Cognitive science

Cognitive science is usually defined as the scientific study either of mind or of intelligence (e.g. Luger 1994). Practically every introduction to cognitive science also stresses that it is highly interdisciplinary; it is often said to consist of, take part in, and/or collaborate with psychology (especially cognitive psychology), linguistics, neuroscience, artificial intelligence (neural network research in particular), and philosophy (especially philosophy of mind and philosophy of mathematics, but also with applications in philosophy of science).

Overview

Cognitive science tends to view the world outside the mind much as other sciences do; thus it has an objective, observer-independent existence. Cognitive science is usually seen as compatible with and interdependent with the physical sciences, and makes frequent use of the scientific method, as well as simulation or modeling, often comparing the output of models with aspects of human behavior. Still, there is much disagreement about the exact relationship between cognitive science and other fields, and the inter-disciplinary nature of cognitive science is largely both unrealized and circumscribed.

Cognitive science has much to its credit. Among other accomplishments, it has given rise to models of human cognitive bias and risk perception, and has been influential in the development of behavioral finance, part of economics. It has also given rise to a new theory of the philosophy of mathematics, and many theories of artificial intelligence, persuasion and coercion. It has made its presence firmly known in philosophy of language and epistemology - a modern revival of rationalism - as well as constituting a substantial wing of modern linguistics.

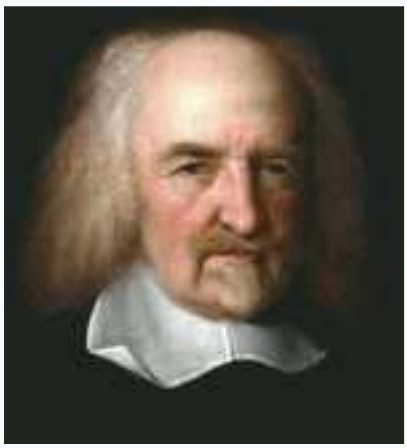
Cognitive science?

The term "cognitive" in "cognitive science" is "used for any kind of mental operation or structure that can be studied in precise terms." (Lakoff and Johnson 1999) This conceptualization is very broad, and should not be confused with how "cognitive" is used in some traditions of analytic philosophy, where "cognitive" has to do only with formal rules and truth conditional semantics. (Nonetheless, that interpretation would bring one close to the historically dominant school of thought within cognitive science on the nature of cognition - that it is essentially symbolic, propositional, and logical.)

The earliest entries for the word "*cognitive*" in the OED take it to mean roughly *pertaining to "to the action or process of knowing"*. The first entry, from 1586, shows the word was at one time used in the context of discussions of Platonic theories of knowledge. Most in Cognitive science,

however, presumably do not believe their field is the study of anything as certain as the knowledge sought by Plato.

Philosophy



"By ratiocination, I mean computation." -Thomas Hobbes (1651)

Many but not all who consider themselves cognitive scientists have a functionalist view of mind/intelligence, which means that, at least in theory, they study mind and intelligence from the perspective that these attributes could perhaps (at least someday) be properly attributed not only to human beings but also to, say, other animal species, alien life forms or particularly advanced computer sytems. This perspective is one of the reasons the term "cognitive science" is not exactly coextensive with neuroscience, psychology, or some combination of the two.

Theories

- dualism
- materialism
    - functionalism
- mind/brain identity
- quantum mind
- *Modularity of Mind*

Mind/brain identity theory

The mind/brain identity theory is the idea that, whatever "mind" and "intelligence" are, they are rooted strictly in the brain, and do not make use of, depend on, or interact with anything non-physical. Nonetheless, there is reasonable consensus that there is sense in talking about the organization of the mind without talking about the organization of the brain, and that cognitive scientists are not simply neuroscientists. Often the justification for this takes place by reference to different levels of analysis. A cognitive scientist is likely to assert that what he says about reasoning is true at the symbolic level of abstraction, while what the neuroscientist says is true at

the physical level implementing the symbolic level (much like a computer as a physical object implements a virtual machine on which a word-processor runs). An exploration of this is found in the Chinese Room argument, which proposes a gedanken experiment to elucidate potential loci for "cognition".

