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THE PSYCHOPHYSIOLOGICAL BASIS FOR TWO KINDS OF INSTINCTS

Implications for Psychoanalytic Theory

JOHN C. LILLY, M.D.

COMMUNICATION RESEARCH INSTITUTE
3908 Main Highway, Coconut Grove
Miami 33, Florida

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JOHN C. LILLY, M.D.[1]

INTRODUCTION

In recent years the brain systems which underlie and produce the phenomena called instinct have been delineated. For the first time the systems, which when stimulated cause either various kinds of pleasure or various types of negative avoiding, painful or fearful reactions, have been discovered and studied in great detail. Work has been accomplished on rats (16), cats (23, 1), monkeys (1, 7), dolphins (8), and in humans (20, 21), which has far-reaching implications for the systematic development of the theory of instincts.

In this paper the levels of discourse must be very carefully delineated to avoid confusion. Experiments using rats, cats, and monkeys involve extremely simple nervous systems compared with those of the human and of the dolphin. The phenomena elicited are completely reproducible. The responses to stimulation of the rat brain are simple and amazingly repetitive kinds of behavioral patterns: the cat introduced slightly greater variability; and the monkey steps up the complexity considerably. However, it is not until one investigates a brain comparable in size with that of the human that the full range of human complexity, which is dealt with in psychoanalysis, is achieved. The phenomena of speech, of writing, of love and hate, of mental symbols, etc., do not appear in

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[1] Communication Research Institute, St. Thomas, U. S. Virgin Islands; formerly, National Institute of Mental Health, Bethesda, Maryland.

the lower animals, so far as can be determined. There is no doubt that analogous types of emotional states exist in these lower animals, such as the anger, fear, pleasure, love, etc., existing in the human. Therefore, the achievement of extremely great variability of responses, numerous degrees of freedom, and vast storage of experiences are possible only with the very large brain of the human and of a few other animals.

Practically all of the richness of reasoning, rationalization, thinking, and similar matters dealt with in the classical psychoanalysis are completely unavailable in animals other than the human. Practically all of the evidence to date for a psychoanalytic theory of instinct has been derived from the case of the human (2). In this sense, then, animal research has very little to add, except by analogy (4, 17, 18).

The human brain has buried within it systems subserving instincts which seem to be present in these smaller-brained animals. Since these systems are more fully developed in the human than in lower animals, their reactions and possible activities are more complicated. The biological substrate for the human kind of instincts, however, persists throughout a phylogenetic series (of mammals, at least). If one accepts the principle that the smaller brain has fewer degrees of freedom of action and reaction, but has instinctual reactions basically similar to those of the larger brain, then the following results of some animal research can be applied to human theoretical psychoanalysis.

Reward and Punishment Systems in the Brain

In working with electrodes implanted in specific areas in a monkey's brain, one can observe reactions which resemble extremely closely various things seen in and felt by humans under extreme conditions. Animal tests now show these to be true emotions felt by the animal (5, 6, 7). Work with humans in stimulating these same systems has corroborated the conclusions from the animal research: these reactions are indeed true emotions rather than "sham" or pseudo-affective reactions (13, 20, 21, 22).

Stimulation of a specific system within the hypothalamus can

cause the monkey to look and act frightened. If presented with a potentially threatening object, which previously caused him pain, he will attack it so violently that he can tear the teeth out of his jaw. This response only occurs in this system. The same object presented without stimulation causes no reaction whatsoever, other than bored withdrawal from it. When electrical stimuli are introduced into adjacent systems within the hypothalamus, the animal can take an inordinate amount of interest in the same object; seek it out, handle it, and become extremely attached to it, in the emotional sense (5, 6, 10).

Stimulation of the human brain in these same systems causes an intense terror in the region of the midline hypothalamus and an intense sense of well-being from the second area (21). In the case of the human, however, the objects that are given closest attention are the physicians and technicians who are stimulating the brain, rather than any other objects in the environment. Stimulation of the reward system immediately causes an intense talking session and intense signs of pleasure, such as smiling, joking, and carrying on activities in the vocal and the exchanging spheres with other humans. Also, if the terror-response area is stimulated, anger results and is directed at the human targets rather than at any portion of the inanimate surroundings.

