ENCYCLOPEDIA OF PSYCHOLOGY

Alan E. Kazdin
Editor in Chief

VOLUME 6

AMERICAN PSYCHOLOGICAL ASSOCIATION

OXFORD UNIVERSITY PRESS

2000

EDITORS

*Deceased

AMERICAN PSYCHOLOGICAL ASSOCIATION
Washington, D.C.

OXFORD
UNIVERSITY PRESS
Oxford New York
Athens Auckland Bangkok Bogotá Buenos Aires Calcutta
Cape Town Chennai Dar es Salaam Delhi Florence Hong Kong Istanbul
Karachi Kuala Lumpur Madrid Melbourne Mexico City Mumbai
Nairobi Paris São Paulo Singapore Taipei Tokyo Toronto Warsaw
and associated companies in
Berlin Ibadan

Published by American Psychological Association
750 First Street, NE, Washington, D.C. 20002-4242
www.apa.org
and
Oxford University Press, Inc.
198 Madison Avenue, New York, New York 10016
www.oup.com

Oxford is a registered trademark of Oxford University Press.

Library of Congress Cataloging-in-Publication Data
Encyclopedia of psychology / Alan E. Kazdin, editor in chief
p. cm.
Includes bibliographical references and index.
1. Psychology—Encyclopedias. I. Kazdin, Alan E.
BF31 .E52 2000 150'.3—dc21 99-055239
ISBN 1-55798-187-6 (set): ISBN 1-55798-655-X (vol. 6)

AMERICAN PSYCHOLOGICAL ASSOCIATION STAFF
Gary R. VandenBos, Ph.D., *Publisher*
Julia Frank-McNeil, *Commissioning Editor*
Theodore J. Baroody, *Senior Development Editor*
Adrian Harris Forman, *Project Editor*

OXFORD UNIVERSITY PRESS STAFF
Karen Casey, *Publisher*
Claude Conyers, *Commissioning Editor*
Marion Osmun, *Senior Development Editor*
Matthew Giarratano, *Managing Editor*
Peri Zeepkov and Norina Prabotta, *Project Editors*
Nancy Hoagland, *Production Manager*
Jessica Ryan and Will Moore, *Production Editors*
AEIOU, Inc., *Index Editor*
AEIOU, Inc., Linda Berman, Denise McIntyre,
Space Coast Indexers, Inc., Linda Webster, *Indexers*
Suzanne Holt, *Book Design*
Joan Greenfield, *Cover Design*

1 3 5 7 9 8 6 4 2
Printed in the United States of America
on acid-free paper

A number of directions of current philosophical inquiry have a bearing on psychology. The field of *philosophical psychology* studies folk psychology, the commonsense view of the mental, which is embodied in our everyday *ways of talking about mental phenomena*. The attempt to get clear about the assumptions and views implicit in our ordinary discourse about the mental might prove helpful in trying to bridge the gaps between psychological theories, brain science, and everyday life. The *philosophy of mind* deals with such issues as personal identity, the "mind-body problem," and the issue of mental causation. Concerning the question of the relation between mind and body, most contemporary Anglo-American philosophers are materialists, which means that they deny that the mind is anything other than the brain and central nervous system. In addition, the philosophy of science has contributed important ideas about theory formation and confirmation, and ethics explores the basis of values, the meaning and implications of moral discourse, and principles of proper conduct in professional life.

The cognitive revolution in the 1950s led to a number of research programs in which philosophers and psychologists worked closely together. Noam Chomsky's views about universal grammar supported the idea of innate capacities in the mind. *Cognitive science* is an interdisciplinary research program that tries to explain cognition in terms of rule-governed symbol manipulation as modeled by computers (Haugeland, 1997) and attempts to account for the intentional or representational capacities of the mind in terms of, for example, a "language of thought" (Fodor, 1983). Philosophers have also been influential in developing the theory of connectionism, which attempts to explain the mental in terms of networks of units similar to the networks of neurons in the brain.

