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Affect: A Functional Perspective

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During the last four decades, dominant theories of comprehension and cognition have ignored affect. In the meantime, several psychologists, social psychologists, and neurophysiologists, have independently had a remarkable impact on theory and research concerning important affective variables. Recently, there has been a surge in attention to the structural aspects of emotions. But structural models have been slow in incorporating the traditional research on affect. Structural theories seek to characterize abstract psychological structures, but the research on affect seems to be more consistent with the view that affect is a functional rather than a structural phenomenon. This paper attempts to present a coherent account of affect based on the functional properties of the nervous system. It is assumed that emotions are created by the simultaneous activity of various components of the neuronal system and that emotional structures persist only as long as the underlying neuronal elements remain in a state of functioning. Some empirical consequences of the functional view are also discussed.

During the last four decades, dominant theories of comprehension and cognition—information processing theories, stimulus-response theories, and schema theories—have ignored affect. In a recent article Zajonc (1980) points out:

> Contemporary cognitive psychology simply ignores affect. The words *affect*, *attitude*, *feeling*, and *sentiment* do not appear in the indexes of any of the major works on cognition (Anderson, 1976; Anderson and Bower, 1973; Bobrow and Collins, 1975; Crowder, 1976; Kintsch, 1974; Lachman, Lachman, and Butterfield, 1979; Norman and Rumelhart, 1975; Schank and Abelson, 1977; Tulving and Donaldson, 1972). Nor do these concepts appear in Neisser's (1967) original work that gave rise to the cognitive revolution in experimental psychology. And in the six volumes and the 2,133 pages of the *Handbook of Learning and Cognitive Processes* (Estes, 1975-78), there is only one entry for *affect* and only one for *attitude*. It is worth noting that both of these entries are in Volume 3 in a contribution written by a social psychologist. In the last three volumes—those principally devoted to cognition—there are no references to *affect* whatsoever. (p. 152, Footnote 3)

This lack of attention to affective functioning is puzzling in view of the fact that several prominent authors have emphasized the indispensable role of affect and have studied it extensively (e.g., Bartlett, 1932; Berlyne, 1960;

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Festinger, 1957; Hebb, 1955; Olds, 1973; Schachter and Singer, 1962; Wundt, 1907; Zajonc, 1980). What is even more puzzling is that authors, from time to time, acknowledge the significance of affect but continue to devote little attention to it. For instance, Ginsburg and Opper (1969) write:

> Piaget recognizes that emotions influence thought, and . . . he repeatedly states that no act of intelligence is complete without emotions . . . . Nevertheless, Piaget's empirical investigations and detailed theories substantially ignore the emotions in favor of the structure of the intellect. (p. 5)

How can this discrepancy between what is preached and what is practiced be explained? There is one explanation, which may very well be the only major reason: Structural cognitive theories are not optimally equipped to deal with affect. This supposition is consistent with the fact that structural theories that study affect (e.g., Bower, 1981; de Rivera, 1977; Lehnert, 1980) have primarily ignored the traditional research on affective functioning. What seems to be missing is a theoretical framework which is able to provide a basis for identifying and integrating important affective variables and for specifying the relation between affect and cognition. In this paper, we have tried to develop one such theory which emphasizes the functional properties of the neuronal system. The principle aspects of traditional structural models and their constituent conceptual metaphors have been discussed by Bransford, McCarrell, Franks, and Nitsch (1977), Jenkins (1977), Iran-Nejad (1980), and Iran-Nejad and Ortony (1982). Iran-Nejad (1980) also discusses how a functional theory differs from a structural approach. Other theories similar in spirit to the present functional approach are those developed by John (1967, 1972) and by Katchalsky and his associates (e.g., Katchalsky, Rowland, and Blumenthal, 1974).

We will first present a brief discussion of what a structural theory is like and will contrast it with a functional view. Then the functional view will be discussed in more detail. Next, we will try to show that traditional psychological research on affective variables such as that of Berlyne (1960), Festinger (1957), and Schachter (e.g., Schachter and Singer, 1962), is more consistent with a functional, as opposed to a structural, theory of affect. Finally, we will discuss some of the empirical consequences of the functional view for the study of the affect-cognition relationship. We will discuss the functional view only insofar as it relates directly to the phenomenon of affect. The reader interested in other aspects of the functional theory, such as remembering, comprehension, and learning, is referred to the sources cited above.

The Structural Approach to Affect and Emotion

As an example of a structural theory, consider first de Rivera's (1977) theory of emotion. While de Rivera describes his views in terms of Piaget's structuralism, his theory is also reminiscent of another slightly different structural approach, namely, the semantic-network theories of long-term memory. In a network model, there is an abstract multidimensional space or network encompassing the entire spectrum of psychological patterning. According to de Rivera, affective structures (emotions) belong in such a psychological space. Each emotion is a schema in the Piagetian sense: a self-regulated, holistic system of transformations. In such a network, "each different emotion has a place in an overall structure of which it is a part" (de Rivera, 1977, p. 36). The relative location of different emotions determines the degree of their psychological similarity.

Transformations are *movements* along dimensions of psychological space. Each type of emotion (e.g., anger, love) reflects different transformations. These transformations are not changes along intrinsic organismic dimensions, such as changes in the activity of the sympathetic nervous system (e.g., changes in heartrate); rather, they are abstract internal representations of overt or covert changes involved in the way the organism, as a whole, interacts with the environment (e.g., "digging a hole," "moving away from or toward others," etc.). They are internalized Piagetian action sequences.

The emotion of *anger*, for instance, involves the transformation of the "person" moving the "other" away from the "self." *Fear* differs from anger since it involves "the person moving away from the other." Similarly, *love* is "movement of person toward the other," and *desire* is the "person moving the other toward him." These transformations also represent overt bodily movements. Love is a "giving" emotion (+ extension) and desire is a "getting" emotion (+ contraction). Anger does not involve extension (– extension) and fear does not manifest contraction (– contraction).

Like de Rivera's theory, the majority of structural theories of affect and emotion (e.g., Bower, 1981; Plutchik, 1962) are network models. Semantic network models were originally postulated to represent the meaning of words in the long-term memory (e.g., Anderson and Bower, 1973; Collins and Quillian, 1969). The most direct application of these models to the problem of affect was made in a recent paper by Bower (1981) who extended the network model to explain the state-dependent aspect of emotion. According to Bower, "each distinct emotion such as joy, depression, or fear has a specific node or unit in memory that collects together many other aspects of the emotion that are connected to it by associative pointers" (p. 135).

