increment occurs regularly in elementary schools, in middle schools, and in high schools, and with functionally illiterate young adults.

Summary

Functional models of learning and of knowledge acquisition, including the biofunctional model, provide a unique perspective and a productive approach to the study of learning in schools. Because they focus on the conditions of learning, and on the processes learners use to generate meaning and to learn with understanding, these models are highly relevant to research on the practical problems of instruction and teaching.

The Art of Memory contained structural elements, and some functional elements, that contributed to its power as a model. Among its functional elements were the conditions that fostered learning through the use of imagery and pictures. To this extent, *The Art of Memory* approach facilitated understanding of fundamentally important concepts in ancient and medieval times, in addition to its practical contribution to teaching orators to generate their speeches without notes or other memory aids. For these reasons, the approach has made a venerable contribution to the education of millions of people. However, it is time for us to explore the contributions that contemporary functional models of learning and knowledge acquisition, including the biofunctional model, can make to the understanding and to the design of the conditions of learning and teaching.

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The Journal of Mind and Behavior
Winter and Spring 2000, Volume 21, Numbers 1 and 2
Pages 213–220
ISSN 0271–0137
ISBN 0–930195–11–6

Issues in Self-Regulation Theory and Research

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Three general problems in self-regulation theory and research are discussed in terms of their application to the model of biofunctional cognition. The three problems are: (1) the development of a tractable conceptual foundation and consistent nomenclature for discussing self-regulation, (2) clarification of the structures or components of self-regulation, and (3) clarification of the processes of self-regulation. These issues are discussed in terms of how they apply to the model of dynamic self-regulation as represented in the articles for this special issue. It is suggested that the model of dynamic self-regulation, as well as all models of self-regulation, can be improved by serious theoretical and empirical attention to these issues.

The articles on brain, knowledge, and self-regulation for this special issue represent an intersection of current issues in educational psychology regarding the role of knowledge and self-regulation in learning as well as the relation between psychological models of learning and behavior and models focused on the physiological aspects of brain functioning. As a researcher in the area of self-regulated learning, I have been asked to comment on the articles in this special issue in terms of the issues they raise for self-regulation theory and research. Accordingly, although issues of knowledge and brain processes are interesting, I will limit my response to issues in self-regulation.

The area of self-regulation in general, and self-regulated learning in education specifically, is a very popular research topic currently. For example, there is a new *Handbook of Self-Regulation* (Boekaerts, Pintrich, and Zeidner, 2000a) which examines how different theories and models of self-regulation are being used in many different areas of psychology including social, personality, developmental, organizational, clinical, educational, and health. Of

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course, given all these different fields of inquiry, the use of self-regulation models and constructs is quite diverse and there are few commonalities among the different models. As Zeidner, Boekaerts, and Pintrich (2000) have pointed out, there are many theoretical, conceptual, and empirical issues left to be resolved in the area of self-regulation theory and research. The current articles in this special issue raise some of the same issues regarding the use of self-regulation constructs and models. I will comment on three general issues that are generated by the articles here.

First, as Zeidner et al. (2000) note, a key issue for research on self-regulation is the development of a tractable conceptual foundation and consistent terminology of self-regulation constructs. There are many extant models of self-regulation and these varied models often use different terms for similar components and processes and similar terms for different components and processes (see Boekaerts et al., 2000a, for numerous examples). Of course, it makes scientific progress very difficult if researchers in the area can't agree on the conceptual foundations and nomenclature of the constructs. There is a clear need for theoretical and empirical work to clarify these issues. Of course, there may never be "one" model or theory, but it seems crucial that we have agreement on the basic components and processes.

In the set of articles in this special issue, the model of biofunctional cognition suggests that there are two systems of self-regulation, one labeled active self-regulation and the other one labeled dynamic self-regulation. Active self-regulation is the more normative process of self-regulation that is conscious, intentional, effortful, and involves the regulation of attentional resources, cognitive and metacognitive strategies, and presumably motivational, volitional, and behavioral resources as well. This process, although not specified in much detail here, is similar to many social cognitive models of self-regulation (see Boekaerts et al., 2000b). In contrast, the process of dynamic self-regulation as proposed in these special issue articles is not conscious, occurs outside the spotlight focus of active attention, operates spontaneously and flexibly across many domains simultaneously, involves tacit and implicit knowledge as well as intuitive self-awareness, and is closely tied to brain functioning and the interaction of brain systems and subsystems.

Although neither of these self-regulation processes is specified in much detail here, it seems clear that dynamic self-regulation processes are being proposed as one way to describe knowledge and skill acquisition, learning, and actual performance that occur without active, conscious self-regulation. For example, as the articles in this issue point out, individuals may learn vocabulary in a second language without active self-regulation or drive a car on different road conditions without much conscious and effortful self-regulation. Moreover, the model of biofunctional cognition suggests that the

dynamic processes of self-regulation are not completely isomorphic with automaticity as traditionally defined in information processing and cognitive models of memory and learning. This proposal is certainly a useful one as it seems likely that there are many types of activities and learning processes that are not actively self-regulated or that are automatized after concerted practice. In fact, a common criticism of social cognitive models of self-regulation is that they often describe a very elaborate process of goal-setting, monitoring, evaluating, and making decisions that just seems too cognitive and metacognitive for many daily activities. In some ways, these cognitive and metacognitive decision making models may be open to the old behaviorist criticism of Tolman's rats that were "lost in thought" and could not perform. In this sense, a second type of dynamic regulatory system may be a useful complementary system to the active model of self-regulation in order to cover many activities that are not so consciously, intentionally controlled and regulated.