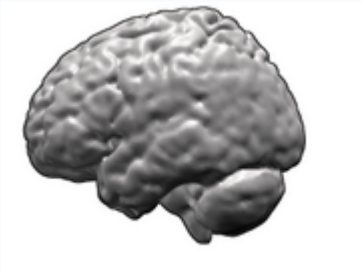
Quantum mind theory

There exist several different quantum models of mind. In one class, the brain is considered a quantum machine; in another, the brain is a classical machine that reduces the universal consciousness function.

Biocognitive theory

A model proposed by Mario E. Martinez in which cognition, biology and historical culture coemerge as an inseparable bioinformational field that contextualizes personal reality and influences health and longevity. The theory of biocognition draws from the research in psychoneuroimmunology and medical anthropology.

Psychology



Rendering of human brain based on MRI data

Particular subtopics of Cognitive Science arguably include perception, attention, consciousness and memory. However, these are all long established fields within psychology, and there is a constant risk that cognitive scientists will merely reinvent discarded psychological analyses under a new vocabulary.

As described, Cognitive Science is an expansive and exhilarating vista. However, it should be recognized that cognitive science is not equally concerned with every topic which might bear on the nature and operation of the mind or intelligence. Social and cultural factors, emotion, consciousness, animal cognition, comparative and evolutionary approaches are frequently de-emphasized or excluded outright, often on the basis of key philosophical conflicts. Some within the Cognitive Science community, however, consider these to be vital topics, and advocate the importance of investigating them.

Experimental methods

- reaction time

The time between the presentation of a stimulus and an appropriate response can indicate differences between two cognitive processes, and can indicate some things about their nature: e.g., if reaction times vary proportionally with the number of elements in a search task, then it is evident that the search task involves serial processing and not parallel processing.

- Psychophysics

Psychophysical experiments are an old psychological technique which have been adopted by cognitive psychology. They typically involve the elictation of verbal judgements of some physical property, e.g. the loudness of a sound.

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    - sameness judgements for colors/tones/etc
    - threshold differences for colors/tones/etc
- brain imagery by means of
    - EEG
    - Positron emission tomography (PET)
    - fMRI
- scores/wins/losses in games
- recording bodily movements in response to a task (e.g. walking towards an object)

Key findings

(partial list)

Discovery of systemic human cognitive bias, usually credited to Amos Tversky and Daniel Kahneman, 1967. Basis of behavioral finance.

Assertion of equivalence of Euler's identity (basis of complex analysis in mathematics) with basic cognitive processes, George Lakoff and Rafael E. Núñez, 2000. Basis of cognitive science of mathematics.

Theories

- Cognitive response theory
- Cognitive dissonance theory
- Cognitive consistency theory
- Cognitive science of mathematics
- Propaganda
- Attitudes and Affection

Linguistics

Noam Chomsky

Linguists find on one hand that people - even the young and the uneducated - form sentences in ways seemingly governed by very complicated rule systems. On the other hand, the same people are remarkably inept at identifying the rules that lie behind their own speech, and linguists must resort to very indirect methods to determine what those rules might be. Thus, if speech is indeed governed by rules, those rules seem to lie below conscious consideration.

Noam Chomsky

- grammaticality judgements

The primary basis of Chomskyan psycholinguistics is the grammaticality judgement. A native speaker of a language is asked whether or not a sentence is grammatically correct, independent of whether or not it makes sense (e.g., 'colorless green ideas sleep furiously.') Collections of these grammaticality judgements are used to generate putative formal (purely syntactic) descriptions of human languages in terms of grammars. (For more on what these are, see formal language, Chomsky hierarchy.) These grammars, in turn, are held to describe the speaker's linguistic competence. Other approaches to linguistics have characterized this approach as too artificial (at least as an exclusive linguistic program), questioning the meaning of grammaticality judgements, a much too frequent emphasis on English grammar, and the exclusive use of orthographic (written) rather than verbal sentences.