Among those who question the possibility of achieving a final explanation of the mental in scientific terms are philosophers like Thomas Nagel and John Searle (1994). These philosophers, sometimes known as mysterians, argue that scientific approaches to the mind cannot account for such basic phenomena as the qualitative feel ("qualia") of sensations or the nature of consciousness itself. Drawing on an old tradition in continental philosophy, hermeneutic philosophers like Charles Taylor (1985) and Paul Ricoeur argue that understanding human phenomena is more like textual interpretation (a matter of interpreting meanings) than it is like scientific explanation. Finally, postmodern figures like Jacques Lacan, Jacques Derrida, Michel Foucault, and Julia Kristeva emphasize the social construction of mental phenomena and attempt to deconstruct the assumed dichotomies that are central to mainstream thought about the mind.

[*See also* Moral Discourse.]

Bibliography

Block, N. (Ed.). (1980). *Readings in philosophy of psychology* (Vols. 1 & 2). Cambridge, MA: Harvard University Press.

Chomsky, N. (1972). *Language and the mind.* (Enl. ed.). New York: Harcourt Brace Jovanovich. Proposes a way of understanding the large-scale structure of mind by way of an understanding of the structure of language.

Churchland, P. M. (1989). *A neurocomputational perspective: The nature of mind and the structure of science.* Cambridge, MA: MIT Press. Shows the importance of neuroscience for philosophy of mind.

Dennett, D. C. (1987). *The intentional stance.* Cambridge, MA: MIT Press. Shows the importance of central concepts in cognitive science for philosophy of mind.

Fodor, J. A. (1983). *The modularity of mind.* Cambridge, MA: MIT Press.

Goldman, A. I. (Ed.). (1993). *Readings in philosophy and cognitive science.* Cambridge, MA: MIT Press. Excellent collection of articles by philosophers and psychologists working in this area.

Haugeland, J. (1997). *Mind design: Philosophy, psychology, artificial intelligence* (Rev. & enl. ed.). Cambridge, MA: MIT Press. Valuable, though challenging, overview of key issues in philosophical psychology.

Melchert, N. (1991). *The great conversation: A historical introduction to philosophy.* Mountain View, CA: Mayfield. Clear historical overview of the main schools of philosophy.

Merleau-Ponty, M. (1962). *Phenomenology of perception* (C. Smith, Trans.). New York: Humanities Press.

Pinker, S. (1997). *How the mind works.* New York: Norton. Best work showing the current state of philosophical thought about the mind.

Searle, J. R. (1994). *The rediscovery of the mind.* Cambridge, MA: MIT Press. Plea for the recognition of the importance of consciousness.

Taylor, C. (1985). *Human agency and language.* Cambridge, UK: Cambridge University Press. Employs existentialist, phenomenological, and hermeneutic approaches in understanding humans.

Charles Guignon

Philosophy of Mind

The 1990s saw a resurgence of a radical reductionist program to eliminate mind as it is understood in "folk psychology." The program was spearheaded by a group of philosophers and scientists who called themselves eliminative materialists (Churchland, 1984). This posture harks back to the radical behaviorism of the earlier part of the century. But in *Plans and the Structure of Behavior*, the book often cited as initiating the cognitive revolution in psychology, Miller, Galanter, and Pribram (1960) declared themselves subjective behaviorists. They showed how one could "do science" on the expressions of verbal behavior (folk psychology) by experimental analysis and by "enactment," that is, by

simulations of such expressions in computer programs in order to understand thought processes. Several further publications (Pribram 1971a, 1971b, 1979, 1986) made a plea for a comprehensive holistic psychology, a science of mind, that would embrace the contributions of behavioral, cognitive, and existential approaches.

Neuropsychology, along with other branches of neuroscience, has made great technical and conceptual strides since these publications. These advances make it most worthwhile to reflect, once more, on whether we are better able to frame an encompassing science of mind that addresses the issues that sages have been pondering throughout the ages.

There are two dualities that have plagued thoughtful philosophers, dramatists, mystics, and scientists over at least the past two millennia. One of these is the mind/brain duality itself. The other is a duality within mind, two ways in which the experiencing subject experiences the self: as a body-centered *me* and as an episode-centered, narrative *I* (Pribram & Bradley, 1998).

A caveat: Thinking in terms of dualities is a primitive analytical tool. To deconstruct any issue in terms of dualities can only serve as a first step. Dualities can serve dialectically to provide a synthesis and from there a hierarchically organized tree of systems, subsystems, and supersystems. There are other forms of organization less amenable to dichotomizing, for instance, the distributed/enfolded order characteristic of holography and the multivariate phase spaces used in nonlinear dynamics. I will use these tools where appropriate to characterize one or another of the dualities under discussion: however, doing so tends to blur the boundaries between the dualities.

