to which our creativity will be put. By the time we have thought things through, it sometimes is too late to put our creativity to optimal use.

An example in science/technology is the invention of ever more powerful weapons of mass destruction (Sternberg, in press). Some of these weapons are enormously creative – novel and effective (in killing people if that is our goal), assuming our goal is offensive or even to create an effective deterrent. But as Dr. Seuss (Geisel, 1984) recognized in his book *The Butter Battle Book*, such inventions can lead to competition where each side is trying to create weapons that out-destroy the others. People tend to view potentially creative acts that are ambiguously bad as more creative than acts that are clearly bad, with the result that, in psychological science (or elsewhere), people may view research outcomes that are not obviously bad as creative simply because of the ambiguity (Cropley, Kaufman, White, & Chiera, 2014).

What are ways we can best encourage positive creativity, as opposed to negative or even neutral creativity? We will make some suggestions of future areas of exploration in the next section.

Looking Forward

Many different areas study creativity, from business to education to psychology to neuroscience. Several chapters (Lubart et al., Chapter 20, this volume; Simonton, Chapter 22, this volume; Vartanian, Chapter 8, this volume) call for further interdisciplinary collaborations. It would seem like such a goal is more reachable today than ever before. We live in a time of hyperconnectivity, online and virtual interactions, and the capacity to travel and meet new people and share new ideas at an unprecedented scale.

However, such joint endeavors are easier proposed than executed. Most academic rewards (such as promotion and tenure) are centered around publications and grants. Staying within a specific domain and topic is a much safer way to reach these goals. Even when interdisciplinary work is attempted, success is not guaranteed. People can talk over each other or not understand another field's jargon. Many scholars are interested in creativity but may not familiarize themselves with the specific creativity research and end up reinventing the wheel for their own discipline. Indeed, one goal of this volume is to gather a great deal of what we know about creativity in one place.

Even with a shared language, it is hard to proceed with imprecise instruments. As Plucker and colleagues (Chapter 3, this volume) note, some criticisms of current creativity assessment may be overblown yet we still are missing large-scale and well-validated tests. Technology may pose the answer. Several groups have developed automatically scored divergent thinking tests, and methods such as the Consensual Assessment Technique (Amabile, 1996) may also eventually be able to be machine-scored.

Yet, again, even affordable, quick, and accurate creativity tests would advance the field but would not inherently enhance positive creativity. We believe that the principles for distinguishing positive from negative creativity, whether in the short or the long run, are the same principles that have contributed to wisdom over the ages: honesty, transparency, sincerity, following of the Golden Rule (of acting toward others the way one would have them act toward oneself), and of course deep analysis of the consequences of one's actions.

Under these circumstances, developing positive creativity would go beyond what is required for developing creativity that can be positive, neutral, or negative. It would mean additionally asking oneself: (1) What are the benefits of and positive uses to which my work can be put? (2) What can I do to augment the positive uses and benefits? (3) What are the potential harmful effects of my work? (4) What can

I do to mitigate the potential harm? (5) What am I not seeing because I do not want to see it, such as long-term effects beyond short-term ones? That is, developing positive creativity would mean developing creativity leavened by intelligence and wisdom (Sternberg, 2003). It would mean thinking about not just coming up with novel and useful ideas but also what the future implications and uses of these ideas would be.

What are some specific suggestions for how to aim for positive creativity?

Recognize the Role Played by Both Perspective-Taking and Empathy in Creative Actions and Actively Use These Processes to Understand and Respond to the Needs of Others with What Is Being Created

Although the two constructs often work together, they are distinct. Perspective-taking is the ability to conceptualize mental representations of the needs, intentions, and beliefs of others; empathy encompasses the possibility of understanding the emotions and lived experience of other people. There is accumulating evidence that perspective-taking and empathy can mediate both individual and group creative expression (Cross, Laurence & Rabinowitch, 2012; Grant & Berry, 2011; Hoever et al., 2012). Perspective-taking is also central to wisdom (Sternberg, 2013). The perspectival model of creativity (see Glăveanu, 2015) goes further by proposing that all creative expression originates in our capacity to develop new perspectives on reality. These arise when we move beyond our own positions and consider what other people (from specific audiences to the general public) might say or do. This process can open up new possibilities to not only act creatively but develop positive forms of creativity.