On the other hand, it is not clear to me how much the dynamic system in the biofunctional cognitive model is similar to the cybernetic systems approach that has been used in organizational psychology to describe how different levels within a system communicate with one another (see Vancouver, 2000, for a review). Common adaptations of this general approach include perceptual control theory (Powers, 1978) as well as Carver and Scheier's (1998) model of self-regulation. In the cybernetic systems approach there are multiple levels (or subsystems) in the larger system that communicate with one another through the various input, output, and comparator functions in the system. These cybernetic models have been outlined in some detail, have empirical support, and seem to be very dynamic models that accomplish many of the same functions as the dynamic biofunctional cognition approach. The cybernetic models seem to allow for both more deliberate active self-regulation as well as relatively automatic and less effortful self-regulation. Moreover, they attempt to specify the processes by which the different subsystems or levels within the system communicate with one another. However, there is little apparent overlap in the terminology used or constructs in the dynamic model proposed here and these cybernetic models. Accordingly, the problem of a lack of a common nomenclature and conceptual foundation is demonstrated again when comparing the dynamic biofunctional model to other extant models of self-regulation.

A second general issue, related to the first issue of a lack of common terminology and conceptual framework, is the clarification and specification of the structures and components of self-regulation (Zeidner et al., 2000). Or, in other words, what is being regulated in the model? Although the articles in this special issue do not represent a formal explication of all the components involved in dynamic regulation, there is discussion of what structures

or components are involved in dynamic regulation. For example, in the article by Iran-Nejad (2000, this issue) on "Knowledge, Self-Regulation, and the Brain–Mind Cycle of Reflection," there are various components described. The two components of intuitive self-awareness are thematic knowledge (TK) and categorical knowledge (CK), and thematic knowledge is further divided into themes and wholethemes, and wholethemes can include direct and indirect representations.

Besides the fact that many of these terms do not map directly onto more common, but seemingly similar, terms used in other models of cognition and self-regulation (again, the first problem of lack of a common terminology occurs), it is also not really clear to me how they operate to promote self-regulation. In this sense, the structure of what is being operated on or regulated is not defined very well. First, in terms of the structures or components of self-regulation, it seems that knowledge, whether called declarative and procedural knowledge in more common terms, or thematic and categorical knowledge in the biofunctional model, is one structure that is being regulated. This is an important issue because many models of self-regulation focus more on general processes and do not consider very seriously the role of prior conceptual knowledge. There is a clear need to integrate knowledge-driven models regarding expertise and performance with more process-oriented models of self-regulation and self-regulated learning (Pintrich, 2000). Accordingly, the biofunctional model is a good attempt to integrate knowledge and self-regulation components. However, there should be more overlap in the terminology used so that comparisons and synthesis across models can be more readily accomplished.

In addition, knowledge is not the only component that can be regulated. Most models of self-regulation suggest that cognition, motivation, affect, volition, as well as actual behavior can be regulated to varying degrees by an individual (Pintrich, 2000). It is not clear to me whether the model of biofunctional cognition is a general model of regulation that can be applied to all components of cognition, knowledge being one aspect of cognition, as well as various motivational, affective, volitional, and behavioral components in line with a general cybernetic approach. Or, is it mainly designed to describe how knowledge, behavior, and actual brain systems are regulated? This type of clarification and more detailed specification needs to be worked out in future versions of the model of biofunctional cognition.

Moving beyond the issue of clarifying the structure of what is being regulated, the third general issue concerns the need for better specification of the processes of regulation (Zeidner et al., 2000). Or, in other words, how does self-regulation take place? There are many different processes mentioned in the special issue articles including ongoing brain activity (OBA), momentary constellation firing (MCF), as well as propositional and dispositional com-

prehension, wholetheme reorganization of knowledge, and biofunctional automaticity or a series of self-guided insights. Although these processes are described and examples given, it is still not really clear to me how regulation really works in the dynamic model of biofunctional cognition. It seems to be implied that regulation is constantly ongoing, but there still should be some ways in which different systems or subsystems are started up or activated and also some processes for stopping the system or subsystem activities. It is not clear to me, but in many of the examples (reading a story, learning new vocabulary, driving a car), it seems that contextual features of the external environment activate or stop the biofunctional system, but the general model suggests that many internal cues can also be part of the self-regulatory system. However, the relations between these external and internal cues is never really set forth.

One of the main difficulties in specifying the processes involved in the biofunctional model of dynamic self-regulation is the seeming lack of a goal-setting or standard specification process. One of the main commonalities of almost all models of self-regulation is the fact that some goal-related construct is used in the model (Boekaerts et al., 2000b; Zeidner et al., 2000). This goal then represents a criterion by which progress is monitored and assessed and then efforts to regulate are guided by feedback on progress toward or away from the goal. This is true of models that propose a more active and conscious process of self-regulation, as in many social cognitive and decision making models of self-regulation and self-regulated learning. It is also true in more cybernetic models that propose some goal, standard, or criterion by which a comparator function makes comparisons to, as in the operation of a simple thermostat (which obviously requires no conscious being), as well as in the self-regulation effort of a conscious human being. Essentially, the goal or standard provides not only guidance for regulation efforts, it also provides a "stopping" rule for when regulatory behaviors can be completed and allows the individual to move onto another task.