A Synoptic History of the Mind/Brain Duality

Today we usually attribute the sharp distinction between mind and matter to Descartes. However, René Descartes articulated a duality that goes back to the origins of propositional utterances: a subject, an object, and a verb that ascribes to the subject an aspect partaken of, or an "intention" taken toward an object. Holophrases, words such as *om* in Sanskrit and *yaveh* in Hebrew, which mean "being," enfold, or rather fail to unfold, propositional meanings. Holophrases are said to have preceded propositional utterances in the development of languages, just as holophrases precede the development of language in children. The process of being becomes a being, a subject with a beard who hands commandments to Moses, an object.

For Descartes, the thinker is subject; all else is object. Immanuel Kant, however, pointed out that the objects of thought are ideas, and ideas have two sources: sensory-initiated phenomenal experience (images of objects) and noumena, the thinker's reasoned contributions. Thus, the thinker and the contents of thought all became subjective, and knowledge of the objective, "material" aspect of the world became "iffy."

Arthur Schopenhauer, bothered by this indeterminacy (our inability to "really" know the world because of our entanglement in it), came to emphasize the role of the thinker, of energy and "will," of intentions, in unraveling the iffiness of the images. He noted that the unraveling of the world knot, made up as it is of entanglements of phenomena and noumena, is up to us. This provides us with the freedom to explore and with the opportunities to shape the world we inhabit. Today we often hear that the solution to certain of our social problems is not just money but political will. This insight is very much in line with that of Schopenhauer.

In a sense, Schopenhauer returned to the wholeness that the holophrase encompasses and indicated that humans, by virtue of operating in a proposition-like mode, by their intentions, have the opportunity to mold the images or representations they experience and therefore their interpretation of the world.

Enter Brain Science

Descartes, Kant, and Schopenhauer knew that, among other determinants, the organization of psychological experience owed something to the way the brain works. A wealth of detail has been added in the past two centuries so that even B. F. Skinner, a pioneer radical behaviorist who led a lifelong crusade against folk psychology and toward a behavioral science of the "empty organism," in 1989 ended his career a year before his death with the following revised insight:

> There are two unavoidable gaps in any behavioral account: one between the stimulating action of the environment and the response of the organism and one between consequences and the resulting change in behavior. Only brain science can fill those gaps. In so doing it completes the account: it does not give a different account of the same thing. (p. 13)

Initially, certain psychological "faculties" were shown to be dependent on the normal functioning of systems that could be more or less localized within the brain. The anatomical connectivity of these systems and their electrophysiological response to sensory input have now been described.

Over the decades, early crude findings were sharpened as better techniques became available. Studies that aim to localize relationships between types of psychological experience and brain systems have attained vigor from revolutionary procedures such as computerized tomography and nuclear resonance imaging.

On the brain's convexity, we can roughly make out a three-tiered arrangement for these systems. Each major sensory apparatus has a fairly direct input to areas in the cortex. Immediately surrounding these areas are

others that, when electrically stimulated, originate movements of the musculature associated with each of the sense organs (e.g., eye muscles for vision, ear muscles for hearing, and body muscles for somatic sensations). These areas are extrinsically connected, that is, connected to organs in the periphery of the body and therefore provide perspectives relating the body to the world beyond.

Surrounding these extrinsic areas are sensory-specific areas that are primarily connected intrinsically, that is, to other brain structures. These areas provide perspectives that are intrinsic to the entities perceived, perspectives such as those provided by color and object constancy. Finally, there are areas that operate on inputs from a variety of senses that relate their perspectives to each other. All of these areas and the brain systems that they represent are involved in organizing our phenomenal perceptions. In today's terminology we call them *sensory-driven aspects of perception* (see Pribram, 1991). Another set of systems, more noumenal in their function, is located frontally and on the limbic medial border of the brain's hemispheres. These systems and their functions in organizing our experience will be dealt with in the last part of this article.