All structural models seem to share at least two global attributes. First, they are all *intralevel theories* (see Wimsatt, 1976): They assume that the holistic structures and their constituent elements are both mental in nature. Thus, they do not take into account the functional properties of the biological hardware; mental structures are characterized in terms of mental elements. Secondly, they assume that psychological permanence is an inherent property of mental structures and their organization—there exist long-term mental structures and relations. By contrast, the functional view is an *interlevel approach*. It assumes that at the mental level there are only unanalyzable wholes and no elements.[1] Elements, on the other hand, exist at the neuronal level; and it is the group functioning of these neuronal elements that results in the creation of holistic mental structures. Furthermore, the functional view assumes that mental structures are inherently transient; and psychological permanence is a reflection of the consistent and stable functional properties of neuronal elements.

Intralevel versus Interlevel Reductionism

While structural theories acknowledge that the mind is unanalyzable, they, nonetheless, proceed to dichotomize and dissect it. It is often claimed that mental structures (or schemata) possess characteristics which are unique to these holistic patterns. Consequently, any elemental analysis of the structures will destroy their properties. But since the notion of elements within a structure is unavoidable, the schema is defined as a collection of *mental* elements and *mental* relations (associations, rules—e.g., multiplication rules, and so on). Since a structure is a whole with "over-all properties distinct from the properties of its elements," one must adopt "from the start a relational perspective, according to which it is relations among elements that count" (Piaget, 1968/1970, p. 79). Integers, for instance, have structural properties "which are quite different from the properties of number individuals" (Piaget, 1968/1970, p. 7); 35 is a nonprime number, while 3 and 5 are prime.

What Piaget (1968/1970) argues against is intralevel reductionism, i.e., reductionism *within* the mental domain. "But there are at least two functionally distinct kinds of reduction which are so different in their functions . . . that one is led to doubt not only the unitary model of reduction but also the primacy of structure over function in its characterization" (Wimsatt, 1976, pp. 214-125). Wimsatt argued that the problems traditionally associated with reductionism are only applicable so long as one takes an intralevel approach. The alternative to an intralevel approach is an interlevel approach which attempts to specify the interface between the mind and the functional properties of the nervous system. Intralevel theorists often specify causal links directly between mental and behavioral states. For instance, Lehnert's (1980) process model is characterized in terms of affect maps that consist of affective units and abstract causal links between them. These links are assumed to

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[1]The analyzability of mental structures has often been called into question. Polyani (1958) has argued that (tacit) knowledge can almost never be formalized, and Bartlett (1932) states that affective structures are "very hard to describe in more elementary psychological terms" (p. 206). Similarly, Huey (1908) points out that "the consciousness of meaning itself belongs in the main to that group of mental states, the feelings, which I regard with Wundt as unanalyzable" (p. 163; also see Minsky, 1980, p. 118 quoted below).

signify causalities of affect within and across characters. The interlevel approach, on the other hand, assumes that causal interaction cannot be specified strictly within the mental or behavioral domain, without reference to the functional properties of the biological hardware. Rather, mental structures exert their causal influence on the functioning of neuronal elements, and the functioning of neuronal constellations, in turn, results in the creation of mental structures (see Dewan, 1976; Katchalsky, Rowland, and Blumenthal, 1974; Maturana, 1978; Sperry, 1976; Wimsatt, 1976). According to Katchalsky and his associates the mystery in the old aphorism that "the qualitative whole is more than the quantitative sum of its parts" is in the word *more*. It implies something for nothing. However, if the "more" emerges as a consequence of the functioning of biological mechanisms, it is no longer obtained for nothing. This is because self-organizing dynamic properties of these mechanisms dissipate energy in order to achieve this.

Such arguments suggest that the solution to the parts-whole problem must be sought in the specification of the functional properties of the components of the biological system and in the way these components function to create mental structures. Mental structures themselves, on the other hand, must be studied only insofar as such investigation bears on the nature of the functional properties of the nervous system.

Structural theories of affect and emotion often postulate a set of basic emotions that mix to produce more complex emotions. Plutchik (1962) used the analogy of the color-wheel to illustrate the mixing of emotions. He argues that "it is necessary to conceive of the primary emotions as hues which may vary in degree of intermixture (saturation) as well as intensity, and as arrangeable around an emotion-circle similar to a color-wheel" (p. 109). Berlyne (1971) has drawn attention to a potential difficulty in such a direct analysis and synthesis of emotional structures:

> Attempts to list basic emotions are like attempts to divide the visible spectrum up into regions of similar color, with the possibility of adding to the number of hues by color mixture. The principle difficulty, with color as with emotion, is a lack of objective criteria, and thus of agreement, on where the boundary lines should be drawn. It has, for example, been established by the experiments of psycholinguists that the familiar seven "colors of the rainbow" are peculiar to our culture; members of other cultures divide up the spectrum quite differently. (pp. 73-74)

While there seems to be no universal criteria for dividing up the color-wheel into primary colors, it has been shown that the universals of color semantics can be explained in terms of the functional properties of the neuronal elements underlying the perception of color. Kay and McDaniel (1978) have reviewed the recent evidence on color-term semantics and argue that a "widespread belief in linguistics and the philosophy of language, challanged by the data reviewed here is the doctrine that there exist ultimate semantic primes which are *discrete* entities" (p. 611). As an alternative, Kay and his associates present a neurophysiological model indicating that "all the basic color categories of the languages of the world are based on the six fundamental neural response categories, whose structures are determined by the firing patterns of . . . cells in the visual pathway" (Kay, 1981, p. 64). Similarly, the functional view assumes that affect and emotion can be more readily explained in terms of the functional properties of the nervous system and not in terms of some abstract emotion-circle or network.

Functional Permanence and Frame Permanence: An Analogy

The second general characteristic of structural approaches is that they all place the locus of permanence at the mental level. They all assume that permanence is a property of mental structures, that there exists a long-term memory store or conceptual network, and that it is in terms of the structure and the organization of such a storehouse or network that psychological permanence must be specified. However, Bransford et al. (1977) and Jenkins (1977) have recently seriously challenged the permanent storage metaphor. They have argued that this is but one of the many possible alternatives.

