THE CONCEPT OF TRANSACTION IN PSYCHOLOGY AND NEUROLOGY

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No single word in the English language satisfactorily carries the meaning embodied in what the ancient Greeks expressed by *genesis*, "the process of becoming." They used the concept to characterize the on-going changes exhibited by all forms of life in their progress from birth, through growth and maturation, to old age and death. Like the movement of the hour hand on a clock, these changes in the living organism may take place so slowly as to be imperceptible to the casual observer, although with the lapse of time it becomes apparent that the organism has been constantly changing into something different than it was before. A comparable "process of becoming" can be observed in certain inorganic materials, such as the radioactive elements, radium, for example, being involved in a complex chain reaction which, on completion, is transformed into lead leaving no trace of its original elemental identity.

This on-going change in life is not a haphazard process but proceeds in a discernible direction, conforming to a progressive outline determined by the pattern of elements, of genetic structure, of built-in rhythms, or of motives as these all play their role in the orchestration of living.

The Concept of Transaction

The philosophers Dewey and Bentley have suggested that the word "trans-action" be used to designate any "process of becoming" in which the individual or "thing" is itself undergoing alterations by action through time when involved as a participant in any on-going situation. They reserve the word "inter-action" to refer to those simpler forms of action taking place "between" elements, or "things" in which the outward aspect of the "thing" may be altered although its own elemental nature is not changed. Dewey and Bentley (6) maintain that scientific thought during the nineteenth century primarily emphasized interactions or reactions *to*, while interpretive thinking of the twentieth century is more characterized by the concept of transaction, or action *within*, *through*, *of* and *by* an environment in which the participating individual is himself an integral part.

One objection to this use of the word "transaction" is that few dictionaries and few individuals make any fundamental distinction between transaction and interaction. Most of us think of transaction as it is used in commerce to designate some relatively simple act of exchange, such as buying or selling, which neither implies any profound affect on the participants nor emphasizes the factor of time. To give the word the meaning Dewey and Bentley ascribe to it may seem an arbitrary notion, recently concocted. Yet this meaning for the word transaction goes back more than a century before the birth of Christ when the Greek historian Polybius of Megalopolis wrote that if anyone really wanted to understand history, he must study its "transactional" branch. Arnold Toynbee (15, p. 44), an admirer of Polybius, believes Polybius coined the word to characterize his own descriptions of the Roman conquest which was his principal topic of interest.

Polybius was frankly critical of contemporary historians who gave discrepant versions of identical events or who "failed to refer to the starting point showing how and why that point led up to the transactions of the moment." Polybius wrote:

> The monographs of the historical specialists give no inkling of the whole picture, and if any reader supposes that a survey of the leading countries in isolation from one another, or rather, the contemplation of their respective chronicles, can give intuition into the scheme of the world in its general setting, I must hasten to expose his fallacy. To my mind, persuasion that an acquaintance with local history will give a fair perspective of the whole phenomenon is as erroneous as the notion that the contemplation of the *disjecta membra* of a once living and beautiful organism is equivalent to the direct observation of the organism itself in all the energy and beauty of life. I fancy that anyone who maintains such a position would speedily admit the ludicrous enormity of his error if the organism could be revealed to him by some magician, who reconstituted it at a stroke in its original perfection of form and grace of vitality. While a part may conceivably offer a hint of the whole, it cannot possibly yield an exact and certain knowledge of it (15, p. 46).

We find the concept of transaction as used by Polybius a particularly apt one to give us a somewhat better toe hold in our understanding of the broad implications of many recent investigations both in psychology and neurophysiology that have a bearing on the ancient problem of mind-brain relationships. If we start from the premise that behavior and neural activity can be correlated without invoking any Cartesian dichotomy, we need a term to describe the processes—and the significance of the increasing evidence for them—characterized by the change and alteration of the participants in those processes and the directional development they show.