If one contrasts the cat and the monkey, the cat when stimulated in these areas will strike at anything and everything surrounding it, especially any moving object. There is not the differentiation of the target itself from the surroundings which there is in the monkey. In the monkey there are not the responses in the vocal sphere that we have in the human.

Stimulating the brain of an animal which is as complex and as large as that of the human, such as in the dolphin or porpoise, one finds that there is an immediate reaction to the humans present and a complex output in the vocal sphere, analogous to that in the human. Stimulating the reward-producing systems in these animals allows an investigation of the complexity of their reactions which remind one very much of the complexity of the reactions of humans. These animals apparently do not use facial expression the way we do, nor do they have hands to use the way

a human does; therefore, certain human modes of expression are missing.

Reward Systems

The following points seem to be well established at the present time with regard to electrical stimulation of the brain in these various animals:

1. Anteriorly, in a system which in the human lies just inside the frontal pole, above orbital cortex, and below frontal cortex, and about 1 cm. lateral to the mid-plane, there is a reward system which is found in the cat, the monkey, and the dolphin as well as the human. During stimulation there is a psychic sense of intense well-being generated which is not tied to any particular aspect of either the body or the environment but diffuses through the whole of the mental life.

2. Posterior to this system in the globus pallidus and similar nuclei, but still lateral to the mid-plane, is another portion of the so-called reward systems. However, this system gives a localized intense sense of pleasure in various parts of the body. This feeling is referred to the skin and muscles of one arm or one leg, for example, depending upon the part of the nucleus being stimulated.

3. Returning to the more forward portion of the brain, further below, in and near the hypothalamus, other kinds of pleasure can be elicited. For example, sexual pleasure and erection in the male can be elicited by stimulation near and in the septal region (10, 13a).

4. In other regions of the hypothalamus, the rewards as if quenching of thirst and as if eating of food when hungry, are found in the mediolateral hypothalamus (15, 7).

5. Moving posteriorly into the mesencephalon, the rewarding aspects of orgasm are found. The animals are driven to self-stimulate in this area of the brain more strongly than in any other: stimulation leads to a generalized seizurelike episode in which the animal passes out, comes to, and barks, looks around for the switch to elicit once more the same reaction (7, 10). Stimulation of this portion of the system wears him out extremely rapidly and forces him to sleep for many hours afterward. Stimulation

near this region in the human caused ejaculation in two episodes (22), but apparently the stimulation was not pushed far enough to cause a full-blown orgasm with all of the mental concomitants and the loss of consciousness.

Punishment Systems

In the punishment (negative) systems, the instinctual emotional reactions that are elicited are as follows:

1. In the mid-plane hypothalamus, in the preoptic region and in the walls of the third ventricle is a system subserving fright, terror, and panic (3, 5, 6, 7, 10).

2. As one proceeds posteriorly in the hypothalamus, the system changes to intense localized pain distributed to various parts of the body (7, 10, 11). There is apparently a pain map of the whole body surface within this system extending posteriorly toward the mesencephalon (11).

3. Farther laterally in the hypothalamus there are systems which cause nausea and others which can rapidly induce fatigue after a few seconds of stimulation. This fatigue is so profound that the animal, if undisturbed, will fall asleep and sleep from twenty minutes to half an hour (3, 7).

Relations to Other Brain Systems

In view of the complexity of these results, it is wise at the present time not to attempt to construct too much theory before the details of these explorations of the brains can be completed. We can make the following statements:

1. There are two kinds of systems within the brain: one subserves rewards, pleasurable sensations, and activities; and the other subserves punishments: painful, and angry kinds of sensations, activities, and reactions.

2. When spots of extreme neuronal activity are introduced into these systems, the emotion or the instinct develops fully. In experiments with implanted electrodes, we are introducing such intensely active spots of neuronal activity within these systems.

3. Research to date on the connections of these systems with

other parts of the brain have demonstrated that there are thorough two-way connections between all of these systems and cortex and with systems lower down within the brain stem and spinal cord. Modern techniques such as those of Nauta (14) show an imposing richness of connections in most directions between these systems.

4. Therefore, it is perfectly possible for any other kind of activity elsewhere in the brain (acoustic, for example), if sufficiently concentrated, to pour enough impulses into these systems to cause them to be as extremely active as weak electrical stimuli.