However, there are types of psychological experience that cannot be so readily divided up with regard to the brain systems that organize them: aspects of conscious awareness, memory storage and retrieval (remembering), and the ability to transfer what has been learned in one situation to another situation, or, what has been learned in one way to another way (for instance, with one hand to another hand). These types of interpretations of the world knot have been found to depend, in part, on processes that are distributed in the brain. Once again, new techniques are invigorating investigation: this time it is the development of massively parallel computational architectures and the use of multiple recordings with microelectrodes.

"The Hard Problem"

Great interest has developed in trying to come to grips with the mind/brain duality. In part this is due to the outstanding successes in the psychological and neurosciences. The apparent gap between mind and matter is being filled with a plethora of data that firmly establish, in great detail, the way in which our experience can be related to brain organization. This success recalls the recent successes in Darwinian theory, where the evolutionary gap between human and nonhuman primates is being filled with new discoveries almost daily.

But some philosophers are still not satisfied. They divide the issue into hard and easy: What we are accomplishing, they claim, is the easy part. They point out that to some considerable extent the cognitive revolution in experimental psychology and its influence on neuropsychology is not only successfully formulating a true psychological science that takes subjective experience seriously, but at the same time is filling the mind/brain gap. But they note that it is much harder to bridge the gap between our personal experience and the experience of others, which we validate through communication by way of verbal and instrumental behaviors.

The philosophers who are not satisfied do have a point, and the point harks back to Descartes, Kant, and Schopenhauer. There is a duality between my subjective experience and that of others. Nonetheless, I believe the current philosophers are in error in restricting the hard problem to conscious awareness of our experience. Descartes's duality was corrected by Kant; *all* our experience involves phenomenal representation and noumena. Neither our senses nor our cognitions readily provide us with unadulterated replicas of what is "out there." That is why we must apply ourselves to understand, not only conscious awareness, but the origins of all our experience. In short, the hard problem applies to all knowledge and all science, not only to the study of consciousness.

The hard problem is the problem of *knowing*, the ontological problem of epistemology. It is the problem of unraveling the world knot, almost harking back to the Cartesian problem of cogito versus all else. However, the new way that Kant and Schopenhauer sensed the all-else, indeed adds to our sophistication, in that the all-else is to be included in the hard problem: to resolve this problem on the plane that they established does require active involvement, intent, and will. Neuropsychological and neuroscientific research is the current expression of this intent.

A final point. While psychologists and neuroscientists are resolving the mind/matter duality from one perspective, quantum physicists have been tackling the issue from another. Niels Bohr, Werner Heisenberg, Wolfgang Dirac, and Eugene Wigner, each in his own way, noted that how we approach an observation determines it to a large extent. As Wigner described it to me personally some years ago, we no longer have observables in quantum physics, we have only observations. Bohr's complimentarity and Heisenberg's indeterminacy principles make the same Kantian point (see Stapp, 1972, a superb summary of their thinking). All of science, not just psychological science, is beholden to the hard problem.

Where does that leave us? In other essays, I have noted that our intense interest in the mind/matter duality was fostered by the industrial revolution. Most scientists are materialists and have begotten mentalists (e.g., Searle, 1983; Sperry, 1980) who perceive flaws in the materialist position. But materialism and mentalism

bear the same relationship to each other as *down* and *up*: one would not exist without the other. Which comes first, our experience of the material world or the material brain that makes the experience possible? Is the chicken an egg's way of reproducing itself—or is it the other way around?

The information revolution is beginning to shift the ground from an intense interest in a mental/material duality to the issue that occupied Plato and Aristotle: the ideal versus the real. Already, some mathematicians (e.g., Roger Penrose) have, not unexpectedly, declared themselves on the side of Plato. Dualities such as these are extremely helpful in exposing issues, but they are relatively primitive tools. Pre-Socratic holistic pragmatisms such as that practiced by Pythagoras in dividing a vibrating string in half to discover the principle of the octave or, for that matter, the American pragmaticism of Charles Peirce, help to place such dualities in proper perspective.

A Duality Within Subjective Experience

As noted, within Descartes's cogito itself, several different conceptions (different dualities) have caught the attention of philosophers. One, most clearly enunciated by Brentano (1973), is the duality between the perceiver and the perceived. This also reflects the Cartesian duality: the perceiver is minding; all else is that which is being perceived and minded. But contrary to Descartes, Brentano was less interested in that which is being perceived but with the perceiver. Shades of Schopenhauer emerge as the perceiver "intends" his perceptions; he can even intend inexistent percepts such as unicorns.