PERCEPTION AS TRANSACTION

The basic problem of "how" an individual perceives the external world around him has preoccupied many psychologists for many years since even the simplest perception is an enormously complex activity involving a wide variety of factors (3). Among the factors except for which perception would not serve as the meaningful signal it is, we would list the following:

1. Some sort of "*externality*"—some object, person, symbol, etc. in the world outside the individual.

2. Some *physical energy* related to this "externality," which has the capacity to initiate a physiological process in the sense organs, as, for example, the light rays reflected from an automobile we see coming down the street.

3. Some *physiological excitation*, including the stimulation of peripheral nerve endings and the entire path of neural transmission both leading to and coming from the higher neural centers.

4. Some *assumptions*, or weighted averages derived from past experience, that have been somehow registered in the nervous system and are activated by the particular situation we are confronting, and that indicate the probability that what *is* "out there" is what we *assume* is "out there."

5. Some *purpose* or some *intention* that catalyzes the individual to pay attention in order to experience or to avoid a particular consequence.

We can focus our discussion by mentioning only three broad and divergent interpretations of the various theories formulated in the effort to answer the question of how we perceive the environment around us.

First, there are the theories that emphasize the native capacity of the sense organs to transmit to the brain the elementary attributes of the external object, such as its size, shape, color, brightness, etc., with the brain somehow compounding these into a "perception" of that particular object. Second, other psychologists do not believe a perception represents a summation of separate attributes but, rather, that the external object and its field constitute a single pattern, form or Gestalt which dictates what the perception must be. According to this hypothesis, the sensory systems transmit this intact stimulus pattern to the brain where it creates a perception that is a replica of reality. Third, there are psychologists who feel that these two interpretations greatly underemphasize the contribution the perceiving individual makes in shaping his own perceptions and who doubt that either the physical attributes of the external object itself or intact stimulus patterns are the dominating factors in perception. They stress, on the other hand, the crucial role played by assumptions, derived from past experience, which an individual brings to every situation concerning the probable significance of the stimuli the sense organs receive.

Each of these three general approaches to perception is in a sense correct as far as it goes: our senses are adapted to transmit some of the elementary attributes of external objects; certain stimulus patterns may be registered in the brain as reasonably accurate replicas of the external object and its field; and the assumptions we make about the significance of a stimulus certainly do often play a crucial role in the final meaning we assign to what we perceive.

While the proponents of any one of these approaches might have a wider conception of their theory than the emphasis epitomized here, each approach could become more adequate and more valid if it were more inclusive. For example, the Gestalt approach could readily subsume the approach of those who stress subjective factors in perception, if it included the notion of an "internal" or "longitudinal" Gestalt built up in the individual in the course of his past experiences, while the subjectivists would be more convincing if they did not at times appear to neglect the fact that one cannot perceive a square as a circle and that many perceptions do seem to become organized into a figure-ground Gestalt.

THE FUNCTIONING OF THE CENTRAL NERVOUS SYSTEM AS A TRANSACTIONAL PROCESS

The most crucial test of any of these or other interpretations of the process of perception would be to know how they fit our knowledge of what the brain is doing. The cybernetic theory with its concept of "feed-back" has provided useful models of what may be going on in the brain. Yet the evidence so far of the activities of the brain seem to indicate that there is far too much plasticity and flexibility to conform to any strictly mechanistic operation. In the past decade, teams of investigators composed of psychologists, neurophysiologists, pharmacologists, anesthesiologists, and computer specialists have developed increasingly sophisticated techniques for studying the activity of the brain by the use of freely implanted electrodes. The result is that brain activity itself is now being described as transactional in nature. In his book on *The Waking Brain*, H. W. Magoun states that

> Within the brain, a central transactional core has been identified between the strictly sensory and motor systems of classical neurology. This central reticular mechanism has been found capable of grading the activity of most other parts of the brain. It does this as a reflexion of its own internal excitability, in turn a consequence of both afferent and corticofugal neural influences, as well as of the titer of circulating humors and hormones which affect and modify reticular activity (11, p. 115).