Artificial intelligence

Main article: Artificial intelligence

Goals

Strong AI versus Weak AI

- simulation vs recreation

Turing test.

Theories

Symbolic vs Connectionist approaches There is some debate in the field as to whether the mind is "best" viewed as a huge array of small but stupid elements (i.e. neurons), or as a collection of higher-level structures, such as "symbols", "schemas", "plans", and rules. One way to view the issue is whether it is possible to accurately simulate a human brain on a computer without accurately simulating the neurons that seem to make up the human brain.

Symbolicism/GOFAI

Artificial intelligence. Turing machine. Chinese Room. Minds, Machines and Gödel.

Connectionism

Connectionism. Neural nets.

Dynamical systems

Dynamical systems theory of cognition (special application of dynamical systems theory).

Notable researchers in cognitive science and related fields

- Maggie Boden
- David Chalmers
- Noam Chomsky
- Kenneth Craik
- Antonio Damasio
- Daniel Dennett
- Gerald Edelman
- Leon Festinger
- Jerry Fodor
- Tim van Gelder
- Douglas Hofstadter
- Edwin Hutchins
- Daniel Kahneman
- David Kirsh
- George Lakoff
- Colin McGinn
- George A. Miller

- Marvin Minsky
- Rafael E. Núñez
- Seymour Papert
- Roger Penrose
- Steven Pinker
- Jonathan Potter
- Karl Pribram
- Vilayanur S. Ramachandran
- John Searle
- Herbert Simon

See also

- Neural Darwinism
- Society of Mind theory
- cognitive science of mathematics
- cognitive bias
- cognitive neuropsychology
- cognitive neuroscience
- notation bias
- neural networks
- neuropsychology
- computational neuroscience
- simulated consciousness
- artificial consciousness
- artificial consciousness NPOV
- Important publications in cognative science

External links

- Stanford Encyclopedia of Philosophy: Cognitive Science (*http://plato.stanford.edu/entries/cognitive-science/*)
- List of leading thinkers in cognitive science (*http://carbon.cudenver.edu/~mryder/itc_data/cogsci.html*)
- MIT CogNet (*http://cognet.mit.edu/*)
- Center for Cognitive Science, Rutgers University (*http://ruccs.rutgers.edu/*)
- Institute for Research in Cognitive Science, University of Pennsylvania (*http://www.ircs.upenn.edu/*)
- Department of Cognitive Science, University of California, San Diego (*http://cogsci.ucsd.edu/cogsci/*)
- School of Informatics, University of Edinburgh (*http://www.inf.ed.ac.uk/*) (Centre for Cognitive Science has been merged into this school)
- Bandung Fe Institute:Cognitive Science (*http://cogsci.bandungfe.net*)

References

- George Lakoff and Mark Johnson. *Philosophy In The Flesh*. Basic Books, 1999.
- Luger, George. *Cognitive science : the science of intelligent systems*. San Diego : Academic Press, c1994
- Bechtel, W. et. al. Ed. (1999). A Companion to Cognitive Science. Blackwell Companions to Philosophy. Malden, Massachusetts. Blackwell Publishers.
- Gardner, Howard. (1985). The Minds New Science. Basic Books.
- Baumgartner, P., et. al. Eds. (1995). Speaking Minds: Interviews With Twenty Eminent Cognitive Scientists. Princeton, New Jersey, Princeton University Press.
- Damasio, A. R. (1994). Descarte's Error: Emotion, Reason and the HUman Brain.
- Gazzanija, M. S., Ed. Conversations in the Cognitive Neursciences. New York, THe MIT Press.