With respect to permanence, affect has been treated heterogeneously by different writers. For motivation theorists such as McClelland and his associates (e.g., McClelland, Atkinson, Clark, and Lowell, 1953), it is a stable and consistent instigator of action. For others (see, e.g., Ryle, 1949), it is little more than transitory "thrills," "pangs," and "glows" (e.g., a glow of pleasure).

The functional approach assumes that permanence is a characteristic of the biological hardware and is reflected in the consistent and stable functional properties of the components of the nervous system. Mental structures, on the other hand, are inherently transient.

The problem of permanence is a particular case of the more general problem of the preservation of form which goes beyond psychological phenomena. Consider an analogy from Jonathan Miller's *The Body in Question* (1978):

> The survival of form depends on one of two principles: the intrinsic stability of the materials from which the object is made, or the energetic replenishment and reorganization of the material which is constantly flowing through it. The substances from which a marble statue is made are stably bonded together, so that the object retains not only its shape but its original material. The configuration of a fountain, on the other hand, is intrinsically unstable, and it can retain its shape only by endlessly renewing the material which constitutes it; that is, by organizing and imposing structure on the unremitting flow of its own substance. *Statues preserve their shapes; fountains perform and reperform theirs.* (p. 140; italics added)

Thus, there are two types of structures: stable and unstable. And there are two types of permanence. Structural permanence is inherent in the structure itself. Functional permanence is inherent in the functional properties of the underlying system(s) which creates and recreates the structures. These systems and their properties are permanent, to be sure, but are not the same sort of stuff as the structures they create. The engines, the pipes, the pressure, and the water are not isomorphic with the fountain they jointly create. Note that by specifying the components of the underlying system and how they relate, one can understand the way the fountain is created; but the latter (i.e., the created fountain) is not reduced to the former. This is the essence of an interlevel approach.

Structural psychological theories assume that permanence is an inherent property of mental structures. The functional view maintains that mental structures are inherently transient. They are created postfunctionally (see, Iran-Nejad and Ortony, 1982). They are formed as a consequence of neuronal functioning. And they last as long as this functioning is rehearsed by hundreds of autonomous neuronal elements each of which can, in principle, participate in the creation of an indefinite number of structures.

In accounting for the permanence of mental structures, therefore, it seems that a choice would have to be made between two different levels of analysis. One can assume the locus of permanence to be in the structure and attempt to specify long-term mental relations. Alternatively, one can assume that permanence is inherent in the functioning of autonomous neuronal elements and try to specify functional properties that would make it possible for these elements to permanently and consistently create and recreate transient functional structures. Since in affect and in cognition, as in the case of fountains, we have to deal with constantly changing structures—structures that can be upheld only as long as the underlying neuronal components continue to function—a shift must be considered in the locus of analysis in psychology from a direct description of abstract structures to a description of the functional characteristics of the underlying system. However, this does not mean that mental relations must not be investigated. Rather, it means (a) that a formal theory of mental structures based on precise algorithmic analyses need not, and possibly cannot, be constructed, and (b) that investigation of mental structures must be conducted, not in the service of constructing a formal description of these structures, but in subordination to the goal of specifying the functional properties of neuronal elements. Mental structures must be analyzed only insofar as such analysis can directly help us understand "the style of the brain" (Arbib, 1981).

Structural theories are best suited to deal with permanent structures. This is probably why philosophical structuralism leads to such questions as whether or not the structure of a statue exists in the block of stone before it is carved, why psychological structuralism hypothesizes permanent mental structures in the head, or why many structuralists tend to hypothesize innate structures (e.g., Chomsky, 1980). According to the functional approach, permanent *mental* structures cannot exist; the latter must be created and recreated.

What then must a functional psychological (as opposed to an artificial intelligence) theory of affect do? Clearly, it must not build a long-term storage or a permanent structural network. Nor must it, as an end goal, construct a formal, algorithmic, representational system of such a repository or network that would be programmable into a computer. Instead, it must (a) specify how global affective states dynamically relate to localized components (e.g., distributed elements) of the nervous system; it must (b) provide a plausible account of affective valence and awareness; it must (c) present a plausible account of the concept of self; and, finally, it must (d) allow plausible definitions for affective variables (e.g., pleasantness/unpleasantness and interestingness). We hope this approach can put us in a better position to design experiments leading toward an integrated body of data on affective and mental functioning. Current research on affective functioning is carried out under a great number of "spot" theories. As Athey (1976) notes from the perspective of reading education, "the literature on affective factors, misses the connecting thread of a good theory to make sense of the plethora of inconclusive and contradictory data" (p. 739).

Functional Properties and the Creation of Affect

Elements of a functional theory of cognition are evident in the work of Bartlett (1932), Bransford and his colleagues (e.g., Bransford et al., 1977), Jenkins (1977), and Minsky (1980). These authors have also emphasized the role affect plays in remembering. Bartlett draws attention to "the fact . . . that when a subject is being asked to remember, very often the first thing that emerges is something of the nature of an attitude" (p. 207). Similarly, Minsky maintains that "attitudes do really precede propositions" rather than the other way around:

> In this modern era of "information processing psychology" it may seem quaint to talk of mental states; it is more fashionable to speak of representations, frames, scripts, or semantic networks. But while we find it lucid enough to speak in such terms about memories of things, sentences, or even faces, it is much harder so to deal with feelings, insights, and understandings—and all the attitudes, dispositions, and ways of seeing things that go with them. . . . We usually put such issues aside, saying that one must first understand simpler things. But what if feelings and viewpoints are the simpler things? (p. 118)

In order to explain mental states, Minsky (1980) conceived of "the mind (or the brain) as [being] composed of many partially autonomous 'agents'." He proposed that "no single one of these little agents need know much by itself, but each recognizes certain configurations of a few associates and responds by altering its state" (p. 119). In this section, we will try to demonstrate how a similar assumption makes it possible to present plausible accounts of such basic aspects of affective functioning as awareness and valence, as well as, the notion of self.