This model does not imply that taking the perspective of others immediately or automatically leads to increased creativity. Students may adopt a teacher's perspective for either praise or a better grade and inadvertently constrain their thinking by excluding other outlooks (e.g., Beghetto & Kaufman, 2014). Further, understanding other people's viewpoints does not necessarily mean becoming more empathetic or attending to their needs. Thinking is not the same as doing. We may have insights into prosocial creative possibilities without engaging in such actions.

Nonetheless, we would recommend cultivating an openness to the ideas and beliefs of others and, importantly, developing our capacity to reflect on such differences in perspective. We believe that this process can increase prosocial motivation (Forgeard & Mecklenburg, 2013) and thereby increase the likelihood that a resulting creative product would reflect positive creativity. Further, being open to and mindful of other people is also a key contributor to wise and humanizing forms of creating (Craft, 2006; Sternberg, 2001).

Explore and Pursue Ways That Creativity Can Enhance Fairness and Equity

We live in a world dominated by tests – IQ tests help determine which students get categorized as gifted or learning disabled (A. Kaufman, 2009; Luria, O'Brien, &

Kaufman, 2016). Standardized group tests, such as the SATs or GREs, determine which students get into college or graduate school (Zwick, 2013). People who graduate from the top universities are more likely to get well-paying and powerful jobs (Sternberg, 1996, 2010). Such measures, however, consistently show significant differences between ethnicities and, often, across gender (e.g., Bleske-Rechek & Browne, 2014). Given that most schools use standardized tests and GPA as the largest determinants of who is admitted (and who receives scholarships), these differences are problematic.

Creativity comes into play here in several ways. First, creativity may contribute to these group differences. Several scholars (e.g., Baldwin, 2003; Heath, 1983) have suggested that African American students approach some cognitive ability or achievement tests differently from majority groups due to a cultural emphasis on creative narrative instead of rote memorization. Second, creativity may be a way of increasing minority student performance on such tests. African American students show higher creative self-beliefs than did majority students (J. Kaufman, 2006). Among middle-class students, a different study found that African Americans rated themselves higher on creativity than did Caucasians; the reverse pattern emerged for ratings of intelligence (Ivcevic & Kaufman, 2013). One proposed reason for ethnic differences in cognitive tests is stereotype threat, in which someone is concerned about confirming a negative stereotype about a group with which they identify (Steele & Aaronson, 1995). Stereotype threat can greatly increase stress, which can lead to increased cognitive load, reduced working memory, and subsequent poorer performance on the test itself (Schmader & Johns, 2003). J. Kaufman (2006, 2010) has proposed that if a standardized test is framed as also requiring creativity to perform well, stereotype threat may be reduced.

Third, and most importantly, there are generally few differences in creativity tests by gender (Baer & Kaufman, 2008) or ethnicity (see reviews in J. Kaufman 2015, 2016). If creativity tests supplemented traditional college admission measures, could student diversity be increased? Relevant to the answer to this question is Sternberg's work at Tufts and elsewhere (Sternberg, 2010; Sternberg et al., 2012; Sternberg & the Rainbow Project Collaborators, 2006), in which additional (and optional) measures of creativity, practical intelligence, and wisdom were administered to applicants. These measures not only reduced ethnic differences but also increased applicant quality (including average SAT score). Further, these tests ultimately better predicted college success than traditional standardized tests (Sternberg, 2008). It is our hope that further efforts will continue (especially if creativity tests improve with new technological resources).

Giftedness and school admissions is but one area that creativity can impact fairness. A series of studies has suggested that interventions aimed at increasing tolerance and combating stereotypes also increase cognitive flexibility (Gocłowska, Crisp, & Labuschagne, 2013) and creativity (Gocłowska, Baas, Crisp, & De Dreu, 2014; Gocłowska & Crisp, 2013). In addition, those who endorse racial stereotypes (regardless of their own culture) are less creative (Tadmor et al., 2013). If creativity and equitable thinking are linked, it is possible that moves to nurture creativity may also increase fairness (Luria & Kaufman, 2017). Certainly, this notion is consistent with the extensive evidence that experiences with other cultures increase creativity (e.g., Leung et al., 2008; Saad et al., 2013).

Given that creativity's potential role in increasing fair assessment of students has been studied for decades (Torrance, 1971, 1973), we believe it is overdue to have more scholarship on this topic. If the creative process can further be a vehicle for increasing equity, we again call for more research both in the lab and in the real world.