We can visualize with the modern view the following series of events in regard to an intensely emotional reaction of a man experiencing fear: There is an explosion and a bright flash of light. After impulses from these two physical events travel over the acoustic and other neurones and through the lower centers, there is an immediate stimulation of a high degree of activity in the emotionally important systems mentioned above (12). In the process of allowing such circuits to be increasingly or decreasingly active, past experience and early experiences, especially, determine both the outcome and how much activity will be facilitated in a continuing fashion within the lower "emotional" systems. An experiment with a monkey can illustrate a few of the many thousands of reactions possible from cortex.

Weak Reward and Punishment from Cortical Stimulation: Multiple Cortical Functions

Using an implanted electrode in the cortex of a monkey, I demonstrated that at very low levels of stimulation, the monkey liked it and would push a switch in order to stimulate this area of cortex himself. However, if something which he also likes came into the neighborhood, such as food, he would abandon this lever, eat the food, and then go back to lever pressing. As the amount of current was increased, the sign of the motivation went from positive to negative: he would now shut off a stimulus which I would introduce with the apparatus in the same spot. Once again, however, this was not so demanding that he could not pay attention to other things in his environment and make use of other

kinds of previous learning. If simultaneously one stimulated one of the lower centers at a level which captured his interest, either in a positive or negative sense, and one of the cortical spots, the latter was completely neglected in favor of the more demanding lower systems. The threshold for these various effects in the cortex was below the threshold for motor movement elicited in the same spot, that is, specific motor movements tied to that particular spot and tied to each stimulus train. Stimulating the lower centers in a similar fashion, either in terms of rewarding or punishing systems, one could obtain almost complete exclusion of the external reality; the experience inside is far more powerful than that from external reality.

Stimulating a human brain in the same manner leads, as has been reported by Penfield (19), to the patient remarking that, "You, or something outside of me, is causing movement of my arm—I am not willing it myself." Stimulation of the lower centers leads to a complete taking over of the ego by extremely emotional reactions, with immediate taking up the initiative. However, there is no loss in the knowledge that the doctor is causing the stimulation within. For example, during stimulation in the fright area, one patient said, "If you do that again, I will tear the electrodes out of my head." Possibly if one increased the intensity, as we have in animals, the man would be quite incapable of using his knowledge to threaten and would attack or flee.

Implications for Psychoanalytic Theory

In the past there have been attempts to assign specific areas of the brain to id, ego, and superego. On the face of it, this seems to be nonsense: one should make much more of a functional kind of division of systems in the brain, not a division from just one massive part to another massive part. As long as there are the natural interconnections, the brain is operating as a total whole. We only have fractions of ego functions, a very small proportion, in the lower systems. The major stores of memory seem to be in the extremely large cortex; at least, not much of the total memory could be stored in the much smaller lower systems. Id functions can be elicited in a most pure form by stimulation of the

lower systems as mentioned above, but there is a full participation of all the brain. There is a sprinkling of these functions throughout the brain with a more attenuated set within the cortex. Since there is an expansion of pathways as one moves from the lower centers out to cortex, stimulation of a small area of cortex would not give the same effects as stimulation deep within the smaller systems. With many, many thousands of electrodes in the cortex one may be able to cause exactly the same kinds of reactions as one can cause by stimulation deep within the subcortical systems.

As presently viewed, the cortex seems to be extremely well differentiated in terms of the projection of external reality upon its multiple-folded surface. The ego processes seem to be predominantly stored and used within this huge structure. However, one cannot conceive of any ego functions existing without some sort of rewarding and/or punishing effects going on concomitantly and continuously. One, as it were, must *like* to talk before one *will* talk; or one must be *forced* to talk in order to terminate a punishment. It seems as if the rewarding and punishing systems must be continuously operative in greatly differentiated detail in all aspects of waking and sleeping life.

There may be an excess of the rewarding activities, i.e., libido, in order to keep the organism operating toward survival (8). Any time we caused too much activity for too long a period in the negative systems in the monkey, it looked as if we were going to end up with a dead monkey. He would give up all initiative, become extremely sick, and withdraw from all participation with us. This picture could be completely reversed by inducing hyperactivity in a small part of a rewarding system: within a few minutes we could reverse a behavioral state, which if allowed to continue would lead to irreversible clinical changes. Once started on a downhill course, the negative systems seemed quite capable of killing the organism: the seeds of destruction of the whole animal lie within its own brain, just as the seeds of its survival are also present (7).