Awareness

As Mandler (1975) has noted, "consciousness (awareness or private experience) . . . has generated some of the most extreme positions in psychological theory, varying from its denial by some behaviorists to an assertion of its exclusive dominance by some phenomenologists" (p. 12). While emphasizing the role of awareness as an important parameter in emotional functioning, Mandler also points out:

> Translating the private datum of consciousness into useful theoretical constructs remains one of the interesting tasks facing theoretical psychology . . . . We still tend to use ancient and philosophical interpretations of consciousness. The theoretical-analytic enterprise that properly dissects the ordinary language meaning of consciousness and constructs theoretically meaningful terms and processes (and not just a single state or mechanism) is still to be undertaken. (p. 12)

The influence of the single-unit philosophical view of consicousness on neurophysiological research has been discussed by Luria (1978). The primary purpose of this research has been to identify a unitary neuronal structure whose stimulation would give the individual conscious experience and whose destruction would render the person unconscious. As an alternative, Luria proposes what he calls a *semantic and system-based* explanation of awareness, one that goes beyond the notion of consciousness as a changing state of wakefulness that results from the activity of the reticular formation. Luria emphasizes the contribution of other brain regions such as posterior and frontal cortical areas. He writes:

> Attempts to seek the material substrate of consciousness at the single-unit or synaptic level . . . thus begin to be seen as completely hopeless. The cerebral basis of man's complex, semantic, system-based conscious activity must be sought in the combined activity of discrete brain systems, each of which makes its own special contribution to the work of the functional system as a whole. (p. 31)

Luria's quotation seems to call for a *distributed* account of awareness. Similar suggestions have been made by Sperry (e.g., 1969, 1976) and by Restak (1979, 1981). According to Sperry (1969), "conscious properties . . . are directly dependent on the action of the component neuronal elements" (p. 534); and as Restak (1981) put it, it is possible "that the interaction between millions of neurons within the brain induces complex electric fields that are ultimately responsible for consciousness" (p. 19). However, the details of a distributed account of awareness have not yet been spelled out. This section attempts to present such an account.

The loci of the generation and perception of awareness. The central assumption of the present functional view is that there exist physically unitary and functionally autonomous neuronal elements, which can function, in principle, independently of other neuronal elements and, therefore, can participate in an indefinite number of functional combinations. "One possible outcome of considering discrete systems embedded in a continuous system would be the subordination of obvious structural discreteness to a functional one: the spatially discrete elements could be brought to functional continuity . . . or the structurally continuous medium to functional (dynamic) discontinuity" (Rowland, reported in Katchalsky, Rowland, and Blumenthal, 1974, p. 78). The predominant principle which determines functional properties of neuronal elements is assumed to be *specialization* or *specificity of function*. This means that each neuronal element is specialized, or is capable of getting specialized, to function in a unique fashion and, thereby, to manifest some specific functional properties. One such property is the generation, by the element, as a neuroanatomic microsystem, of a unique feeling of awareness, a means of "communicating" to the global macrosystem that "I, the functioning microsystem component, am in a state of functioning." Functioning can occur either singly (explicit awareness) or in combination with other microsystems (implicit awareness). (We refer to neuronal elements as microsystems because they are assumed to be systems, rather than neural segments, because only a system can be assumed to generate such phenomena as awareness.) Conceptualized in this fashion, awareness not only can equip the overall macrosystem with a means of directly "monitoring" the activity of its component microsystems, but also with a basis for distinguishing between them. This is, however, to speak metaphorically. In functional terms, the active microsystem is assumed to be at the same time the creator and the perceiver of awareness. Awareness mediates the microsystem-macrosystem (element-whole) relationship by means of two complementary mechanisms of simultaneous and independent functioning, which will be discussed later.

Functional constellations and nonspecific awareness. Functional properties of individual neuronal elements are *specific properties*; they can, in principle, be traced to a specific physical microsystem, the element itself. However, it must be emphasized that neuronal elements do not represent particular emotions or ideas. The latter are created when a great number of elements function simultaneously. Such functional combinations have nonspecific properties, properties which cannot be traced to any one specific physical microsystem. Mental states and patterns, therefore, are nonspecific and unanalyzable in this particular sense, as are, by analogy, the physical (structural) properties of water. It is not clear what oxygen or hydrogen contributes to the physical properties of water; only it is possible to see that such properties emerge when the two gases combine. The functioning of the neuronal system and the generation and the experience of awareness can be conceptualized more readily by analogy to a light constellation. Imagine a constellation of lightbulbs in which each individual lightbulb is painted a unique color and, consequently, produces a unique pattern of light. In such a constellation, when a subset of lightbulbs is on, it creates a unique nonspecific light pattern. The pattern is nonspecific because its global properties (i.e., the overall color of the generated light pattern) are created by group functioning of several lightbulbs and can be traced only to the functioning constellation as a whole and not to any discrete (specific) elements (i.e., to any one lightbulb).

An important consequence of this view of awareness is that changes in awareness occur as a function of changes in the functioning of underlying neuronal elements. At one extreme, abrupt changes mean sharp awareness of the changing elements. At the other extreme, no change in functioning generates no awareness. By analogy, changes in the overall light pattern generated by a set of colored lightbulbs can come about when new lights go on, old lights go off, and/or when some lights go brighter or dimmer, not by changing the resultant light pattern itself into a new form.

If the present view is correct, it means that, within certain specifiable constraints, the constellation of neuronal microsystems that are active at a given moment will combine to create a unitary functional pattern, and consequently, a unitary feeling of awareness. Evidence for such combinatorial nature of awareness comes from the split-brain research carried out by Sperry (e.g., 1968) and others. This evidence suggests that, "in the normal brain, the right and left hemispheric components combine and function as a unit in the causal sequence of cerebral control. In the divided brain, on the other hand, each hemispheric component, gets its own separate causal effect as a distinct entity" (Sperry, 1976, p. 174); in the latter case, each separate hemisphere forms its own unitary functional combination; each hemisphere creates "a mind of its own."