Role of the reticular formation. The "central transactional core" consists of many different kinds of nerve cells centrally situated throughout the length of the spinal cord, forming great masses in the core of the brain stem, and extending into the thalamus to surround many of its nuclear masses (Fig. 1). The fact that this "reticular

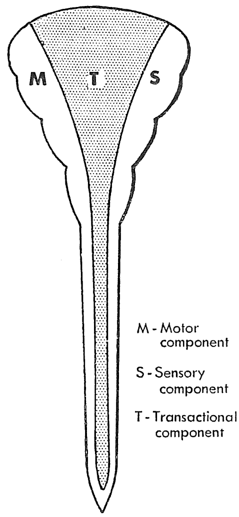

FIG. 1. Schematic diagram of central nervous system. "The functional attributes of the central nervous system may be better explained and investigated by admitting the possibility that they consist of "trans-actions" occurring in many portions of the brain and spinal cord. Such trans-actions may be initiated by sensory input and always find their expression in motor activity, but have an identity of their own which is greater than the sum of these two component parts." From Livingston, Haugen, & Brookhart (10).

formation" was found in the nervous systems of all vertebrates, its axial location, and its many types of nerve cell would suggest that it must perform important functions. Yet what these functions might be is only recently becoming apparent.

One reason for the delay in demonstrating its functions is that in an anesthetized animal few signs of electrical activity can be demonstrated in this part of the brain. Another reason is that the reticular formation as a whole shows little evidence of a functional organization into definite tracts and nuclei that characterize the arrangement of the sensory and motor systems of classical neurology. Furthermore, the absence of definite and long tracts made it difficult to identify the source and destination of any impulses the reticular formation might transmit along its short synaptic relays. These factors combined to give rise to the impression that the nerve cells in the reticular formation had no more function than anatomists ascribed to glia cells, and they were thought to act in supporting and padding the tracts and nuclei of the known sensory and motor systems like excelsior packed around dishes in a barrel to keep them from rattling about and breaking. In fact, the great mass of reticular formation in the midbrain was sometimes jocularly referred to as the "manure pile of the brain."

Until some thirty years ago about all that was known about the reticular formation functions was that it contained a vaguely located "center" in the medulla that controlled respiration and heart beat, while other portions served as relay stations in the "extra-pyramidal" system that modulated the output to muscles from the pyramidal tracts. Then, in 1932, William F. Allen (1) read a paper before the Washington Academy of Science entitled "Formatio reticularis and reticulospinal tracts." His investigations had shown this formation to be a very old structure phylogenetically and he said of it, "It apparently serves as an effective mechanism which enables these animals to adapt themselves properly to their various inside and outside conditions."

Allen's paper attracted little attention until about 1945 when Moruzzi and Magoun discovered that, in addition to contribution to the extrapyramidal outflow, the reticular formation was also transmitting sensory impulses. They demonstrated that sensory impulses were ascending to higher centers through the reticular formation by way of short relays, along paths quite apart from the sensory tracts of classical neurology. They showed that the anterior portion of the formation represented an "arousal" center, which has since been demonstrated to have much to do with maintaining animals in states of alertness and attention, as well as waking them from sleep. Still more recently investigations have indicated that "down-stream" influences from the cortex can modulate activity in the reticular formation. Furthermore, this down-stream influence can be transmitted by way of the reticular formation throughout the nervous system to modulate all sensory input at any relay station along the route it must follow to reach the cortex. Indeed, there is now evidence that this regulating effect on sensory input may extend all the way out to peripheral receptors in sensory organs outside the central nervous system.

Some experimental evidence. By the use of implanted electrodes neurophysiologists have been able to record what is happening in various parts of an animal's brain when it is unrestrained and fully alert. Using this technique, Sharpless and Jasper (14) showed that when a cat had become "habituated" to a tone signal of given pitch and intensity, the response reaching the auditory cortex was markedly suppressed or abolished. Later, Galambos (7) demonstrated that the cortical response in the habituated cat could be restored to its original amplitude if the sounding of the tone was accompanied by some added stimulus which gave the tone a new "significance" to the cat. In other series of experiments, Hernandez-Peon, Scherrer and Jouvet (8) found that anything which diverted the "attention" of the cat produced a suppression of the cortical response in much the same way as did "habituation." For example if, while the tone is producing a cortical response of good amplitude, the cat is shown a bottle with mice in it, or has the odor of fish oil blown into its cage, as long as its attention is thus diverted, the cortical response at the auditory cortex is seen to be suppressed.