However, in the biofunctional cognition model it is not apparent to me what the goal or standard is, or where it comes from, or how it is generated from the person interacting with the context, or how different systems or subsystems set goals or standards. At some level, the biofunctional model may rest on a general assumption that the systems or subsystems are always working toward maintaining equilibrium or avoiding disequilibrium. This would provide the stopping rule, that is, when the system reaches equilibrium, then efforts to regulate are completed and the system is not activated again until there is some new perturbation in the system. This may be useful in models that attempt to describe regulation based on the operation of brain and physiological functions. And it is certainly a time-honored assumption that has served cognitive developmental models (e.g., Piagetian theory) and

social psychological models of dissonance reduction well, but it seems rather vague at this point in the development of our models of self-regulation.

Moreover, as Zimmerman (2000) has pointed out, the difficulty with discrepancy reduction as a principle in cybernetic closed-loop systems is that it does not allow for the fact that individuals sometime attempt to create discrepancies in order to develop their skills or adapt their behavior. Students often choose to try harder tasks in order to learn more. Athletes often choose to compete against stronger players by changing their league or moving up in the rankings of players. Individuals move to new jobs that provide a challenge in order to learn new skills. In this case, open-loop systems that allow for the active, intentional production of disequilibrium or discrepancies through the setting of higher goals or standards seem to reflect an important aspect of active self-regulation in humans. It is not clear to me how the model of biofunctional cognition deals with goals, standards, or active, intentional attempts to produce discrepancies between behavior and goals or standards.

In summary, the three general problems of developing a consistent framework and terminology for self-regulation, specifying the structure or components of self-regulation, and clarifying the processes of self-regulation, are common to all models of self-regulation, not just the biofunctional cognition model (Boekaerts et al., 2000b; Zeidner et al., 2000). Nevertheless, the biofunctional cognition model would benefit from serious consideration of these problems in the refinement of the theoretical propositions of the model as well as the empirical support for the model. As we all attempt to develop better models of self-regulation that are theoretically generative, empirically supported, and also useful in practice, these three problems can serve as good goals or standards to strive for in our own research. As we attempt to approach these goals, they can serve as useful guides to monitor and regulate our own scientific work on self-regulation and hopefully lead us to more productive and fruitful exchanges as well as to a better understanding of how individuals self-regulate and learn in different contexts.

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The Journal of Mind and Behavior
Winter and Spring 2000, Volume 21, Numbers 1 and 2
Pages 221–234
ISSN 0271–0137
ISBN 0–930195–11–6

Heeding Prawat and Hruby: Toward an Articulation Between Biofunctional and Postmodern Theories of Human Experience

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In this essay, Rosiek and Iran-Nejad embrace the advice of Prawat (2000) and Hruby (2000) to explore the possibility of an interdisciplinary articulation between biofunctionalist psychological theory and postmodern socio-cultural theory. Whereas postmodernists interpret the social production of understanding as a function of the nature of language and symbols — things external to the human organism — biofunctional theory views understanding, in both its individual and social manifestation, as the immediate accomplishment of bodily systems — things internal to the human organism. Selected affinities between these two apparently different traditions of thought are examined, starting with Wittgenstein. This exploration is extended to continental philosophy and social science — including phenomenology, Heideggerian existentialism, structuralism, and contemporary postmodernism. Specific places are identified where: (1) the integration of theoretical frameworks seems possible; (2) collaboration at the level of empirical research seems possible; and (3) the philosophy of John Dewey and Charles Sanders Peirce will be of assistance in accomplishing this articulation. Following this, significant remaining disciplinary divergences are acknowledged and examined, but are not found to preclude the value of continuing in this exploration.

The commentaries in this special issue by Prawat (2000) and Hruby (2000) on Iran-Nejad's (2000, this issue) biofunctional brain–mind cycle of reflection theory, biofunctional theory for short, complement as well as favorably contrast one another. Both recommend interdisciplinary expansion of the theory and identify research to which it might be productively applied. Prawat, on the one hand, suggests that (a) the postmodern cultural critical

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theory has "beat Iran-Nejad to the punch" (p. 91) in identifying the centrality of the role tacit knowledge plays in human experience, (b) the solution the theory offers is on target, and, therefore, (c) Iran-Nejad would be wise to expand the problem domain of his solution to encompass contemporary postmodern theories. Specifically Prawat directs our attention to the works of Charles Sanders Peirce and John Dewey as most relevant sources for the facilitation of the proposed cross-disciplinary articulation (p. 94). Hruby, on the other hand, identifies resonances between biofunctional theory and Gibson's ecological approach. He attributes some of the current appeal of Gibson's theories to weaknesses in contemporary sociocultural theory. He states that there is a "need among socioculturally inspired educational researchers for conceptual tools that can move their work beyond mere ethnographic anecdote or theoretic solipsism" (p. 101). Gibson's work, he claims, is inadequate for the job and biofunctional theory might serve this purpose better.