Brain research has shown (see Pribram & Bradley, 1998) that systems occupying the posterior convexity of the cerebral hemispheres are involved in organizing Brentano's (1973) duality. When the parietal lobe systems are injured, the individual may no longer feel the arm on the side opposite the brain injury to be his or her own. (One of my students who suffered such an injury dubbed her arm Alice and stated that "Alice doesn't live here anymore.") Despite this loss of belongingness, the arm routinely performs many tasks, such as bringing a cup of coffee to the person's mouth, much to the surprise of the person when he or she becomes aware of what has happened.

Damage farther back in the convexity produces "blindsight." Here again, the person can perform many routine tasks that demand an optical input from the blind side, but is unaware of (is blind to) that input. With an intact brain, we are aware both of ourselves as "see-ers" and of what is being seen.

In these and similar instances, awareness of one's bodily self and the environment are impaired: Alice isn't any longer part of me; the blindsighted, optically guided behavior isn't mine. From such observations one can infer that ordinarily these brain systems operate to allow awareness of a corporeal *me* to occur. When impairment takes place, the distinction in awareness between perceiver and perceived no longer exists, much as a person with color-blindness cannot differentiate between red and green. In the absence of differentiation, neither color exists for that person. In the absence of awareness of the difference between perceiver and perceived, neither exists.

There is another totally different duality that has concerned philosophers. In addition to a self, a *me*, the concern has been with a transcendental awareness of one's unity with a larger, more universal order. Jung's (1933) archetypes address this aspect of experience. Paradoxically, this experience is as intensely personal as it is holistic. The experience cannot be analyzed into "in here" versus "out there" as in Brentano's intentionality. Rather, it partakes of a holy, healthy awareness that lacks boundaries.

Psychological and brain science have recently made great strides in understanding this type of awareness. First, Endel Tulving (see Pribram & Bradley, 1998) differentiated two types of human memory: a dictionary or semantic type and another that deals with episodes of one's experience. At the same time, research with nonhuman primates has distinguished a difference between brain systems that deal with reference memory and those that deal with trial-by-trial types of processing.

There is good evidence from human neuropsychological research that allows identification between the processes responsible for semantic memory and those of reference memory. These processes are impaired when the posterior convexity of the brain is damaged. Referencing is what is entailed in the Brentano duality, the ability to be aware of the distinction between perceiver and perceived.

There is also good evidence obtained with animals that trial-by-trial processing leads to remembering unique instances and therefore to the processing of episodes. Episodic processing is impaired by damage to the limbic systems that lie on the inner border (thus the term *limbic*) of the hemispheres of the brain.

Impairment of episodic processing leads to a surprising difficulty. Individuals with such impairment are personable and able to interact socially on a moment-by-moment basis by virtue of their intact semantic/referential processing. An interruption or distraction will, however, totally erase the episode from further awareness as if that unique instance had never taken place. Therefore, over time, over successive episodes, no personal hermeneutic, narrative *I* becomes established.

The episodic processing that leads to experiencing a narrative *I* is separate from that leading to a corporeal *me*. Children who have bilateral damage to the limbic systems from birth can learn to read and have other

aspects of semantic processing that are unimpaired. A case history dramatically demonstrates the deficiency in constructing a narrative *I*. This child was born with large cysts involving the limbic and frontal part of his brain. He underwent two surgeries before the age of 6 months. He has never given any evidence of episodic memory; however, he was capable of learning verbal language to age-appropriate levels. At age 8 he was able to give his name, age, birthday, and names of family members. He reported his favorite game, television program, and favorite color across trials. Expressive language capabilities were age appropriate, and there were no obvious weaknesses in grammar. Despite this, he was unable to recall what he had eaten for breakfast a few hours earlier. He was unable to correctly identify an examiner with whom he had worked that morning from among a group of four people. He was unable to say what he had eaten for lunch after returning from a restaurant.

Obviously, episodic processing is not necessary for the establishment of normal semantic processing. The converse is also true: children who suffer injury to the systems that process the corporeal *me* for instance, those who are spastic from birth, have no difficulty with episodic processing and develop a normal narrative *I*.