From these and many other experimental observations a new picture of function in the central nervous system is emerging. Instead of its having only the classical sensory and motor systems to control adjustments to the outside world, it has two control mechanisms. The second one is centered in the reticular formation, and it is now known to exert a constant modulating influence on sensory input as well as on motor output. This less discrete and more generalized control of sensory input is of particular interest to psychologists because the evidence indicates that the ability of the brain to "police" its own sensory input is conditioned by past experience together with the "innate drives" that serve to direct behavior and determine for the animal at that particular time the "significance" of all it may be seeing, hearing or feeling.

It may not be justifiable to assume that a cat "hears" the tone each time its cortical response is being recorded or that it no longer hears the sound when its attention is diverted or it has become habituated to the tone. Yet, we know from common experience that we, ourselves, no longer hear the ticking of a clock, the noise of city traffic or other familiar sounds unless we give them our attention. We know, too, that the significance we ascribe to a particular sound may let us hear it while other sounds of less significance but much greater intensity, are no longer heard. The classical example of this is the Chicago housewife, living in an apartment beside the elevated railroad who is instantly wakened from sleep by the faint cry of her baby yet fails to awaken in response to the roar of the passing trains. Such a highly selective "tuning" of a person's auditory system in a phenomenon of great interest, and it is only now that we begin to understand how a brain is able to "police" its own sensory input so effectively that it lets go by only the traffic it wants to reach perceptual levels, while blocking out all traffic lacking in significance.

Implications. Observations of this kind have a direct bearing on perceptual theory. For if the brain can selectively block out sensory impulse patterns long before they can reach perceptual levels, "nip them in the bud" as it were, it becomes apparent that neither the "elementary attributes" of the external object nor the Gestalt can be the *sole* determinants of a perception. Instead, it seems that an animal's perceptions are constantly subject to modulation from higher centers in the brain, based on all the animal has learned from past experience, including its "purposes" as determined by hormonal and other internal drives, and its entire physiological status at that particular time.

NEUROPHYSIOLOGY AND MOTIVATIONAL SYSTEMS

Many psychologists working in many different areas are increasingly concerned with what is loosely called "motivation." In their effort to conceptualize this important subject, various theories of needs, purposes, and motives have been proposed. A particular concern of modern psychology is to understand the role of motivation as it is brought to bear on perception, determining in part the range, the intensity, the quality, and the meaning of what a person becomes aware of. Since "motives" cannot be directly observed, all the psychologist can do is to infer what such motives might be and to create abstractions which seem to him best to conform to behavioral evidence. Some psychologists have invoked the concept of homeostasis as helpful in understanding the stability an individual maintains and the continual process of readjustment he makes to situations. But this appeal to homeostasis does not encompass the type of change in which the individual or the various factors involved in the on-going process of living are themselves modified and altered by experience.

Again, a test of what the concept of motivation might best refer to is a search for some physiological equivalents without sacrificing the subtlety, complexity, and development of purposive behavior as it is observed. While the neurophysiologists still cannot give us clear-cut answers, they are now finding basic systems in the nervous system which do apparently propel the organism toward or away from certain situations and further help to account for the interdependence of perception and motivation.

Two systems differentiated. In 1954, Olds and Milner (13) found that a rat with an electrode in its posterior hypothalamus apparently derived some kind of satisfaction from electrical stimuli to this area. If the experiment was arranged so that by pressing on a lever, the rat could deliver an electrical shock to its brain, it would "self-stimulate" up to several thousand times each hour, apparently preferring to experience the effects of the stimulation to eating or resting. That the rat "liked" the effect could be readily demonstrated by disconnecting the electric circuit. When pressing the lever no longer produced its previous "affect," the rat soon stopped pressing it and turned to food or lay down to rest, coming back once in a while to give the lever a tentative push. If the circuit was again closed, the rat promptly resumed its persistent self-stimulation performance.