Finally, the interface between the functionally autonomous neuronal microsystem and the nonspecific, postfunctional psychological patterns may be conceptualized by analogy to the concepts of genotype and phenotype as used in genetics. At the "genotypic" neuronal level, there are specialized neuronal microsystems which can, like genes, participate in an indefinite number of combinations. The psychological level itself, however, corresponds to the phenotypic level. In the same fashion that a particular combination of genes acts as a basis for the creation of a particular organism with particular phenotypic characteristics, a particular functioning constellation of neuronal microsystems create a particular psychological structure. The analogy, however, soon breaks down as far as the relative permanence of phenotypic organismic structures, as opposed to the transience of phenotypic psychological structures, is concerned. Grown organisms cannot be "undone" into their elementary genes, so the latter could each participate in some other organism. Psychological structures can, presumably, "uncombine," freeing, at the genotypic level, their component microsystem elements to participate into other structures.

The Combinatorial Aspects of Mental Functioning

What holds the system together? A system comprising functionally autonomous microsystem components that interact via the establishment of transient postfunctional relations constitutes a fully dynamic system. In order to run, such a system would have to somehow resolve two problems, both having to do with how the complex macrosystem holds together as a unitary and coherent whole. First, the component microsystem elements would have to have some way of establishing dynamic relations with the overall macrosystem and vice versa. Following Bartlett (1932), we believe that the mechanism responsible for such interaction is awareness; the active component microsystem is the creator and the perceiver of a unique feeling of awareness, thereby catching, via its very functioning, the "attention" of the overall macrosystem by becoming itself the focal center of awareness in it. As Bartlett (1932) states, awareness gives the system a way of "turning round upon itself."

Secondly, the component microsystems would have to have some way of establishing dynamic relations among themselves. What sort of mechanism would render this interaction possible? The functional view assumes that the causal locus of microsystem-microsystem interaction must also be sought in the functioning of the specialized autonomous microsystem itself. For instance, a functioning microsystem can generate a unique pattern of physical energy whose presence in the macrosystem can, in turn, serve as a sufficient condition for another specialized microsystem, or a constellation of microsystems, to get activated.

Three types of functional relations may be hypothesized: consonance, dissonance, and irrelevance (Festinger, 1957). Two (or more) neuronal microsystems are consonant if they are specialized such that the functioning of one leads to initiation and/or maintenance of functioning in the other. One way this could happen would be if the functioning of the first microsystem resulted in the generation of a unique pattern of energy which would, in turn, serve as a (sufficient) condition for the second microsystem to begin and/or maintain functioning. The functional relation between two microsystems is irrelevance if functioning of one has no effect on the functioning of the other.

Functional dissonance arises when consonantly related microsystems tend to function in a direction opposite to the one required by their consonant functioning. Suppose the consonant relation between A and B is activation-activation and between C and B is activation-inhibition. Dissonance will arise if A *and* C tend to function simultaneously; since this will cause B to fluctuate in two opposite functional directions, namely, activation (due to stimulation from A) and inhibition (due to stimulation from C).

The simple system of postfunctional relations hypothesized here can provide a basis for explaining the creation and recreation of affective and cognitive patterns. Together with awareness, it also makes it possible to see how component-component and system-component interaction may take place.

The transient aspect of mental combinations. In a fountain, there is only one actual configuration, namely, the configuration of the (present) moment. Past configurations no longer exist; nor are they relevant. By analogy, the only actual psychological pattern is the schema-of-the-moment, the totality of the functioning neuronal elements distributed in various regions of the nervous system. An emotion is a schema-of-the-moment in which the affective component is predominant.

Thus, emotions, as well as other mental structures, are transient phenomena and last only as long as the underlying neuronal elements maintain functioning, in the same fashion that the fountain lasts only as long as the underlying system runs. There is no need for storage of any mental frames or any other mental entity. (For a discussion of the problem of remembering see Iran-Nejad and Ortony, 1982.) Furthermore, beyond the functional constraints imposed by specialization of autonomous neuronal elements (e.g., consonant and irrelevant relations) there is no need for any underlying structural blueprints. As Arbib (1981) put it, "we can no longer think of a single localized schema for each familiar object in our environment, but we must rather imagine that the appropriate pattern of activity can be reproduced" (p. 33). This is especially true if we think of a concept as a transient pattern created by the activity of autonomous neuronal elements distributed across various regions (visual, auditory, tactile, olfactory, etc.) of the nervous system.

While mental structures are transient, duration of functioning in autonomous neuronal elements can vary. Some elements are always active or follow a regular functional rhythm (cycle). Elements involved in the concepts of self, of time, and of space are examples. Functioning of other elements is more transitory.

Initiation of functioning in neuronal microsystems takes place either endogenously or exogenously. One obvious example of endogenous initiation is the activity of those neuronal elements which are involved in the awakening of the organism from sleep. Another example is the activation of neuronal elements as a function of their relationship with other active elements in the schema-of-the-moment. Exogenous initiation occurs independently of the schema-of-the-moment, as when neuronal elements get activated under the influence of external energy patterns (e.g., textual stimuli).

Resolution and Dissolution Aspects of the Schema-of-the-Moment

If neuronal microsystems generate energy patterns that provide sufficient conditions for other microsystems to get activated, how is it that upon the activation of the first microsystem, all other microsystems subsequently related to it do not get activated in some sort of a chain reaction? The first reason for this is that particular microsystems (or constellations) often function in combination and, when they do, their characteristic energy pattern combines with that of other microsystems to form interference patterns (see Iran-Nejad and Ortony, 1982, for a discussion). These interference patterns are different from specific energy patterns generated by individual components and, consequently, cannot serve as sufficient conditions for the activation of microsystems that they would otherwise activate. In other words, the generation of a characteristic energy pattern can activate other elements only if the element (or the constellation) functions independently of other active elements. The second reason that a reaction chain does not occur is that internal energy patterns are not the only source of initiation. Often, elements which must enter the chain of activation, so to speak, have to depend on external energy patterns. For these, and perhaps other reasons, the development of the schema-of-the-moment is always constrained by the extent to which the problem of initiation of functioning in neuronal elements is gradually resolved. Consequently, the term *resolution* can more aptly describe the dynamic development of the schema-of-the-moment than *combination*.

A particular schema-of-the-moment can be either *resolved*, *resolving*, or *unresolved*. A *resolved* schema-of-the-moment is one in which all the elements function in a harmonious (consonant) fashion and, consequently, the global and local functioning go hand in hand. Completeness (closure) is another aspect of a resolved schema-of-the-moment. A *resolving* schema-of-the-moment is one in which all the local elements cannot yet function in a harmonious global fashion—because in order to do so functioning of other as yet inactive elements is necessary. However, since consonant elements are constantly being introduced, the dynamic mechanism that moves the schema toward resolution is kept alive. An *unresolved* schema-of-the-moment is a (temporarily) "stalling" schema which cannot move in the direction of resolution because new consonant elements fail to get activated.

