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The Biofunctional Theory of Knowledge and Ecologically Informed Educational Research

George G. Hruby

University of Georgia, Athens

In this commentary I compare Iran-Nejad's (2000) biofunctional theory of knowledge and self-regulation with the ecological psychology of James Gibson and his admirers. Gibson's work is currently being reappraised by some educational researchers within sociocultural and situativist theoretical frames in the hopes of establishing a more comprehensive theory of cognition and human behavior. I maintain that ecological psychology alone is not up to that task, but that Iran-Nejad's biofunctional theory may well fill the bill.

While reading "Knowledge, Self-Regulation, and the Brain–Mind Cycle of Reflection" (Iran-Nejad, 2000, this issue), I was repeatedly reminded of the work of the ecological and perceptual psychologist James Gibson (1966, 1979/1986). This is not as peripheral an observation as it might at first seem as Gibson's work has been much on the minds and tongues of educational researchers recently (e.g., Wertsch, 1999). Being a researcher in reading education myself, I have for some time been interested in the *affordances* inherent in an ecological theory of learning and knowledge (Hruby, 1999a). So allow me to review some of the parallels.

Iran-Nejad uses the demands of driving an automobile to illustrate how the nervous system functions as an intuitive figure–ground navigation system. Driving is precisely the navigational conundrum which initially inspired Gibson's perceptual research in the 1930s (Gibson and Crooks, 1938). The gestalt figure–ground trope is central to Iran-Nejad's theory of self-regulation; Gibson himself was much influenced by Kurt Koffka whom

Requests for reprints should be sent to George G. Hruby, President and Program Chair of the American Educational Research Association's Brain and Education Special Interest Group, Department of Reading Education, 309 Aderhold Hall, University of Georgia, Athens, Georgia 30602–7125.

he met while both were teaching at Smith College (Reed, 1988). Gestalt psychology's perceptual alternative to Helmholtz's concept of internal processing of sensory inputs likely influenced Gibson's ecological approach to perception (Reed, 1988). And Gibson made use of the figure–ground distinction as the basis for his oppositional pairings between permanence and change perceived in the environment, and between invariance and disruption of the optical array (Gibson, 1966, 1979/1986).

More substantially, Iran-Nejad's distinction between thematic and categorical knowledge (though more finely discriminated) seems strikingly parallel to Gibson's distinction between perception of the environment and recognition of things and sets (which Neisser [1993] has playfully described as "where" and "what" systems). On the basis of this, Gibson was able to address the symbol grounding problem by distinguishing between what he termed tacit knowledge (from perceiving information in the ecological surround directly) and explicit knowledge (represented indirectly through symbolic communication systems). Thus, symbols get grounding because "perception precedes predicating" (Gibson, 1979/1986, p. 260), the gist of which is shared by Iran-Nejad's biofunctional theory (see below). So Iran-Nejad's use of the term "direct representation" calls to mind unbidden Gibson's controversial notion of "direct perception" (Gibson, 1979/1986). There are important differences, but let us first explore some of the similarities.

Gibson, like Iran-Nejad, rejected outright the idea of the mind as a storage–retrieval system and rejected the ubiquitous conduit metaphor. Instead, somewhat like Iran-Nejad, Gibson maintained that animals, as a matter of evolutionary necessity, had evolved the capacity to make direct use of the information provided by their environment as presented at any given point by way of the surrounding optical array. As Gibson explained in *The Ecological Approach to Visual Perception* (1979/1986):

> Words and pictures convey information, carry it, or transmit it, but the information in the sea of energy around each of us, luminous or mechanical or chemical energy, is not conveyed. It is simply there. The assumption that information can be transmitted and the assumption that it can be stored are appropriate for the theory of communication, [but] not for the theory of perception. (p. 242)

For Gibson there is no communication necessary in perception because there is no space across which to communicate; the organism and its environment (or the perceptual array it emanates) are continuous and complementary, hence perception is "direct." The "information" available to the perceptual systems (Gibson's term for the senses) was not the same as that postulated by cognitivists for mental processing, and this distinction allowed for Gibson's theory of ecological self-regulation.