At first, Olds and Milner thought they had demonstrated a "pleasure center" in the rat brain. However, further studies showed that an animal will self-stimulate in a similar fashion, though perhaps at a lesser rate, when the needle is situated in many other parts of its basic brain. Other investigators have confirmed this fact and have assisted in proving that all of the higher vertebrates have, within the most primitive parts of their brains, a "system" rather than a true "center" which, when activated produces *approach behavior.*

There has been no agreement as to what this system should be called. John Lilly (9) has referred to it as the "I Like" system since its activation evidently produces some sort of "affective state" that is interpreted by the animal as rewarding and desirable. In fact, the rewarding effect produced by its activation seems to supercede the rewarding effect of food, so that in the study of animal behavior in running mazes and other tests, the direct stimulation of some part of this system has largely replaced the use of food as a reward. Since no one knows just what sort of sensation an animal experiences during such stimulation or can tell how the animal interprets the effect, most observers simply prefer to say that the system produced "approach behavior" rather than giving a label to the affective state.

There is also evidence now of the existence of another system extending throughout the basic part of the animal brain, sometimes found only a few millimeters away from the system just described. The activation of this second system has been called by Lilly, the "I Dislike" system. The behavior of the animal when this second system is activated certainly suggests that it dislikes the effect because it may vocalize exactly as it would if subjected to great pain and will struggle frantically to escape. This is particularly true when the more caudal portions of the system are stimulated. In fact, the first intimation that such a system existed came in 1954 when Jose Delgado (4, 5) demonstrated what he then thought were three "pain centers" in the brain of a monkey. However, it soon became apparent that he was not dealing with a true center for pain but was stimulating the lower portions of an extensive system influencing "aversive behavior." It was found that when more cephalad portions of this system were stimulated, the behavior of the animal was less suggestive of "pain" than of such emotions as "horror" and "fear."

The problem of finding an appropriate name for these two systems is complicated by the fact that behavior may change while a single area is being activated, and also by the fact that the two systems are not invariably in opposition to one another in any simple "yes" and "no" relationship. For instance, a rat will cross an electrically charged grid for the privilege of initiating a series of electrical shocks to part of its brain and then will run back over the same grid to turn off the series of shocks after it has experienced a short train of stimuli.

As another example of the complexity of a single system, there are two areas, not far apart, in the hypothalamus, both producing approach behavior and both related to food intake. Stimulation of the laterally situated area increases the rat's appetite for food, while the activation of the medially located area seems to produce a feeling of satiety and leads to the avoidance of food. Opposite effects are produced by destructive lesions in the two areas—so that a laterally placed lesion can lead to the animal's death from starvation in the presence of food, while a medially placed lesion can induce overeating to an extent that can immobilize a rat from excessive obesity. There is also evidence to show that the stopping of a train of stimuli to an "I Dislike" area may have a "rewarding" effect, an observation that reminds one of the man who said he liked to have someone kick him in the shins because "it feels so good when he quits."

Although the exact anatomical limits of these two systems have not yet been established and the study of their functions is yet in its early stages, the mere fact of their existence is of wide significance. One gets the impression that in them may arise those vague sources of motivation that have been called "instincts" and "drives" and are related to food intake and sexual activities. It is possible that some day these terms may lose much of their vagueness when their source can be definitely ascribed to a particular part of one or the other of the two systems. It is also conceivable that when we know more about how these systems function in a human brain we might be able to name the sensations and emotions that are associated with each kind of "drive."

The concept of appetite. No one who observes the facial expression of a monkey or watches his frenzied efforts to escape when some part of his "I Dislike" system is being stimulated can doubt the intensity of his emotional state. To call this system "one which produces aversive behavior" seems to give only a superficial description of what is happening. We prefer, for want of a better designation, to think of the two systems as "appetitive" in the way that Aristotle used this term.