Not all schemata-of-the-moment can be characterized by resolution. The latter is a combinatorial mechanism. Any system comprising autonomous elements, must have some way of unbinding the already combined elements in order for the latter to be used in new combinations. This is accomplished by what might be called schema dissolution. Therefore, in principle, a schema-of-the-moment can also be *dissolved*, *dissolving*, or *undissolved*. A *dissolved* schema-of-the-moment is one that can maintain a coherent organization only to the extent that many elements dissonant with it can be inhibited. The global experience of the moment may be labeled as "unconvincing." A *dissolving* schema-of-the-moment is one that is in a state of crisis because, while the schema is not yet totally disrupted, dissonant elements are being introduced. An *undissolved* schema-of-the-moment is a "stalling" schema which cannot move in the direction of dissolution because further dissonant elements fail to get introduced into it.

Nonspecific Properties of the Schema-of-the-Moment

If one considers the configuration of a fountain at a particular point in time, a set of unique global properties can be identified—the particular shape, the silverish beads or spray, the diffused movements, the sound, and so on. These are nonspecific properties because, while the fountain consists of a great number of specific springs, the properties of the whole fountain cannot be traced to any discrete underlying component; they are the creation of the act of combination. Analogously, every schema-of-the-moment has its unique global properties. If the functional theory is correct, the relevant variables influencing the global properties of the schema-of-the-moment are such factors as awareness valence (positive and negative), resolution/dissolution (resolved, resolving, unresolved, dissolved, dissolving, or undissolved), independent/simultaneous functioning (local or global focus), and change (gradual or abrupt). A resolved schema-of-the-moment can give rise to such feelings as coherence, completeness, meaningfulness, contentment, and so on. A resolving schema-of-the-moment may generate suspense, curiosity, expectation, and interestingness. Similar feelings of awareness may be associated with unresolved (e.g., incompleteness, discontent), dissolved (e.g., incoherence, senselessness, anomaly), dissolving (e.g., anxiety, confusion), and undissolved (e.g., stress, restlessness). It is beyond the scope of this paper to discuss in any detail internal state concepts in the context of the functional approach. Therefore, we close this section with the hypothesis that factors governing the meaning, categorization, and use of internal state words (see, e.g., Hall and Nagy, 1979) may vary along the functional dimensions suggested here. Consider, for instance, meaning. Earlier, it was claimed that awareness is an indispensible aspect of affective functioning. If this is true, it must somehow be reflected in the meaning of internal state words. The unacceptability of (1a)-(1c) supports this claim:

(1a) I am *angry* but I am not aware of it.
(1b) Father Brown *believes* that God created the world in seven days but he is not aware of it.
(1c) I *remember* the name of my cousin but I am not aware of it.

In fact, if the functional theory is correct, there is nothing else to the meaning of internal state words than the transient state they refer to. This counterintuitive claim is in direct opposition to the notion that there exists a permanent representation for the meaning of every word in some alleged semantic network.

Mental Functioning and the Self

Traditional research bearing on the phenomenon of affect, especially the research motivated by consistency theories (see, e.g., Abelson, Aronson, McGuire, Newcomb, Rosenberg, and Tannenbaum, 1968), suggests a close interrelationship among the self, dissonance, and affective valence. The nature of this interaction, however, is currently unclear. Perhaps the major reason for this is that we know nothing about the *self* beyond the phenomenological, ordinary language notion of self, a unitary homuncular entity capable of performing essentially everything the individual as a whole can do. For instance, Puccetti (1981) speculated, based on evidence from split-brain patients, that there are two "selves," one in each hemisphere. In her commentary on Puccetti's article, Churchland (1981) argued that the controversy over the number of selves and their location is like the dispute over how many angels can dance on the head of the proverbial pin. The self, like angels and demons "is so ill-defined that we do not know how to begin to count or what to take as a reasonable estimate. In the absence of theory to provide principles for individuating, one man's considered judgment is another man's jest" (p. 103).

While phenomenological ordinary language can easily lead to the notion of self in terms of countable homunculi, the functional view provides the concepts and the language for a plausible *distributed* account of the nature of self and its interaction with other aspects of affective functioning. It makes it possible to see how the phenotypic psychological level and the genotypic neuronal level might interact to create a unitary experience of self-awareness.

At the phenotypic psychological level, the totality of the functioning elements of the moment combine to constitute the unitary experience of the moment. We will refer to this unitary experience as *the inherent self*. That this global experience does constitute an (inherent) self has been suggested by Zajonc (1980). Zajonc cited evidence indicating that "the self involved . . . is probably some global and general impression suffused with affective quality" (p. 167). In contrast with the inherent self, there is what might be called *the acquired concept of self*. This aspect of the notion of self involves the particular ideas about the self and is based, at the genotypic level, on active neuronal elements which, by themselves or in combination with other active elements of the moment, create our self-image, self-esteem, personal history, immediate or long-term concerns or goals, and so on. Under normal circumstances, the inherent self—the schema-of-the-moment—always includes an implicit concept of self. However, given the functional perspective, it must be possible for the inherent self to exist without an active concept of self. And indeed, this seems to be the case. It can happen, for instance, when, as a result of some dramatic life-threatening incident, a person forgets everything up to the moment of the incident. The permanently active elements creating the acquired concept of self somehow undergo inhibition. The inherent self, however, does not go away. Even though, the schema-of-the-moment must persist in a resolving state before everything can be back to normal, the overall sense of unity is presumably never lost.

At the genotypic neuronal level, there are only functionally autonomous specialized neuronal elements, each of which generates a unique feeling of awareness. At this level, the categories the neuronal elements fall into may have a bearing on the notion of self. For instance, it can be assumed (a) that all the specialized neuronal elements fall into three broad categories with respect to the valence of the awareness they generate—positive, negative, and neutral—and (b) that positive and negative elements somehow (e.g., via gross phylogenetic specialization) constitute two mutually inconsistent sets (or neural networks).

