Adding Body to the Mind†

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For many years now, I have been attempting to develop a comprehensive, yet precise and operational theory of complex human functioning. While I sense that some in cognitive psychology have misunderstood much of what we have done, I believe that we have achieved a considerable degree of closure as to theoretical foundations. (The interested reader is referred to Scandura (1980) where the major developments and ideas are summarized and where the underlying philosophy is expounded.)

At the present time we are extending these ideas by using them as a basis for designing theoretically sound diagnostic/instructional systems and are implementing them in a highly practical microcomputer environment. (Some of these systems were developed by Instructional Micro Systems, Inc. exclusively for Borg-Warner.)

There is still, however, one foundational issue of paramount importance that has bothered me for a long time. To date, I have not been able to resolve or to integrate it fully into my theoretical framework. In fact, my immediate reason for writing this open letter is to present some incomplete, tentative ideas I have on the subject, and in general to solicit commentary from the readership on matters pertaining to “perception”, “hemispheric dominance” and “dual coding” as they interact with symbolic information processing.

Essentially, my concerns center about the problem of how to integrate the mind with the body, including such things as perception, overt responding, the left brain–right brain distinction and dual coding.

In most contemporary cognitive theories, including my own, knowledge is assumed to consist of structures/processes of one type or another (e.g., my “rules”), and all behavior is assumed to be rule-governed and goal directed. Thus, for example, problems may be characterized as composites of initial and goal states, and solving problems may be viewed as applying

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rules to these states under control of hypothesized control mechanisms. I have reasons for preferring my own formulation in this regard, mostly because "rules," characterized as triples consisting of a domain (D), a range (R) and a restricted type of procedure or operator (O), combine the advantages of both structures and processes and to satisfy the broader system constraints imposed by insuring compatibility with instruction, but never mind—this is incidental to the present issue (e.g., see Scandura, 1980).

By analogy to digital computers, cognitive states, structures, etc. are normally believed to be symbolic in nature. Cognitive processes, correspondingly, are normally thought of as computational in form. I have always felt uneasy with these assumptions, for making them seems to be more a convenience in attempting to develop computer models of cognition, than a true or complete characterization of the way human activity and thought take place.

In brief, I believe that internal states, structures, etc. may be iconic in form as well as symbolic, and that transformations acting on these (static) icons may be continuous as well as discrete. (Note: Icons are continuous images of continuous transformations.) Most dual coding theories, of course, involve icons in one form or another. But, I personally am unaware of any dual coding formulation that deals effectively with the mind-body problem in broader perspective.

My own highly tentative ideas in this latter regard go something as follows: Any complete theoretical account of human behavior must deal with the processes by which inputs are internalized and by which cognitive outputs are realized in overt behavior, as well as internal processing per se. Now, reasoning from first principles, sensory inputs (and outputs) are essentially continuous in nature; stimulation from and actions on the real world may vary along arbitrary dimensions in arbitrarily small increments. (Inputs may, however, appear more or less simultaneous, as when light strikes the eye, or sequential, as when sound reaches the ear.)

After it enters the body (and before the body physically acts on a cognitive output), internalized stimulation is assumed to be represented as integrated wholes, that is, as internalized groups of icons—canonical "pictures" together with algebras of allowable continuous transformations on these pictures. These wholes are viewed simultaneously in different ways, as icons, which may be transformed continuously, and as symbolic wholes, which may be operated on discretely (as in a computation). (The obvious implication is that the two implied ways of dealing with internalized stimulation take place on the two sides of the brain but this is not a crucial issue to deal with at the current high level of description.)

In any case, the process by which external stimulation gets encoded
involves an abstractive analog process by which this stimulation is matched against internal groups of icons (e.g., of visual images, sound rhythms or kinesthetic stimulation). Generating overt behavior is also an analog process, whereby outputs (e.g., physical movements) are constructed from internalized icon groups. These analog processes presumably have a biological basis but that should not keep (and I would presume has not kept) such phenomena from undergoing behavioral study.

Insofar as information processing is concerned, the important point is that internalized icon groups may be transformed continuously, as well as operated on as discrete wholes, as is assumed in computational theories of perception and information processing. (Indeed, in this view, computational perception and computational information processing are simply two names for essentially the same phenomenon.) Because continuous transformations (e.g., movements) themselves are icons, it is important to note that they too must be interpretable as symbolic wholes for discrete processing (on the left?).

Moreover, continuous transformations may have the effect of defining new percepts (i.e., new iconic wholes against which external stimulation is judged and/or which control overt responding). For example, mentally transforming one view of an object into another view, as in solving a Shepard-type comparison problem, has the effect of equating the class of views between the two. Correspondingly, performing such a transformation mentally depends on having available a continuous transformation group which maps the icon group for one view into that of the other. I haven’t worked out all of the details but it seems plausible to go on from there to observe that many objects may be defined uniquely via a finite number of transformations: all views of solid objects, for example, may be derived from one or another combination of transformations along the three possible dimensions. Cognitive integration of such transformations presumably gives permanent “reality” to the “objects” themselves, which thenceforth may become stable wholes. These wholes may range from concrete objects to abstract symbols. When this state has been reached, any continuous iconic realization (view) of an object may (under cognitive control) be recognized via analog comparison to the integrated whole (object).