Starting from very different points of departure, the two commentaries point toward a common horizon for interdisciplinary research on human agency. We find the critiques salutary and the horizon appealing. In what follows we take a few steps in the direction they suggest. The result we hope to achieve is a preliminary identification of some of the unique contributions contemporary psychological studies of human self-regulation can make to wider cross-domain efforts to understand human agency.

Beyond Wittgenstein

The first step in this articulation will be identifying a bit more explicitly the philosophical roots of postmodernism. According to the commentators, biofunctional theory can be enriched by broadening its scope to include postmodern insights about social influences on understanding, while postmodernists might benefit from biofunctional explorations of how understanding occurs at the individual as well as physiological level. Whereas postmodernists interpret the social production of understanding as a function of the nature of language and symbols, things external to the human organism, biofunctional theory views understanding, in both its individual and social manifestation, as the immediate accomplishment of bodily systems, things internal to the human organism. Prawat suggests that both of these lines of analysis are important elements of the interdisciplinary approach to research on human meaning making.

Prawat points to Wittgenstein's writings for an illustration of the postmodern styles of analysis. To address the problem of tacit knowledge, Wittgenstein (1987) took advantage of the distinction between "knowing how" and "knowing that," suggesting that tacit knowledge is "knowing how"

to use something without "knowing that" which is being used. "Knowing how to use" type understanding occurs outside the realm of conscious knowing altogether and is made possible in part by "family resemblances" that exist among linguistically framed concepts.[1] These family resemblances are the way, according to Wittgenstein, that our mind provides both stability and flexibility to our understanding of the world. How do family resemblances between concepts arise so well-suited for use, especially if we are not even aware of their existence before they come to our conscious understanding? Wittgenstein, Prawat suggests, did not have the answer to this "how" question, which is where the biofunctional theory's solution to the mind–body problem comes in. What makes understanding outside the realm of conscious attention possible is dynamic self-regulation. According to biofunctional theory, whereas conscious attention is mind-regulated, dynamic self-regulation is directly brain-regulated. Together, these two sources of self-regulation make tacit and explicit knowing and understanding possible (Iran-Nejad, 1990, 2000, this issue). Thus, a rapprochement between Wittgenstein's theory of knowledge use and the biofunctional theory, Prawat concludes, would be worth the trouble because it would constitute a significant step beyond Wittgenstein, on the one hand, and make the biofunctional theory more salient to a wider array of philosophical problems, not the least of which is the mind–body problem.

Making Contact with Phenomenology

As Prawat suggests, with Wittgenstein we are only at the beginning of the recommended journey toward an integration of postmodern and biofunctional theories. One literature with which we may continue this journey, we offer, is early twentieth century continental philosophy, especially the tradition of phenomenology. The phenomenal experience that constitutes the phenomenologist's primary object of analysis is familiar territory to biofunctional theory (Iran-Nejad, 1980, 1987):

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[1] Consider the statements *The rock held the door, The pole held the roof, The ceiling held its weight, The box held the door,* and *The teachers held a conference.* Wittgenstein argued that no fixed set of relationships can be said to exist across all and every use of a concept such as "held," which could be identified as its core meaning. Instead, we are able to identify the different uses as belonging to the same word in the same way that we might understand the different members of the same family to belong together — two members may share no similarities at all but still be understood as being brothers or sisters by virtue of the overlapping similarities they each manifest with other members of the family. On the other hand, the fact that the subtle nuances of meaning for a concept serve to intrigue us as we go from one use to the next indicates that we are not ordinarily aware of these subtleties until the contrast in use brings them to our conscious attention, hence the notion of tacit knowledge (see Anderson, 1984).

> Underlying cognitive patterns are, according to the structural assumption just discussed, relatively permanent, frame-like, knowledge structures with long-term internal connections. Counterintuitive as it may seem at first, it is entirely conceivable, however, that [what is generally seen as] the patterning aspect of cognition is a transient functional–phenomenal, rather than long-term memory structural, organization. (1987, p. 115)

Particularly relevant, as far as this integration is concerned, are the limitations phenomenologists discovered in knowledge produced through conscious representational processes. Phenomenology, starting with the work of Husserl (1964) and continuing later with Heidegger (1962), Schutz (1932; Schutz and Luckmann, 1973), and Merleau–Ponty (1962) did not begin as an analysis of "tacit knowledge." It began as an attempt to describe the essential contents of consciousness, and to use those contents as the ground of all other forms of knowledge. Very early in this project, however, phenomenologists recognized the need to distinguish between the experience of phenomena that was the product of conscious reflection and the pre-reflective pre-phenomenal kind of experience. Iran-Nejad and Ortony (1984) discuss the pre-phenomenal aspect of the human experience in detail under the rubric of "pre-subjective foundations of the schema-of-the-moment" (pp. 184–196).

The pre-reflective aspect of the human experience was referred to as *Erlebnis* or lived-experience by Husserl (1964) and Schutz (1932); and was assumed to exceed our ability to know objects of direct perception. According to Husserl (1964):

> We must, therefore, distinguish between the empirical being of the lived experiences, their being prior to the reflective glance of attention directed toward them, and their being as phenomena. Through the attending directed glance of attention and comprehension, the lived experience acquires a new mode of being. *It comes to be "differentiated," "thrown into relief,"* and this act of differentiation is nothing other than the act of comprehension. (p. 178)

Erlebnis, according to the phenomenologists, can never be consciously known, because as soon as the object of inquiry is consciously reflected upon, it is caught within the mind's eye of reflection, which edits and transforms it into recognizable phenomena. In biofunctional theory, this pre-subjective foundation of self-reflection is nothing other than the brain itself at work creating both the figure and the ground of the ongoing phenomenal experience (Iran-Nejad, Marsh, and Clements, 1992).