How do the phenotypic psychological aspects of self (i.e., the inherent self and the acquired concept of self) relate to the genotypic neuronal level (i.e., to the three categories of positive, negative, and neutral neuronal elements)? It may be assumed that only positive elements constitute, via gross phylogenetic specialization, the *default* valence of the inherent self and that negative elements are phylogenetically self-dissonant. (Note that, as far as the inherent self is concerned, there can be no self-irrelevant elements.) The acquired concept of self and exogenous conditions then determine the *actual* valence of the inherent self, which can be either positive or negative and which will be negative if and only if the acquired concept of self or exogenous conditions are dissonant with the default valence of the inherent self. Thus, a person having a concept of self involving many negative elements (a low self-esteem individual?) would ordinarily be in a state of conflict and in a negative mood, even though, transient euphoric spells might be experienced to the extent that the default valence is enforced by momentary activation of positive elements and/or inhibition of negative elements. Similarly, a predominantly positive concept of self (a high self-esteem individual?) may have to put up with a negative inherent self for some time, if the individual is temporarily caught in an aversive situation.

Thus, according to the functional view, there can be no homuncular self to reside in some location in the head. Self-awareness is a *distributed* phenomenon inherent in the very functioning of whatever specialized neuronal elements happen to be active. Thus as long as the overall neural network remains functionally intact and some neuronal elements are functioning, they combine to create the inherent self. To the extent a particular portion of the network is disconnected (e.g., one hemisphere), integration between that portion and the disjoined portions (e.g., the other hemisphere), will be hampered. Thus, the distributed view of self-awareness is consistent with inter-and intra-hemispheric unity. For instance, in a split-brain patient, one hemisphere may not know what the other hemisphere just did if it is separated from it. And since each hemisphere is in contact with an otherwise intact neural system, whatever neural elements that are active in it will join to constitute a unitary self.

The distributed view of self also means that as long as some neuronal elements are active, the unity and the identity of the inherent self is preserved. Even in the most fragmentary dreams, we seem to somehow maintain the identity of a unitary self and the feeling that what is happening is happening to "me."

Attentional Consequences of Neuronal Functioning

Global functioning, in which a constellation of elements function in a simultaneous and harmonious fashion, has the advantage of allowing the totality of the psychological experience of the moment to constitute a unitary feeling of self-awareness characteristic of a single individual organism or self. However, if organismic systems were only capable of global functioning, they would have (a) no way of becoming explicitly aware of the functioning of their constituents, and (b) they would have no control over them. Therefore, as Bartlett (1932) has noted, there must be some way for the individual component (consisting of one or more neuronal elements) to function independently in the context of the overall schema-of-the-moment. By independent functioning we mean that there should occur a change in the functioning of a particular component, compared to the global level of functioning of the schema-of-the-moment. When such independent functioning occurs, the particular component becomes the center (focus) of awareness (or attention) of the organism. Focusing or attention may be either local, if an element or a local constellation manages to function independently, or global, when the element or constellation functions in unison with the global schema-of-the-moment. Local focus leads to explicit awareness of the particular component and global focus to implicit awareness of it. According to this view, independent functioning is simultaneously a mechanism responsible for attention (broad or focused) and for awareness (implicit or explicit). If a constellation of neurons do not change their (rate of) functioning, we will not be aware of them. If they change their functioning simultaneously with other groups of neurons, we will be implicitly aware of them. If they change their functioning as a single group by themselves, we become explicitly aware of them as a single unit.

The scope of independent functioning varies and may be constrained by the physical organization of the neuronal system. Consider a neuronal organization which seems to be consistent with the known organization of the brain: Assume that the totality of neuronal elements divide into several grossly specialized, phylogenetically, neuroanatomic regions—the visual cortex, the auditory cortex, the motor cortex, the pleasure/unpleasure areas and so on. Let us assume that further specialization of the neuronal elements within each of these localized areas can occur ontogenetically such that, at a given point in the life of the organism, each region contains its own repertoire or pool of specialized neurons. At the most global level, some elements within each and every area would be active, and all the active consonant elements distributed in all the areas would function harmoniously. This would create the most nonspecific experience of the moment—the global inherent self. At the next level, while neuronal elements in other areas are also in a state of functioning, some group of elements in one area (e.g., the visual cortex) manages to function independently, by changing its rate of functioning under exogenous or endogenous stimulation. The particular area becomes the focus of attention at that moment, and the imagery unique to that area is created. Yet at another level of focusing, particular local elements in a given area can function independently of other elements in the same region and/or of elements in other areas.[2]

If this way of characterizing attention is correct, there must be two distinguishable aspects to attention on a given component. There must be an attention phase of short duration. This we will call the attention-catching aspect and we believe it is determined by independent functioning. There must also be an attention phase of variable, and often longer, duration. This can be called the attention-holding aspect and must be determined by simultaneous functioning. This account of attention is consistent with the known neurophysiological and psychological data on attention. Pribram and McGuinness (1975) who reviewed this data concluded:

> Three neurally distinct and separate attentional systems—arousal [the short phase], activation [the long phase], and effort—operate upon the information processing mechanism. The presumed operation of these control systems is perhaps best illustrated as follows: The orienting reaction involves arousal but no activation; vigilant readiness involves activation but no arousal; the defense reaction involves arousal and activation; when neither arousal nor activation is present, behavior is automatic, that is, stimulus-response contingencies are direct without the intervention of any of the control mechanisms of attention. (p. 133)

An obvious difference between our account and that of Pribram and McGuinness is that the present functional view does not allow neurally distinct mechanisms. On the contrary, the functional view implies that attention must be a *distributed* phenomenon; any neuronal constellation can become the focus of attention provided that it functions independently.