> [In ecological psychology] information is conceived as available in the ambient energy flux, not as signals in a bundle of nerve fibers. It is information about both the persisting and the changing features of the environment together. Moreover, information about the observer and his movements is available, so that self-awareness accompanies perceptual awareness. (Gibson, 1979/1986, p. 263)

> According to [information] pickup theory, information does not have to be stored in memory because it is always available. (p. 250)

There are sound evolutionary reasons for conceptualizing an organism's navigational system this way. As Iran-Nejad and colleagues have noted elsewhere, "the brain's evolution-tested biofunctional processes evolved as survival solutions to figure–ground (FG) problems . . ." (Iran-Nejad, Marsh, and Clements, 1992, p. 474). The neuron itself does not merely respond to stimuli, but to *variance* in stimuli (otherwise, it quickly habituates). Neurons in congress, as in the retina of the eye, organize in levels of center-surround arrays that further particularize this phenomenon, allowing the brain to respond directly to the permanence and variance of evolutionarily meaningful distinctions in the environment.

While more complex theories of the cognitive processing of internal representations to regulate behavior may seem appropriate for the mighty human intellect, they sure seem a rather fanciful way to explain the behavior of a sea squirt, a salamander, or a squirrel (Cairns–Smith, 1996). In truth, they are perhaps even unlikely explanations for much human behavior as it is difficult to imagine how evolutionary pressures would ever have generated such complex, rigid, and indirect structures to replace simpler, more adaptive, and more direct processes which had the added virtue of being time-tested and perfectly serviceable. So the human capacity for conscious symbolic representation and manipulation is not, as Iran-Nejad notes, an appropriate model for conceptualizing non-conscious brain functioning. The more fundamental processes of the brain (which consumes the lion's share of its attention) require more visceral and environmentally responsive models.

If Gibson's theory of direct perception intimates the need for such visceral and ecological models, it does not actually provide them. Although Iran-Nejad's biofunctional theory does provide such a model, it has little to say about how such processes connect with the organism's ecological surround. This is, I believe, a complementary distinction between the two perspectives, and one worthy of further consideration.

Although Gibson's theory seems biologically credible, Gibson himself was uninterested in the neurological substrate and likely underestimated its complexity (Marr, 1982). As Neisser (1993) points out: "Because Gibson cared little for the study of the brain — and because he insisted on using the term 'direct perception' to describe the pickup of information from the optic array

— it is often assumed that the ecological approach is incompatible with neuroscience. That assumption is quite unjustified . . . . The ecological approach does suggest, however, that we are unlikely to understand the workings of the brain . . . without first having some idea of the task it must accomplish" (p. 158). According to ecological psychologist Edward Reed, "for ecological psychology, the study of psychological processes is a study of *functional adjustment to the environment*, in which input and output are not meaningfully separable" (1996, p. 65, emphasis in the original). It is precisely this neurological lacunae that Iran-Nejad's biofunctional theory cohesively addresses.

An important difference (one of many) between Gibson's ecological psychology and Iran-Nejad's biofunctional theory is in localization of knowledge. While ecological psychologists seem focused on the complementary interaction of organism and environment, the biofunctional theory is focused on the nervous system and the mental processes that emerge from it. While Gibson claims an organism's tacit knowledge derives from direct perception of environmental information in the sensory array, Iran-Nejad maps this knowledge onto an inner landscape, an "internal ground." Indeed, aside from a few vague allusions, this inner ground seems the deepest grounding possible for symbols in Iran-Nejad's model. In effect, he has moved Gibson's directly perceived environment indoors as a non-representational wholetheme. From this emerges direct and indirect representations which are analogous to Gibson's tacit and explicit knowledge. So, to recap, Gibson's "direct perception," which is a process of information pickup from the ambient sensory surround, is quite different from Iran-Nejad's "direct representation," which is comprised of non-symbolic sensory images derived from a wholetheme itself presumably the result of perception, direct of otherwise.

This difference can be somewhat narrowed, however, once the special meanings Gibson attached to "perception," "information," and "environment" are acknowledged. Perceptions are not necessarily conscious, and according to Gibson (1979/1986), "The environment of animals and men is *what they perceive*. The environment is not the same as the physical world, if one means by that the world described by physics" (p. 15, emphasis added). Presuming perception and knowledge require neurological activity of some sort, this would seem to move Gibson's "environment" and the organism's tacit knowledge of it nearer Iran-Nejad's "internal ground" and direct representation. In both cases, the purpose is to facilitate the organism's self-regulation, presumably both internal and external. As Iran-Nejad notes, "The brain's figure–ground system may be described from many different viewpoints" (Iran-Nejad, 2000, p. 73).