At this point, the soundness of Prawat's advice to expand the scope of biofunctional theory becomes clear. Biofunctionalists share with phenomenologists a sense that substantive inquiry into human processes of understanding requires entering the realm of pre-reflective foundations of that understanding. Iran-Nejad (2000) illustrates these concerns by noting that the statement "I know how to know" lacks meaningfulness (p. 69), making

paramount the distinction between insights about what we know and insights about the (biofunctional) process by which knowing and understanding come about. Paralleling the phenomenological analysis, Iran-Nejad claims that the latter kind of biofunctional know-how is impossible to access through self-examination of phenomenological experience (p. 70).

Phenomenology and the Ontological Status of Tacit Knowledge

The phenomenologists have treated the tacit knowledge/explicit knowledge problem as something that could be resolved through rational reflection and introspection. Iran-Nejad, by way of contrast, speaks primarily of those tacit forms of understanding that are beyond the reach of individual self-awareness because they belong to the realm of brain functioning. Thus, the biofunctional approach has the potential to add something empirical to the rationalism of phenomenological analysis. The phenomenologists, however, through their rationalist approach came upon an implication of the tacit/explicit knowledge problem that can also deepen the biofunctional analysis.

The unique contribution of the phenomenologists lies in the way they treated the tacit knowledge question not just as an epistemological issue, but also as an ontological one. What sort of *being*, what sort of reality, are we privileging when we emphasize the aspects of our experience that we can consciously know? This eventually became the key question for phenomenologists. Heidegger (1962) offered what remains the most influential answer to this question. He asserted that those things which we know through conscious reflection have a peculiar kind of ontological status that he called "presence-at-hand" [*Vorhandenheit*] (p. 88). Things that we tacitly know through working with them have another kind of ontological status that he called "readiness-to-hand" [*Zuhandenheit*] (p. 98). For example, a car that we know how to drive is ready-to-hand; we do not know its being directly, but only indirectly, through the driving. But if the car breaks down, its being changes for us. Suddenly it becomes the object of conscious observation and inquiry; it is present-at-hand.[2] Of readiness-to-hand Heidegger (1962) said:

> The ready-to-hand is not grasped theoretically at all, nor is it itself the sort of thing that circumspection takes proximally as a circumspective theme. The peculiarity of what is proximally ready-to-hand is that, in its readiness-to-hand, it must, as it were, withdraw in order to be ready-to-hand quite authentically . . . . That with which we primarily concern ourselves is the work — that which is to be produced at the time. (p. 99)

[2]Heidegger's ontological categories of "present-at-hand" and "ready-to-hand" are similar to Wittgenstein's epistemological distinction between "knowledge that" and "knowledge how." That being said, it is important to note that Heidegger's writing predates Wittgenstein's and that he analyzed both the epistemic and ontological implications of such distinctions.

This is very similar to the kind of reasoning Iran-Nejad (2000) cites as justification for finding a place in education for the brain's own dynamic self-regulation. Dynamic self-regulation relieves conscious or active self-regulation of the paralyzing burden that it would otherwise have to carry to make complex real-world tasks possible. Iran-Nejad refers to our inability to "know how we understand" because that "know how" resides in the brain outside of the reach of our consciousness (p. 70). If our conscious attention does not regulate that which lies outside its grasp, then, according to the biofunctional theory, it is the brain itself that does so through so-called dynamic self-regulation (Iran-Nejad, 1990; Iran-Nejad and Chissom, 1992).

Once again the differences remain a matter of focus as well as of philosophical depth. Where Iran-Nejad asks what biofunctional sources regulate the kind of understanding that seems to be done for us in the background, so to speak, as opposed to by us (i.e., consciously), Heidegger (1962) asks what the existence of such understanding can mean for the things we include in our definition of reality. By casting the tacit/explicit knowledge dilemma as an ontological, as well as an epistemological issue, Heidegger accomplished on a philosophical plane what biofunctional theory set out to accomplish within psychological theory: to provide alternatives to the distorting influence of conduit metaphors (Iran-Nejad, 1990; 2000; Reddy, 1979). Conduit metaphors of knowledge assume an empty vessel of consciousness that is filled by knowledge of all sorts, tacit as well as explicit. Heidegger revealed how this view of knowledge has ontological implications. What "is," according to Heidegger, includes objects separate from human consciousness, but it also includes the relations between us and the objects. Heidegger turned the relationship between epistemology and ontology around; instead of making what has "being" a subset of what is known, he made what is known a subset of what has "being."

In doing so, Heidegger (1962) identified a huge cultural misstep in the persistent Western habit of assuming that what "is" is the same as what we can know in the conduit metaphor sense of knowing. To expand our sense of knowing is to expand our sense of what *is*, not just what can be known. Heidegger's unique contribution lies in his recognition of this and his articulation of an expanded ontology. This expanded relational ontology is one of the things the phenomenological tradition and its postmodern successors have to offer to biofunctional theories of human knowing.

