

Complementarity and the Relation Between Psychological and Neurophysiological Phenomena

Douglas M. Snyder

Berkeley, California

In their recent article, Kirsch and Hyland questioned the relation between psychological and associated neurophysiological phenomena in the introduction of complementarity into psychology. Mishkin's work on the neurophysiological basis of memory and perception provides an example of the extension of complementarity that I have proposed and that can serve as the basis for empirical testing of this extension. Mishkin's thesis that memory storage occurs at sensory stations in the cortex allows for the resolution of a fundamental problem in cognitive psychology, namely the reciprocal dependence of perception and memory. Also, Mishkin's thesis allows that psychological phenomena do not depend on an objective world for their existence.

In a recent paper, it was proposed that attempts to introduce complementarity into psychology imply that "awareness, or one's psychological state, . . . does not ultimately depend on an objective world for its existence" (Snyder, 1989, p. 121). Kirsch and Hyland (1989) disagreed with this characterization of their work on complementarity. Though Hyland (1985) has maintained that simultaneous mutually exclusive descriptions of some psychological and/or physical phenomena can occur, he and Kirsch continue to maintain the notion of a one-to-one correspondence between psychological and physiological phenomena. Hyland has included this correspondence in his concept of complementarity. Kirsch and Hyland consider their own work to allow for an objective world of neurophysiological phenomena to which mental phenomena are correlated in terms of identity relations.

The extension of complementarity that I have proposed is one in which simultaneous mutually exclusive descriptions of some phenomenon characterize the same concrete circumstances. In psychology, I have proposed, for example, that the same behavior can be seen as indicative of health or illness depending on the theoretical reference frame maintained by the therapist. In physics, it has been maintained that, in principle, the same concrete measuring apparatus can

be used to measure either the position or momentum of an electron, depending on the theoretical structure in which the concrete measuring apparatus is found. This last result essentially follows from Einstein, Podolsky, and Rosen's (1935) analysis of quantum mechanics in which they found that the same concrete physical circumstances can be described by two different wave functions, each wave function being an eigenfunction of one of two non-commuting operators. In quantum mechanics, the precise descriptions of physical quantities represented by non-commuting operators are mutually exclusive. These precise descriptions are associated with the eigenfunctions noted. In that mutually exclusive descriptions can characterize the same concrete physical circumstances, they can be considered simultaneous descriptions.

Kirsch and Hyland (1989) implied that the position reflected in the above quote from my work involves a "disembodied spirit" (p. 201). They failed to point out that I referred specifically to an objective world in the above quote. By an objective world, I meant a world uninfluenced by the observing, thinking, and in general experiencing individual. An objective world is not the only world to which awareness may be related. In the notion of complementarity that I have proposed, the world exists in a fundamental relation to the observing, thinking, and in general experiencing individual.

The relation between one's mind and body is in line with Merleau-Ponty's (1962) notion of the experienced body. For Merleau-Ponty, experience, and in particular the experienced body, serves as a fundamental level upon which objective knowledge can be developed. In commenting on the ambivalent stance of the psychologist as regards one's body and experience in general, he wrote:

To concern oneself with psychology is necessarily to encounter, beneath objective thought which moves among ready-made things, a first opening upon things without which there would be no objective knowledge. The psychologist could not fail to rediscover himself as experience, which means as an immediate presence to the past, to the world, to the body and to others at the very moment when he was trying to see himself as an object among objects. (pp. 96-97)

Bohr (1961) alluded to the experienced body in discussing his concept of complementarity:

It is very instructive that already in simple psychological experiences we come upon fundamental features . . . of . . . the reciprocal view. . . . One need only remember here the sensation, often cited by psychologists, which every one has experienced when attempting to orient himself in a dark room by feeling with a stick. When the stick is held loosely, it appears to the sense of touch to be an object. When, however, it is held firmly, we lose the sensation that it is a foreign body, and the impression of touch becomes immediately localized at the point where the stick is touching the body under investigation. (p. 99)

Kirsch and Hyland's comment on the relation between psychological and other phenomena in the world nonetheless raised an important issue. Given

the proposed flexibility in awareness, or psychological states, what is the relation between awareness, or these states, and the nervous system which is no doubt related to these phenomena? It is possible to make a hypothesis concerning this question, one that is open to progressively more sophisticated empirical testing. The areas of concern are perception and memory. Perception and memory are problematic in cognitive psychology because each requires the other for its proper operation (Snyder, 1983). Perception is, of course, central to the development of memory. It is also the case, though, that memory, presumably long-term memory, is central for perception, particularly as concerns recognition. In cognitive psychology, recognition is generally explained in terms of a template or feature analysis function. The development of the memories needed for the proper operation of a template or feature analysis ability depends on experience, and yet this ability is at the same time supposed to correctly categorize experience. If perception and memory are dependent on one another for their proper operation, the question arises as to how either of them function properly?