Be that as it may, Gibson's ideas do not extend well to developed theories of cognition, culture, and learning (although see Johnston and Pietrewicz, 1985, and Reed, 1996). His is a theory of perception which has implications

for cognition, but does not displace the need for a theory of cognition. As Gibson noted, "The ecological theory of direct perception cannot stand by itself. It implies a new theory of cognition in general" (1979/1986, p. 263). For Reed, the theory of mind that direct perception implies is one where,

> cognition is a life process, not a mechanism. It is dynamic, not static. It is a suite of functions and processes, not a hierarchical system . . . . From the ecological point of view, in which knowing is not separated from living, cognition might best be defined as an animal's capacity to keep in touch with its surroundings . . . . This capacity is everywhere subject to perceptual learning . . . . In the case of human beings, perceptual learning is often a collective process, not a solitary one. (Reed, 1996, p. 169)

To his credit Reed acknowledges recent moves in anthropology and sociology to preserve personal agency against the reification of overly abstract conceptions of culture. He references anthropologist Michael Carrithers who has noted that "Individuals in relationships, and the integrative character of social life, are slightly more important, more real, than those things we designate as culture. According to the culture theory, people do things because of their culture; on the sociality theory, people do things with, to, and in respect of each other, using means that we can describe, if we wish to, as cultural" (1992, p. 35). Such moves have begun to temper sociocultural discourse in education, as witness Wertsch's (1998) theory of mediated action. (Indeed, at an annual meeting of the American Educational Research Association, Wertsch [1999] devoted a considerable portion of his invited address to discussing the implications of Gibson's theory of affordances for educational research!)

But is a demonstration of knowledge the same thing as knowledge itself? Is the enacted evidence of understanding the same thing as understanding? This is a question which haunts the periphery of theories of situated and distributed cognition currently piquing the interest of many educational researchers (Anderson, Reder, and Simon, 1996, 1997; Cobb and Bowers, 1999; Cole, Engeström, and Vasquez, 1997; Greeno, 1997; Kirshner and Whitson, 1997, 1998; Lave and Wegner, 1991). Reed himself connects many of Gibson's concepts to the situativist work on apprenticeship of Lave (1990) and others in this vein. But he is quick to note ecological psychology's extension of these ideas to explain the apparent internalization of social practices, "The appropriation of cultural activities rests on the ability to *see things for oneself*" (Reed, 1996, p. 181, emphasis added).

Given the current need among socioculturally inspired educational researchers for conceptual tools that can move their work beyond mere ethnographic anecdote or theoretic solipsism, the allure of Gibson's thinking is not surprising. Yet, ecological psychology is not sufficient in itself to explain knowledge and knowing. While reasonable people can argue with

the emphases of traditional cognitivist research models, any comprehensive theory of knowledge and understanding must be able to make integrative use of the critical mass of empirical research accruing in psychobiology and the neurosciences. This is precisely why I find Iran-Nejad's work so exciting. The biofunctional theory of knowledge and learning provides a conceptual structure with which to connect a biologically coherent explanation of cognition with an ethologically rich description of human behavior. Moreover, it is precisely along such a connection that I predict the bridging between the neurosciences and education (Hruby, 1999a, 1999b), a bridge others have dismissed as at best premature (Bruer, 1997).

Perhaps knowledge and understanding are not about the mechanics of data processing, but about the organic development of epigenetic, ontogenetic, and phylogenetic adaptations to an ecological surround (Bidell and Fischer, 1997; Hendriks–Jansen, 1996; Michel and Moore, 1995). Perhaps knowledge is not about the algorithmic manipulation of representations, but about the meaningfulness inherent in the organism's relationship to its perceived world (Bruner, 1990; Clancey, 1997; Neisser, 1993). But an understanding of understanding, as Iran-Nejad suggests, requires a disciplinarily integrative approach that is "wholetheme" in nature; that relates, in other words, to the many aspects of our perceived ecological surround — a surround at once physical, biological, psychosocial, cultural, linguistic, personal, sensory and symbolic.

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