To admit a relational ontology changes a great many things. It essentially puts an end to the original phenomenological project of identifying the essential elements of consciousness.[3] If the reality of conscious experience is relational, then it can no longer be described simply as having an analyzable

[3]This does not, however, suggest that phenomenological methods of analysis are useless. It simply means they are inadequate for this one extremely ambitious project. They may still be

"content." And if it is relational, meaning dependent on context for its identity, then nothing about it is essential. *This* is the door through which most of what we now call "postmodernism" enters the scene. Iran-Nejad does not explicitly address the ontological implications of his inquiry. But the implications he does trace out for his brain–mind cycle theory of reflection shares, in part, the trajectory taken by postmodern thought. These parallels, we offer, are a good place to begin an articulation between postmodern cultural critical theory and contemporary cognitive science.

Among the most revolutionary features of Heidegger's (1962) relational ontology was its implication that *Being*, reality, is influenced by the sociocultural features of the time and place in which we find ourselves. In other words he historicized ontology; our most fundamental reality was no longer identified with the eternal and unchanging, but in Heidegger's philosophy became a product of historical and social processes. Iran-Nejad, by way of comparison, does not historicize his notion of tacit knowledge, *at least not in a social history*. The brain's ability to understand, according to biofunctional theory, is something that operates beyond our conscious awareness and does not depend on any particular social condition for its functioning.[4] But Iran-Nejad *does* historicize our ability to understand in biological history. He suggests that this capacity is a product of the evolution of the organism (2000, p. 80). We don't learn the kind of know-how that makes tacit understanding possible; the brain has learned it, through evolution.

Why do these two modes of historical contextualization need to be kept separate in our analyses? Prawat recommends Dewey's work as one possible place to look for help toward a synthesis. Dewey was neither a phenomenologist, nor a social-scientific empiricist. His philosophy was a sustained attempt to conceptually integrate these two kinds of analysis. More than any other recent philosopher, Dewey (1958) conceived of the mental manifestations of biological and social processes of adaptation as continuous. One of the specific places Dewey's philosophy might help us, we offer, is in integrating this analysis of the social and biological history of tacit understanding processes.

Joining Programs of Empirical Research: Structuralism, Poststructuralism, and Biofunctionalism

Any truly robust articulation between biofunctionalism and postmodernism would need to happen at both the conceptual and the empirical

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deployed profitably in the analysis of a wide variety of experiences, including the experience of teaching and learning (Van Manen, 1988).

[4]These operations, of course, can be influenced by consciousness and our social environment via the brain–mind cycle of reflection, however, the origin of their activity lies outside of consciousness.

levels. Presumably, as a psychological theory, biofunctionalism will provide the foundation for empirical programs of research on the brain–mind cycle of reflection including the contributions of thematic and wholethematic contents of the intuitive self-awareness. Other lines of empirical research might explore biofunctional implications of the brain's electrical activity (see Iran-Nejad, 2000). Very few of the early phenomenologists, given their rationalist orientation, have taken the step into empirical investigation. Within the continental tradition of social science, empirical investigations of the way social activity shaped human understanding was taken up by a group of linguists, anthropologists, sociologists, and literary critics known as the *structuralists*.[5]

Ferdinand de Saussure (1915), a contemporary of the early phenomenologists, independently invented a method of analyzing relational forms of meaning. His was originally a framework for analyzing language systems as a whole structure in which individual elements — signs — get their meaning only in relation to other elements of the system. Language systems, according to de Saussure, were socially distributed phenomena, and as such could be analyzed independently of the functioning of individual minds.

The structuralists picked up de Saussure's theory of signs, or *semiotics*, and used it to address the empirical questions left unanswered by phenomenology (Dosse, 1997). If human knowledge and reality were in part tacit and relational, then those relations obviously included relations between people — in other words, reality was a socially distributed phenomena. The structuralists treated the tacit relational dimension of human experience like a language, as a system of socially distributed signs that could be analyzed semiotically. Depending on which structuralist you read, Levi–Strauss (1969), Lacan (1977), Foucault (1970, 1977), Barthes (1957), various theories are offered about the content and sources of tacit background knowledge. All, however, shared a practice of locating evidence for that structure in cultural traditions, such as kinship systems or taboos (Levi–Strauss, 1969), or in the cultural practices of historical epochs (Foucault, 1977), or in the language and iconography of literature and popular culture (Barthes, 1957).

In retrospect it seems clear that the structuralists overestimated the stability of socially distributed meaning, and this led them to reify specific structures as a necessary feature of all human meaning. Despite this ontological overinterpretation, they nonetheless amassed a considerable amount of empirical evidence that documented profound similarities in the way human communities all over the planet and throughout human history organize their shared understanding of the world — for example, through reifying

[5]For an excellent summary of the historical development of this school of social analysis, we recommend Francois Dosse's (1997), *History of Structuralism*, Volumes I and II.

binary oppositions, generating narratives of normality and abnormality, producing elaborate taken-for-granted cosmologies that justify social status hierarchies, and so forth.