In an article by Mishkin and Appenzeller (1987), an avenue explored by Mishkin was discussed for understanding memory and perception that fits a concept of complementarity in which mutually exclusive descriptions simultaneously characterize the same concrete circumstances. Specifically, Mishkin has proposed that the same sensory stations in the cortex serve as centers for perception and memory and that essentially the same neurophysiological processes at these sites are associated with these aspects of cognition. Empirical evidence indicates that after the initial sensory processing of stimuli, impulses related to these stimuli are processed by the limbic system as part of the development of memory. After processing by the limbic system, Mishkin proposed that impulses are eventually directed from the limbic system back to those cortical stations where the initial sensory processing occurred.

The likeliest repositories of memory, in fact are the same areas of cortex where sensory impressions take shape. . . . After a processed sensory stimulus activates the amygdala and hippocampus [the limbic system], the memory circuits play back on the sensory area. That feedback presumably strengthens and so perhaps stores the neural representation of the sensory event that has just taken place. The neural representation itself probably takes the form of an assembly of many neurons, interconnected in a particular way. As a result of feedback from the memory circuits, synapses (junctions between nerve cells) in the neural assembly might undergo changes that would preserve the connectional pattern and transform the perception into a durable memory. Recognition would take place later, when the neural assembly is reactivated by the same sensory event that formed it. (Mishkin and Appenzeller, 1987, p. 7)

If, as Mishkin implied, the processing at these cortical sensory stations for memory and perception is the same, then there exists a concrete structure that allows the removal of a thorny problem in cognitive psychology. It is also an elegant neurophysiological correlate for the cognitive structures of memory and perception, which, of course, often share many common features (Glass, Holyoak, and Santa, 1979).

The primary evidence that Mishkin relied on for his thesis that the memory store is found at cortical sites where initial processing of sensory stimuli occurs is that human patients with severe damage to the limbic system retain long-term memory for events they experienced prior to the insult, but they lose the capacity to develop long-term memory for any experiences they have after the insult. In addition, Mishkin relied on established anatomical connections among the neurophysiological structures of concern. Also, Mishkin's thesis is supported by the close association between perception and memory indicated by their reciprocal dependence on each other, specifically that each depends on the other for its proper operation.

Mishkin's thesis can be interpreted as involving simultaneous mutually exclusive psychological descriptions of perception and memory in that both descriptions are associated with the same neurophysiological correlate. If these cognitive functions are indeed associated with the same neurophysiological correlate, what would distinguish between perception and memory? Perhaps, it is the initial direction of stimulation of the neural assembly that determines whether the activation of this assembly is associated with the figured experience of perception or memory. The above quote from Mishkin appears to indicate that this is his proposed solution.

An issue arises, though, as to how internal stimuli, emanating from within the individual, are distinguished from external stimuli, emanating from outside the individual. There is no comparison feature (e.g., a feature analysis function or template) in Mishkin's thesis that is definitely inside the person and that can thus be used to determine whether stimuli are emanating from either outside or inside the individual. For a particular event, there is a neural representation at the cortical sensory site that is common to both its perception and memory.

In conclusion, it is important to note that Mishkin's thesis allows that perception and memory do not depend on an objective neurophysiological substrate for their existence. In Mishkin's thesis, the substrate consists of the cortical stations associated with initial sensory processing. First, in Mishkin's thesis, there does not exist a unique one-to-one correspondence between psychological phenomena and the associated neurophysiological processes that is expected to exist in an objective world. Second, these neurophysiological processes, when studied by researchers, are subject to the same cognitive consideration as regards their perception and/or memory as are other phenomena in the world. That is, the neurophysiological processes themselves are associated with simultaneous mutually exclusive cognitive descriptions.

References

- Bohr, N. (1961). *Atomic theory and the description of nature*. Cambridge: Cambridge University Press.
- Einstein, A., Podolsky, B., and Rosen, N. (1935). Can quantum-mechanical theory be considered complete? *Physical Review*, 47, 777-780.

- Glass, A.L., Holyoak, K.J., and Santa, J.L. (1979). *Cognition*. Reading, Massachusetts: Addison-Wesley.
- Hyland, M. (1985). Do person variables exist in different ways? *American Psychologist*, 40, 1003–1010.
- Hyland, M., and Kirsch, I. (1988). Methodological complementarity: With and without reductionism. *The Journal of Mind and Behavior*, 9, 5–12.
- Kirsch, I., and Hyland, M. (1989). Causal isomorphism and complementarity: Setting the record straight. *The Journal of Mind and Behavior*, 10, 197–204.
- Merleau-Ponty, M. (1962). *Phenomenology of perception* [C. Smith, Trans.]. London: Routledge & Kegan Paul.
- Mishkin, M., and Appenzeller, T. (1987). The anatomy of memory. *Scientific American*, 256(6), 80–89.
- Snyder, D.M. (1983). Mutual inclusion and cognitive psychology. *Perceptual and Motor Skills*, 57, 930.
- Snyder, D.M. (1989). Causal isomorphism: A concept in search of a meaning; Complementarity and psychology. *The Journal of Mind and Behavior*, 10, 117–122.