These results and further results too lengthy to discuss in this paper force one to derive two kinds of systems: one negative and one positive; in other words, at least two kinds of basic instincts:

positive and negative; rewarding and punishing; loving and hating. There seems to be no satisfactory theoretical alternative.

"Rebound Phenomena"

One can show that the cessation of rewarding stimulation can act as a mild punishment, but it cannot act, at least in the animals with which we have dealt and in the humans, as a punishment as intense as stimulation of the negative systems themselves. Similarly, cessation of active stimulation of the negative systems can act as a mild reward but never with an effect as great as direct stimulation of a rewarding system. A dolphin will stimulate his own brain in the rewarding systems for hours. When we shut off the current, so that he can no longer self-stimulate by pushing a lever, he will immediately vociferate in spite of the fact that he has been quite silent while working with the lever. A human being will react similarly and ask, "Why do you shut off the current?" and then go on and make all sorts of remarks concerning the situation. But if one stimulates the negative systems, there is an obvious screaming terror and one has no alternative but to say that the two states are at opposite poles with regard to instinctual activities. The former leads to obtaining more of the stimulation and the latter leads to its termination: avoidance or escape from the stimulation. The first is intensely pleasurable; the second is intensely nonpleasurable: antipleasurable, painful, fearful, or anger-causing.

I call these "rebound" phenomena and visualize one possible explanation: during intense stimulation of one kind of system (A) the activity in the other kind of system (B) also increases but not in proportion: there are controlled two-way connections (A⇌B) between the two kinds of systems which become active. Hence, one kind of function (A) is existing in greater quantity than the other (B). If the intense stimulation then ceases in (A), the intense activity in (A) for a short time decreases more rapidly than the milder activity in (B). The activity in (A) may be less than is usual. For a time the activity in (B) is then more intense than that in (A), and the opposite function predominates.

There may be ways of so influencing the young vulnerable

animal that one can cause the permanent lowering of the thresholds for starting and/or maintaining intense, continuing activities in either or both kinds of system. Such "programmatic" effects may generate the ultimate picture of the kinds of character; the choice of kind and form of psychosexual development; and the predominating algebraic sign of the personality, positive or negative. The total maintained activity in both kinds of systems without provocation may be the basic determinant of the "strength of instinctual drives" so necessary for challenge to and mastery by the developing ego. All of these systems, of course, are in the absolutely unconscious but psychodynamic parts of the mind: only by indirect means can their operations be influenced.

In the light of the above experiments and results, the concept of "cathexis" *("Besetzung")* is still a useful one if we realize that the emotional "charges" can have two signs: positive (for a rewarding object or idea, etc.) and negative (for a punishing object, or idea). In pure form, a purely rewarding idea, process, person, or object is wanted again and again; a purely punishing one is rejected, retreated from, and destroyed. However, there are practically no such pure forms existing, except in fantasy, in dreams, in the unconscious, and in the primary process. The reality principle insists that one endow a means of starting a rewarding situation with a positive "reward" charge but that one also so endow the means of terminating negative punishing situations with a positive charge. A monkey loves (positive charge) his switch which he uses to *start* his rewarding stimuli, but also he loves the switch which he uses to *stop* the pain or fear stimuli. In the opposite modes, he dislikes (even hates) the person or apparatus which starts his fear or pain stimuli or similar objects which stop his rewarding stimuli. Signals associated with these various kinds of events take on charges of the same sign, somewhat attenuated. These are the simple reasonable logical combinations: repetitions cause only deepening and strengthening of the bonds and not the development of "perverse" values, such as taking intense pleasure in punishing situations, or hating or fearing pleasures.

In real life very few things, processes, or persons are either purely rewarding or purely punishing: the electric stimuli in the brain allow us to create the pure cases discussed. The psychic

"cement" binding us to our images and to reality is positive to enable us to start work on them and is later negative to enable us to stop when enough has been done within physiological healthy limits. Probably the term "cathexis" should be redefined to encompass both aspects of our being bound by and our binding of psychic objects: "for now I want, need more, but soon I'll want it stopped." Each of these two aspects is an active process, each in its own brain system.

Such basic thinking can be applied to clinical and theoretical problems and may be helpful if one also applies all the other knowledge of psychoanalysis. The complexity of the experienced human animal is fantastically great: the above facts and formulations may eventually be integrated into our greater understanding of patients.

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