Such children also develop normal semantic processing, indicating that the *me* has two distinct aspects: one related to sensory input and another to motor output. This separation of motor skills from body awareness is due to the increased importance of these somatic motor systems. The distance senses depend on their motor components primarily to enhance sensory processing. By contrast, the somatic motor system has the ability to skillfully and dramatically change the environmental input. As a result, the motor systems in primates, including those of humans, become more distinctly separated from the somatic sensory input systems, whereas there is more overlap between input and output in the distance senses.

The brain systems that organize episodic processing also have inputs and outputs and these also overlap considerably. A mediobasal motor system covers the anterior portions of the limbic cortex and centers on the amygdala, a basal ganglion. Electrical stimulation of this cortex produces marked changes in heart and respiratory rate, blood pressure, and gastrointestinal contractions. In contrast to the results of electrical stimulation of the somatic motor cortex, only gross turning of the body and eyes away from the side of stimulation were produced (Pribram, 1961).

Also, the input from the body comes mainly from tracts concerned with visceral, autonomic, pain, and temperature stimuli. Together these inputs can be classified as mediating hedonic (pleasant/unpleasant) emotional aspects of awareness. There is, therefore, not surprisingly, an anatomical-physiological relationship between hedonic and episodic processing. After all, the narrative *I* experiences the episodes, and research has shown that rewards and deterrents are critical in "stamping in" an episode so that it becomes a remembered part of the personal narrative (Pribram, 1970).

Schopenhauer emphasized the importance of the body in the organization of intention, of will, although he failed to distinguish between the body as a skilled *me* and the body as a hedonic *I*. *Plans and the Structure of Behavior* (Miller et al., 1960) separated these aspects of will by distinguishing between motivations (hedonic) as predispositions and intentions as dispositions. Intentions, in turn, are divided into strategies (prior intentions) and tactics (intentions in action, as Searle (1983) called them).

There is a relationship between emotion, motivation, strategy, and tactics. As William James pointed out, emotions stop at the skin, motivations (termed *instincts* in the literature of that time) reach beyond. To implement motivations we develop intentions, both strategic and tactical. Separate brain systems are related to each of these behavioral categories: amygdala to emotion; caudate putamen to motivation; anterior frontal cortex to strategies; and the more posterior frontal, the precentral cortex to tactics.

Schopenhauer, though well read in the Upanishads, failed to follow them in their emphasis on the hedonic aspects of wholeness, as exemplified in gardening or in lovemaking, and he therefore failed to understand fully the holistic transcendental aspect of the *I*. Despite his attempts to ground the will in the body, Schopenhauer's development of body involvement in untangling the world knot results in a corporeal *me*, not a holistic *I*. The consequences of this failure led both Nazi (idealistic) and communist (materialist) philosophies to neglect individual incentive, and paradoxically, to an unhealthy, unholistic, unholy society.

If we follow the lead of the eliminative materialists, our society might end similarly. As a judge pointed out at a recent meeting devoted to consciousness studies, reducing psychology to neurons is a category error that would destroy our entire moral structure; we cannot hold neurons accountable for our behavior. One of the eliminatists (Francis Crick) has noted that categories are human inventions and that we often change categories as our knowledge increases. But this misses the point: the category error deals not with how we categorize per se, but with the level or scale with which the category deals. Thus, the sections here detailing the role of brain systems in organizing the *me* and the *I* deal with one level of inquiry only. At a more encompassing level, ego- and allocentric organization of the *me* depend, of course, on environmental input to the senses. In the same fashion, the organization of the *I*

depends on input from a caretaking person and all further social transactions experienced by and processed by a person. It is only the processing medium provided by the brain that is the focus of neuropsychological research.

The category error is not just a trivial philosophical contrivance: making this error has serious personal and social consequences. Kant (who was trained in the law), Schopenhauer, and even earlier, the Upanishads, illuminated this healthier alternative to eliminatism: the humble realization that the way to knowing is all of a piece, that the hard problem encompasses all of knowing, and that it takes personal involvement and dedicated work to unravel the world knot.

[*See also* Agency.]

Bibliography

Brentano, F. W. (1973). *Psychology from an empirical standpoint*. London: Routledge & Kegan Paul.