Develop More Participatory Forms of Creativity That Encourage Collaboration and Co-Creation

The idea that creative processes are not located solely within the creator has a long history, from the systemic models proposed more than thirty years ago (e.g., Csikszentmihalyi, 1999) to more recent models of distributed creativity (Glăveanu, 2014). What these frameworks emphasize is that creativity, from its most mundane forms to revolutionary creations, requires the interaction between multiple elements. Many of these components take place outside the creator and in the material, social, and cultural worlds (as discussed in multiple chapters in this volume). These different facets are not disconnected but co-constitutive. Thus, from a methodological perspective, we should be asking questions and using methods that recognize and maintain this complexity instead of analytically reducing it to different "levels" or "units" of creativity, studied separate from each other (see, for instance, the proposal to move from the Four P's to the Five A's of creativity; Glăveanu, 2013).

What do systematic and distributed views of creativity mean in practice? Such models switch the focus from individual skills and attributes to the person in context. There is an aim to develop networks of creativity rather than study predictors of the creative person. Creativity is seen as a system that involves people, objects, institutions, and has its own specific temporal dynamic. Empowering people to participate in this system, from an early age and independent of domain, is a key concern of this approach (Glăveanu & Clapp, 2018). This perspective aims to overcome the power disbalances that prevent collaborating on equal terms. It entails being mindful that one's own creative expression should not result in stifling the creativity of others. We believe that being creative in ways that enable others to be creative in turn is a necessary, albeit not sufficient, condition for positive creativity. We hope to see further work within these approaches.

Highlight New and Understudied Positive Outcomes of Creativity, Including Increased Personal Well-Being and Purpose

The majority of studies in this field analyze the factors that predict creativity (Forgeard & Kaufman, 2016). Research that does focus on positive outcomes of creativity tends to stick to the same basic constructs, such as GPA (Gajda, Karwowski, & Beghetto, 2017). We argue that although these studies and outcomes are important, we need more ways to demonstrate that creativity merits the time, resources, and financial investments of organizations, schools, and families. Certainly, fairness and equity are potential additional positive outcomes. There are many more, and we believe that the more we can present a plethora of reasons why creativity is a uniquely powerful and beneficial attribute, the more we can increase not simply its appeal but also more investment in its study and development.

The concept of creativity helping well-being has been around for decades (Maslow, 1943; May, 1994/1975) but actual empirical studies of the healing powers of creativity (Forgeard, Chapter 15, this volume) have only become common relatively recently. Studies have been conducted on a variety of topics related to positive well-being. One of them is creativity's role in post-traumatic growth, or the ability to recover and even thrive after a terrible life event (Forgeard, 2013). Another stream of research is on expressive writing, sometimes called the writing cure (Pennebaker, 1997). Writing on a regular basis, particularly if a general narrative is followed (which could be a fictional story or a diary-like narrative of one's life), produces both mental and physical health benefits (Pennebaker & Seagal, 1999; Travagin, Margola, & Revenson, 2015). Art therapy, long used in clinical practice, has also been the subject of empirical advances. Evidence for both its usefulness and its underlying mechanism (namely, that it helps distract people from their troubles, as opposed to providing an emotional outlet) has shed tremendous insight in recent years (Drake & Winner, 2012, 2013).

Another possible area is how creativity can enhance a person's meaning of life (Kaufman, 2018). People find meaning in many ways; these can include coherence (making sense of one's life), significance (feeling as though one's life has been valuable), and purpose (having goals for the future; Martela & Steger, 2016). Creativity can help in all of these ways, whether someone understands their life by writing a narrative (McAdams, 2013), enjoys their life with the optimal experience of Flow (Csikszentmihalyi, 1996), or uses creativity as a way to leave something behind for family, friends, or the world after their death. We are eager to see additional work that explores how creativity can actively enrich the quality of people's lives.

Conclusion

Being creative is uncomfortable – it potentially involves defying the crowd, defying oneself, and defying the Zeitgeist (Sternberg, 2018). People always have been afraid of being creative, because it entails risk and ambiguity. People who are creative run the risk of displeasing their teacher or supervisor, of experiencing mortification if their creativity is rejected (Beghetto, 2014), or of being successful and drawing jealousy and contempt.

Psychological science and the world at large need *positive creativity* more than ever before. We argue that future scholarship needs to continue to address how we can encourage positive creative thinking to flourish and be accepted. As technology makes it possible for our work to reach larger audiences than ever before, we have a responsibility in how we approach this field. We hope that the next generation of creativity researchers will take this advice to heart. We hope that they not only conduct outstanding studies and devise powerful theories but also make sure that their efforts contribute to a better world and not simply a better vita.

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Index