On the other hand, continuous processing may only treat symbolic icons as wholes. The possibility of relating discrete parts to other parts, or to the whole, resides solely in discrete processing. These symbolic wholes are the elements, relations, etc. which constitute the structures on which rules (in my system) operate and which are defined by rule domains. Since any number of symbols, both parts and wholes, may be recognized in any
given icon, it is possible to conceive of arbitrarily complex kinds of processing. In this regard, I should also note that new symbolic wholes may be derived via discrete processing. Specifically, percepts that are computed from given ones (as in computational models of perception) may come to function as (new) wholes via “automatization”. (For discussion of the latter process from a structural learning perspective, see Structural Learning I: Theory and Research, 1973, p. 104, for example, or a recent paper, Scandura, this issue, which deals explicitly with the subject of automatization (specifically, passage from the naive learner to the neophyte to the master.)

Clearly, because of the symbol-icon duality, discrete symbolic processing may operate on and/or generate the iconic just as iconic continuous processing may define the symbolic. Thus, symbols may define what in an iconic percept matters and may be interpreted (via the right brain?) as icon groups in controlling the body’s effectors, and iconic transformations may serve to introduce new symbols (for the left?).

The primary advantage of discrete processing is that relationships among symbols are exact and consciously knowable, that of continuous processing lies in the increased breadth of possibilities. Thus, for example, one may sense equivalences in unconscious iconic modes but one proves them by symbolic processing.

Obviously, this sketch is not complete. It does, however, make it possible to devise some fairly supportive examples ranging from cognitive “insight” on the encoding side to performing a “slick” take-down in wrestling. (The “ex-jocks” among us know all too well the importance of having the “right feel” in performing complex and/or precise feats. It is not sufficient to simply “know what to do” in the left-brain sense. This “feel”, I would propose, derives from the controlling mental icons.)

To get some feel for what may be involved, consider the problem of learning to coordinate usage of the clutch and gas pedal in shifting gears on a car. Shifting itself generally causes few problems for the neophyte driver. Initiating a shift amounts essentially to discrete knowledge of a pre-learned continuous process. Most learners also know or quickly learn how to gradually add pressure to the gas pedal and to gradually let up on the clutch. The problem comes in in letting up the clutch just as the gas pedal goes down, and remembering not to do either before the gear is in the proper position. It ordinarily takes much practice before a proper “mix” of actions is attained. Whatever learning is involved in this case is primarily iconic, gradually learning that certain combinations of continuous actions are acceptable and that others are not. Once learned, the resulting icon equivalence becomes a new symbolic whole that may be called upon whenever needed.
Since I have not followed the experimental (or theoretical) literature in this area all that closely, I am not entirely sure which parts of what I am proposing are new and which are not. For one thing, some of the ideas described above may be gleaned from my own earlier writings (e.g., Scandura, 1970, especially pp. 521–26; 1973, pp. 95–6, 110–111 and 236–34; 1977, pp. 526–8). More important, I would like to solicit commentary which contributes toward further clarification of the problem including relationships to other “dual coding” theories and research.

One might wonder why I have bothered to write about what are regely theoretical speculations. In this regard, I can only say that (1) any of the sketchiest parts of my proposal (e.g. what happens embolically on the left side of the brain?) have (to my preliminary dissatisfaction at least) been worked out in considerable detail with strong empirical support and (2) I am of the opinion that too little theorizing in psychology takes the broader picture into account. Very frequently, theories tend to be very precise formulations about very little, theories that in the broader scheme of things are almost certain to be wrong and, hence, not worthy of serious development. I personally prefer to employ my own efforts in “sharpening” more global theories that have a reasonable chance of holding up over a period of time.

These personal opinions aside, I have one further thought in mind in publishing my thoughts on this matter. As co-editor of the Journal of Structural Learning, I have been exploring new ways of promoting lively scientific discussion, and/or more aptly capturing in print some of the insightful and often highly instructive dialogue that frequently takes place at many small and targeted scientific conferences.

Toward this end, I would be delighted to receive candid reactions from readers, whether for publication or not. (In this regard, natural sounding letters of dialogue might be a welcome innovation in scientific publication.)

Joseph M. Scandura, Co-editor

References


Scandura, J. M. (1981). Problem solving in schools and beyond: transitions from the naive to the neophyte to the expert. Educational Psychologist, in press. (Also see a related paper in THIS ISSUE dealing with medicine which includes contributions by Dr. David Yens.)