Churchland, P. (1984). *Matter and consciousness*. Cambridge, MA: MIT Press.

Jung, C. G. (1933). *Modern man in search of a soul*. Harvest Books.

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*. New York: Holt.

Peirce, C. S. (1934). Pragmatism and pragmaticism. *Collected Papers* (Vol. 5. pp. 34–131). Cambridge, MA: Harvard University Press.

Pribram, K. H. (1961). Limbic system. In D. E. Sheer (Ed.), *Electrical stimulation of the brain* (pp. 311–320). Austin: University of Texas Press.

Pribram, K. H. (1970). Feelings as monitors. In M. B. Arnold (Ed.), *Feelings and emotions* (pp. 41–53). New York: Academic Press.

Pribram, K. H. (1971a). The realization of mind. *Synthese, 22*, 313–322.

Pribram, K. H. (1971b). *Languages of the brain: Experimental paradoxes and principles in neuropsychology*. Englewood Cliffs, NJ: Prentice Hall.

Pribram, K. H. (1979). Behaviorism, phenomenology and holism in psychology: A scientific analysis. *Journal of Social and Biological Structure, 2*, 65–72.

Pribram, K. H. (1986). The cognitive revolution and mind/brain issues. *American Psychologist, 41*, 507–520.

Pribram, K. H. (1991). *Brain and perception: Holonomy and structure in figural processing*. Mahwah, NJ: Erlbaum.

Pribram, K. H., & Bradley, R. (1998). The brain, the me and the I. In M. Ferrarri & R. Sternberg (Eds.), *Self-awareness: Its nature and development* (pp. 273–307). New York: Guilford Press.

Searle, J. R. (1983). *Intentionality: An essay on the philosophy of mind*. Cambridge, UK: Cambridge University Press.

Skinner, B. F. (1989). The origins of cognitive thought. *American Psychologist, 44*(1), 13–18.

Sperry, R. W. (1980). Mind/brain interaction—mentalism, *yes*—*dualism, no*. *Neuroscience, 2*, 195–206.

Stapp, H. (1972). The Copenhagen interpretation. *American Journal of Physics, 40*(8), 1098–1116.

Karl H. Pribram

Philosophy of Science

Advances in formal logic made during the late nineteenth and early twentieth centuries encouraged the search for a universal character of science, or as Rudolf Carnap hoped, a logical syntax of the language of science." Combining Ernst Mach's views on science (i.e., sensationalism, Humean causality) with Ludwig Wittgenstein's and Bertrand Russell's theories of logical atomism, members of the Vienna circle (e.g., Moritz Schlick, Otto von Neurath, Philipp Frank, Rudolph Carnap) recommended a verificationist view wherein atomistic propositions in the language of science were thought to be proven true through empirical investigation.

Positivists relied heavily on Newtonian mechanics as an example of the type of scientific program that might emerge from adherence to their prescriptive rules of scientific conduct. In psychology, several productive research programs modeled themselves upon positivist visions of science. Psychologists, such as Clark Hull and Kenneth Spence, accepted notions such as Bridgman's (1928) operationism, believing that the meaning of a concept was synonymous with the corresponding set of operations used to measure that construct. Some positivists were too quick to condemn the nonpositivist approaches to research in psychology because these programs failed to conform to orthodox positivist methodology. When several of these nonpositivist research programs subsequently flourished, psychology concluded that positivist proscriptions were overly narrow and potentially injurious to research in psychology.

Several developments in philosophy of science around the mid-twentieth century were also responsible for the decline in logical positivism. Positivists, following Mach's sensationalism, believed science could produce atomic facts: the momentary sensations in the sensory fields of individual persons. Science, then, would discover regularities among these facts, which could be described in an entirely clear and unambiguous formal language (as suggested by Russell). Science was to be a net of propositions that were thrown over reality to ascertain the regularities present in the world. For members of the Vienna circle, a proposition was empirically meaningful (i.e., worthy of consideration by scientists) if and only if a method for verifying (confirming or testing) it could be described. This verifiability principle was first subverted by Karl Popper (1959), who offered his own principle: Empirical propositions should be known by their potential falsifiability. Popper attempted to extend his falsification principle to the do-