Although it is the most empirically productive theory in continental social science, and is one of the primary disciplines that gave rise to contemporary postmodern social science, sociological structuralism does not provide sufficient parallels for integrating postmodern and biofunctionalist programs of research. Iran-Nejad's biofunctionalist theory of the brain–mind cycle of reflection explicitly rejects all psychological versions of structuralism (Iran-Nejad, 1987; Iran-Nejad and Winsler, 2000, this issue). Iran-Nejad has described "themes" and "wholethemes" as psychologically distributed forms of understanding. Although he has not yet explored the role of these types of knowledge in socially distributed forms of understanding, one of the key features of biofunctionalism is that it rejects the reification of specific mental structures of meaning. Iran-Nejad and Cecil (1992) have characterized human wholetheme understanding as being "inordinately stable" and, at the same time, "infinitely flexible." As such, any theoretical articulation with structuralism research seems unlikely.

Poststructuralism, the parent theory of most postmodernism, provides a more apt place for making these connections at the level of empirical research. Poststructuralists, such as Jacques Derrida (1972, 1974), for the most part adopted structuralist modes of analysis. In other words, they analyzed human understanding as a socially distributed phenomenon that can be analyzed like a language. However, they turned structuralist analysis on its own rhetoric, and exposed the way structuralists reified structure. The logical implication was that while patterns of meaning may be present, they can never be conclusively shown to be a necessary feature of human nature (Derrida, 1972; Dosse, 1997). The parallels to Iran-Nejad's rejection of psychological structuralism (Iran-Nejad, 1980, 1987) should be clear. According to the poststucturalists, stable patterns of human meaning-making appear ubiquitous ("inordinately stable"), however, human meaning is always at play in a process of infinite semiosis ("infinitely flexible").

The general challenge, it seems, of doing research on distributed forms of meaning, be they social or psychological, lies in identifying forms of evidence that can provide insight into the nature of that meaning. The further challenge lies in avoiding the reification of patterns of understandings immediately available for empirical observation. Biofunctional psychology and poststructural sociology meet these challenges. Here, then, is yet another site where the proposed articulation might take place — a comparison and integration of the types of evidence used in these two traditions to identify and analyze the distributed nature of tacit knowledge.

Biofunctionalism and Postmodernism: Challenges to Interdisciplinary Collaboration

So far we have emphasized some selected affinities between Iran-Nejad's cognitive scientific theories and the recent history of sociocultural research. Differences exist as well, differences that may be generative sites for discussion, but which will pose a significant challenge to any effort at integrating these two traditions of research. We find the most significant of these differences to be related to the academic developments that followed poststructuralism, namely postmodernism.

The first of these challenges is internal to interpretive sociocultural scholarship, one already acknowledged by a wide variety of postmodern scholars (Bauman, 1993; Butler, 1997; Eagleton, 1996; Haraway, 1991, 1997; Ortner, 1996; Rorty, 1989; Rosenau, 1992; West, 1993) and alluded to by Hruby in his commentary (2000, p. 101). It has to do, most basically, with an assumption on the part of many postmodern writers that signs get their meaning only in relation to other signs. This assumption, traceable to the semiotic theories of de Saussure (1915), leads in some cases to anti-realist conceptions of human meaning. The resulting emphasis on cultural contingency, on the one hand, is salutary, because it inhibits the reification of cultural categories like, individuality, truth, race, normality, intelligence — just to name a few — that have had such brutal effects on people's lives. On the other hand, such conceptions in their extreme forms seem not only to defy our common sense, but also to frustrate efforts to acknowledge and respond to the reality of suffering and injustice in our world (Haraway, 1991; West, 1993).

Hruby offers that Iran-Nejad's biofunctional theory of self-knowledge may provide a tonic for the latter sort of postmodern excess. Iran-Nejad distances his own position from that of information processing theory, which shares with Saussurean semiotics the assumption that symbols get their meaning from relations to other symbols. Human understanding, according to Iran-Nejad, "is more than the sum of elements involved in interconnections that result from a constructive elaboration process" (2000, p. 70). He proposes, instead, that we ground our understanding of "understanding" in the reality of brain functioning. The brain, he argues, builds figure–ground relations to our environment that are pre-representational. The processes underlying tacit knowing may not be immediately transparent to us, but we can empirically know things about brain functioning, and armed with this knowledge we may be able to infer something about the reality of human mental experience.

This suggests quite a chasm, between a postmodern anti-realism that emphasizes the cultural contingency of our tacit and explicit knowledge and a psychological realism that grounds this tacit knowledge in the biological reality of brain functioning. Here again Prawat's advice about pathways to integration seems sound. He suggests that Iran-Nejad look at the work of

Charles Sanders Peirce. Peirce (1955), independently of his contemporary de Saussure (1915), developed an alternative theory of semiotics. Peirce's semiotics took into account a wider variety of sign activity than did de Saussure's, and was capable of simultaneously emphasizing the cultural contingency of sign activity while still allowing for realist commitments.