In clarifying what he meant by sense, Aristotle (2, pp. 59 & 105) wrote: "In regard to all sense generally we must understand that sense is that which is reception to sensible forms apart from their matter, as wax receives the imprint of the signet ring apart from the iron or gold of which it is made: it takes the imprint which is of gold or bronze but not *qua* gold or bronze." And he goes on to say, "Where sensation is found, there is pleasure and pain and that which causes pleasure and pain; and where these are, there also is desire, desire being appetite for what is pleasurable."

Webster's International Dictionary defines appetite as "an inherent or habitual desire or propensity for some personal gratification, either of body or mind." We like this inclusion of mind in the definition because we believe that perceptual events as well as behavior are modified by purpose and that purpose may have its origin in influences derived from past experience and learned values as well as from bodliy appetites.

However, the designation given the two systems is of less importance than the fact that the brain is now known to possess "built-in" mechanisms in control of behavior. When we combine this fact with the knowledge we are gaining about how the brain can "police" its own sensory input, we begin to get a new picture of the *transactional* nature of all perceptual processes.

With this new picture we no longer see a "perception" as *solely* dependent upon the elementary attributes of the external object nor upon its object-field relationships, nor on past experience and purpose. Instead, we get a glimpse of how all of these factors work together to create a perception that may or may not be an exact replica of what is "out there," depending on what parts of the incoming stimulus pattern have significance for the individual at that particular time.

SOME IMPLICATIONS FOR DEVELOPMENTAL PSYCHOLOGY

These findings also give us a glimpse of how an infant actually "creates" its own "mind" and its own "self." From the time Dietrich Tiedemann in 1787 published his meticulous observations of the behavior of his infant son, followed nearly a century later by Charles Darwin's *Biographical Sketch of an Infant,* up to the ingenious studies of today, such as those of Piaget and Gesell, child psychologists have demonstrated that the infant begins at birth learning what things are and what he himself is. Tiedemann (12), for example, records that when his son was a month old, "the boy did not beat or scratch himself with his hands as frequently as before; so it seemed that painful, oft repeated experience had taught him to draw some distinction between himself and foreign bodies." Most of us have observed that infant development involves a gradual selectiveness in favor of objects and people associated with its nourishment and well-being, at first, for example, reflexly sucking on everything it can get into its mouth regardless of what the object may be or what effect it may have and gradually discriminating so that it sucks longer and harder and with more signs of satisfaction when it is experiencing some reward.

We can assume that at birth, aside from a few pre-formed reflex circuits, the association areas of an infant's brain and the reticular formation from which these areas are fed represent little more than an unorganized diffusion system. The great areas of interposed "neuropil" are still trackless, not yet organized into the complex patterns necessary to control skilled motor performance or to "police" sensory input. But into this vast reticulum come impressions of the outside world from the sense organs, leaving faint imprints in the neural substance. At the same time, the scanty information from the sensory input is activating parts of the appetitive system so that certain inputs are beginning to acquire significance because of their emotional coloration.

Without intent or anything that might be called "thought," the child is impelled toward objects and people that give it comfort and satisfaction and away from objects or people that cause it distress. The traces left by these early experiences lead to an association between certain objects and persons and the feelings they elicit. These associations, in turn, lead to "intelligent" recognition of objects and persons and to selective behavior in relation to them as information is transformed into useful knowledge through the processes of intake, digestion, assimilation, and utilization to borrow the terms Paul Weiss (16) has used in describing growth.

It is at this point, we think, that "mind" is born, establishing its own identity as definitely as did the first mass of living protoplasm originating from the chemicals in the sea.

And just as a person participates in the creation of his own mind, so too he inevitably participates in the creation of what he believes is "reality," drawing upon many sources as he weighs innumerable cues transmitted in terms of their potential significance to him. The continual refinement and discrimination of ways and means to satisfy the appetitive system becomes essentially a search for a concept of reality that will provide a greater degree of correspondence between what is "out there" to be adjusted to and experienced, and what actually is experienced after purposive action is undertaken.

Simultaneously, the individual gradually builds up a concept of Self in which the nervous system provides the unity, supplying the individual with built-in purposes that become refined and directed in the course of its particular development and according to its individual capacities, regulating output toward greater efficiency in accomplishing these purposes, and policing input so that what is most significant in achieving purposes can be appropriately attended to and evaluated.

While such an interpretation is, to be sure, still based on somewhat sketchy evidence, it does seem to indicate that a transactional view of human behavior and of its development may be worth thinking about as an aid to rid us of any conception that leads to mind-body dualism.

SUMMARY

The concept of transaction apparently formulated by the Greek historian Polybius, and recently differentiated by Dewey and Bentley from interaction, is utilized as an appropriate description of the

processes involved both in a dynamic view of perception and the functioning of the central nervous system. There is a brief review of the selectivity and policing activities of the central nervous system as demonstrated by recent experiments, especially the growing knowledge of the reticular formation.

The implications of Aristotle's concept of appetite for interpreting current neurophysiological research dealing with motivational systems are described and their relationship to perceptual processes indicated.

The potential value of the concept of transaction in accounting for mind, Self, and what a person considers reality are discussed.

REFERENCES

1. ALLEN, W. F. Formation reticularis and the reticulo-spinal tracts. *J. Washington Acad. Sci.*, 1932, 22, 490-495.
2. ARISTOTLE. *De anima*. Book II. R. D. Hicks (Trans.) Cambridge: Cambridge Univ. Press, 1907.
3. CANTRIL, H., AMES, A. JR., HASTORF, A. H., & ITTELSON, W. H. Psychology and scientific research. *Science*, 1949, 110, 461-464, 491-497, 517-522.
4. DELGADO, J. M. R. Cerebral structures involved in transmission and elaboration of noxious stimulation. *J. Neurophysiol.*, 1955, 18, 261-275.
5. DELGADO, J. M. R., ROSVOLD, H. E., & LOONEY, E. Evoking conditioned fear by electrical stimulation of subcortical structure in the monkey brain. *J. comp. physiol. Psychol.*, 1956, 49, 373-380.
6. DEWEY, J., & BENTLEY, A. F. *Knowing and the known*. Boston: Beacon Press, 1949.
7. GALAMBOS, R. Processing of auditory information. In Mary A. B. Brazier (Ed.), *Brain and behavior*. Washington, D. C.: Amer. Inst. Biol. Sciences, 1961. Pp. 171-204.
8. HERNANDEZ-PEON, R., SCHERRER, H., & JOUVET, M. Modification of electrical activity in cochlear nucleus during "attention" in unanesthetized cats. *Science*, 1956, 123, 331-332.
9. LILLY, J. C. The psychophysiological basis for two kinds of instincts. *J. Amer. psychoanal. Assoc.*, 1960, 8, 659-670.
10. LIVINGSTON, W. K., HAUGEN, F. P., & BROOKHART, J. M. Functional organization of the central nervous system. *Neurology*, 1954, 4, 495.
11. MAGOUN, H. W. *The waking brain*. Springfield, Ill.: Thomas, 1958.
12. MURCHISON, C., & LANGER, S. Tiedemann's observations on the development of the mental faculties of children. *J. genet. Psychol.*, 1927, 34, 210.
13. OLDS, J., & MILNER, P. Positive reinforcement produced by electrical stimulation of septal area and other regions of rat brain. *J. comp. physiol. Psychol.*, 1954, 47, 419-427.
14. SHARPLESS, S., & JASPER, H. Habituation of the arousal reaction. *Brain*, 1956, 79, 655-680.
15. TOYNBEE, A. J. (Trans.) *Greek historical thought*. New York: Mentor Books, 1952.
16. WEISS, P. Knowledge: a growth process. *Science*, 1960, 131, 1716-1719.