Peirce's (1955) semiotics, like de Saussure's, emphasized that the relationship between linguistic signs and their referents is arbitrary. And he recognized that this can lead to an infinite play of meaning for any given sign — something Peirce and Derrida (1974) called "infinite semiosis." This is similar to the kind of situation that Iran-Nejad identifies as fertile ground for the symbol-grounding problem. Peirce, however, also allowed for what he called "iconic signs" (1955, p. 104), signs that have direct relationships to the things they signify — such as a weather vane that points in the direction of the wind because the wind blows on it, or the needle on a fuel gauge that moves because of a physical relation to the liquid in a fuel tank. Such connections between signifiers and what they signify still permit that the meaning of these signs can pass through infinitely many more layers of cultural mediation, but that at some level they can and occasionally do get connected to an extra-human reality. Peirce, to our knowledge, never applied this insight to the reality of mental phenomena, however nothing in his theory excludes such a possibility. If we read Iran-Nejad's biofunctionalist theory of the brain–mind cycle of reflection as suggesting that iconic signs exist at the level of brain function, as well as existing external to the organism, then Hruby may be correct. This theory may provide the beginnings of a bridge over the disciplinary chasm mentioned above.

The second challenge posed by these disciplinary differences concerns reflexiveness in social scientific analysis. One of the most profound insights of contemporary sociocultural scholarship has been the way it has turned its methods for analyzing other cultures and people onto its own rhetoric and practices. The singular contribution of Derrida (1974) was the way he used structuralist theories of human meaning-making to analyze the works of structuralist writers themselves — a practice that, once elaborated upon, came to be known as poststructuralism. He demonstrated that indeed, those theories were also examples of a certain kind of cultural production. Disconcertingly, this both empirically corroborated structuralist theories *and* called into question their structuralism's claim to have arrived at truths that transcended culture. This mode of self-reflexive analysis was applied to other tacit assumptions that constitute modern Western culture — e.g., Western philosophy, science, theories of governance, etc. — a practice that, once elaborated upon, came to be known as postmodernism.

Postmodern cultural critique calls into question all forms of taken-for-granted cultural authority, including the authority accorded to scientific and

social scientific knowledge. This, not surprisingly, has inspired frequent defensive dismissals from within the social scientific community. Increasingly, however, scholars who study human experience are taking postmodern critique to heart and are becoming more critical about the tacit cultural influences on their own research — for example, how the unit of analysis for their research is determined, the way their research topics are chosen, and how their research will be interpreted in the broader cultural discourses into which it feeds.

This is something that psychology, as a field, has been slow to do. There are exceptions of course, such as Richard Valencia's (1997) outstanding book, *The Evolution of Deficit Thinking*. Valencia is an educational psychologist who has examined the way in which using the individual as the unit of analysis in psychology has historically lent itself to theories about school failure that, in effect, "blame the victim." Low performing students have been diagnosed as being "genetically inferior," "culturally deprived," "lacking in self-esteem," "lacking in motivation," "possessing different learning styles," and so forth. The problem is almost always, according to Valencia, located by educational psychologists in the individual child or the child's family, and not in the institutionalized classism and racism in which children are so often immersed. To explain this peculiar myopia, we need to look beyond the bounds of the discipline at the cultural conditions that produce and sustain educational psychological research. To rectify it, we need scholars capable of this sort of disciplinary self-reflexive analysis.

Self-reflexive analysis is now a permanent and central feature of contemporary sociocultural research. No integration between this postmodern cultural critical scholarship and contemporary cognitive psychology that seeks exemption from the demands of such disciplinary self-interrogation is likely. Iran-Nejad's theory, while it provides much with which to build bridges, has done less to provide a model of this kind of reflexivity for psychological research. Such a thing, however, is not in principle impossible. Valencia (1997) provides one example. There may be others. Hopefully there will be many more.

In summary then, we agree with Prawat and Hruby that an interdisciplinary approach to research on tacit knowledge and self-regulation is desirable. We are encouraged by their suggestion that the biofunctional theory of the brain–mind cycle of reflection may contribute constructively to such an interdisciplinary program of research. We have attempted to identify where, specifically, Iran-Nejad's theory might make contacts with contemporary postmodern scholarship. Among the connection points biofunctionalism provides are: (1) a biofunctional explanation of the operation of what Wittgenstein called "family resemblances" between concepts; (2) a biofunctional explanation of some parts of what phenomenologists called *Erlebnis*,

the aspect of our experience that is beyond our ability to consciously represent it; (3) a distinctively psychological parallel to postmodern sociocultural historicism (e.g., Heidegger) in the form of a biologically historicized view of mental function; and, perhaps most profoundly, (4) a program of psychological research that conceives of individual human understanding as a stable distributed phenomenon without reifying that stability, which is very similar to the way poststructural sociologists conceive of their empirical research enterprises on socially distributed meaning.

We also agree with Prawat that the philosophy of Charles Sanders Peirce and John Dewey will be important resources in this effort. Peirce's realist semiotics provides a foundation for creating a theoretical framework that might retain the best features of postmodern self-reflexive criticism and psychological scientific realism. Dewey developed Peirce's pragmatic epistemology and elaborated on its social, psychological and ontological implications. His philosophical framework can help biofunctional theory address the mind–body problem by providing further theoretical muscle to bridge the sociocultural, the individual, and the biological realms of inquiry that currently separate most of the cognitive sciences from postmodern scholarship. There is much work that remains to be done on either side of this disciplinary divide before an integration of biofunctional psychological theory and postmodern sociocultural scholarship is complete enough to be practically useful — fundamental issues remain to be resolved. While optimism about such efforts at interdisciplinary integration cannot yet be justified, we have attempted in our response to establish that in at least one case the possibility is real and worth working toward. Speaking for ourselves, we are hopeful, and committed to the effort.

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