How about the "effort" aspect of attention? While independent functioning under the influence of external stimulation may take place in a more or less

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[2]The limit on such independent functioning or focusing is the individual neuron, when some single neuron manages to change its rate of functioning singly. Though the latter is in principle possible, it presumably never occurs. In reality, several (hundred) neurons function at any given time to create an idea and/or to focus on a certain aspect of it in a particular region of the brain; ideas are not created locally, while images probably are. Neuronal elements creating a particular idea or meaning are distributed in various areas throughout the nervous system.

effortless fashion, endogenous independent functioning—that caused by internal sources of initiation—often involves the psychological experience of "effort." What functional conditions give rise to this experience? We believe it results when an inactive element or constellation must get activated under the influence of other already-active elements. In other words, active components of the schema-of-the-moment must be utilized as a source of initiation of functioning in inactive elements. This is possible because if a component of the schema-of-the-moment functions independently, it generates a characteristic energy pattern which, as we mentioned earlier, can serve as a sufficient condition for activating other elements; as might happen, for instance, when the schema-of-the-moment already contains an idea and we want to verbalize it. At times, this type of functional initiation may involve trial and error and, as Bartlett (1932) has noted, it may be only possible through the mediation of awareness. It happens when the global structure manages to influence the functioning of local neuronal elements; when the overall system somehow manages to "turn round upon itself."

If the present account of attention is correct, the interface between the phenotypic psychological level and the genotypic neuronal level must form a causal loop. First in this loop comes *initiation* of functioning in particular neuronal elements. This can happen in different areas of the nervous system, under the influence of different internal or external sources of stimulation, and at different times—elements creating an idea need not initiate functioning at the same time. Next comes the *combination* of these elements, within themselves and with those that are already active, and creation of particular ideas at the phenotypic level. When this happens, recognition and explicit awareness of the just-created idea occurs. The idea is conceived, so to speak. After this attention-catching phase, i.e., once an idea is created, it can become implicit in the schema-of-the-moment—the attention-holding aspect. This occurs through *simultaneous* or "choral" *functioning* of the genotypic neuronal elements, when elements come to function harmoniously with those participating in the schema-of-the-moment. Once an idea is implicit in the schema-of-the-moment, explicit awareness (discrimination) of it can occur only if the underlying neuronal element can somehow manage, endogenously or exogenously, to *function independently* (i.e., change its rate of functioning to a level different from that of the schema-of-the-moment). Finally, independent functioning at the genotypic neuronal level generates a unique pattern of energy which can serve as a sufficient condition to *initiate* functioning in other neuronal elements, and the causal loop continues during all waking hours.

Thus, the functional view provides the concepts for specifying the interface between the phenotypic psychological level and genotypic neuronal functioning. It also makes it possible to specify the functional interrelationship among different regions (i.e., visual, auditory, motor, etc.) of the nervous system. For instance, at a broad level, the functional view is consistent with the notions of partial independence of affective functioning (Zajonc, 1980). Physiological evidence, such as gathered by Olds and his associates (see, e.g., Olds, 1973), suggests that there are areas of the brain, sometimes called the pleasure/unpleasure regions (Weil, 1974), that may contain the genotypic neuronal elements underlying what Zajonc (1980) calls the *preferenda*. At the genotypic level, it is conceivable, therefore, that initiation of functioning in valence-specific neuronal microsystems can occur before, after, or even without such cognitive acts as recognition, discrimination, or awareness of an idea at the phenotypic level—Zajonc's *discriminanda*. This is because ideas are created and are, consequently, felt, recognized, or discriminated only when constellations of elements required to create them are fully, but not partially, in a state of functioning. The elements responsible for the liking of an idea may be active long before the constellation responsible for its creation as a whole becomes functional and the idea is created.

The creation of explicit awareness, as a discriminatory mechanism, resulting from independent functioning deserves to be mentioned again in closing this section. It is perhaps in reference to such coincidence of functional change and awareness that William James considered physiological changes (such as in heartrate or muscular activity) to be the same as emotions. It is ony when our heartrate reaches above its normal rate that we become aware of it, or it catches our attention. And everyone has had the experience of "hearing" the clock only after it stops ticking.

The Functional Approach and Traditional Theories of Affect

Unlike current cognitive psychology, several traditional lines of research—consistency theories, optimal-level theories, psychophysiological theories—have concentrated on the study of affect and its relation to cognition. In addition to the concern for affect, there are other attributes of these approaches that seem to contribute to their greater similarity to a functional than a structural view. They all deal, one way or another, with what might be called the functional interaction among the components of mental content (i.e., ideas, cognitions, etc.); they all attribute a critical role in mental functioning to subjective qualities (i.e., awareness, affective valence, and the detection of congruity and incongruity) and to phenomenal data; and they are all tied to concrete activity in the nervous system. In short, it might be said that, like the functional model, they are all based on the assumption of the primacy of the concrete and ongoing contents of the mind rather than on the primacy of abstract and static mental structures.

Consistency Theories

Several psychologists have assumed that the functional interaction among the components of the ongoing mental contents tends toward consonance or consistency (Festinger, 1957; Heider, 1958; Osgood and Tannenbaum, 1955).

Furthermore, the motivational force behind this tendency is the quality of the concrete affective experience. One major hypothesis is that dissonance or inconsistency produces negative affect and, consequently, people try to avoid or resolve dissonance.

By far the most influential consistency theory has been dissonance theory, developed by Festinger and his associates (Aronson, 1968; Aronson, Carlsmith, and Darley 1963; Carlsmith and Aronson, 1963). Aronson pointed out in 1968 that the major strength of Festinger's theory is that it constantly generates research (see also Zajonc, 1968, p. 359). Today it still continues to do so (see, e.g., Higgins, Rhodewalt, and Zanna, 1979).

In its original and still standard formulation, dissonance theory is primarily concerned with the inconsistency between one's internal cognitions (e.g., ideas, beliefs) and one's actions. Imagine subjects writing an essay in favor of a topic to which they are strongly opposed (e.g., the military draft). If they do so under conditions of internal justification (e.g., free choice, or insufficient reward), they will change their attitude in a more favorable direction. If, on the other hand, they do this under external justification (e.g., forced compliance, or sufficient reward), no such change would occur. According to Festinger, freely choosing to write a counter-attitudinal essay creates cognitive dissonance between the cognitions involved in:

1. I am opposed to the military draft, and
2. I am engaged in writing (hence, falsely, telling readers that I am) in favor of it.

As the number of elements consonant with #1 increases, the magnitude of dissonance will increase. Subjects may think that they are rightly opposed to the draft because American youths should not be forced to fight other people's wars in faraway lands. Similarly, if the number of elements dissonant with #2 increases, the magnitude of dissonance will also increase. The subject may think that he/she is being dishonest by arguing publicly in favor of what he/she is privately opposed to. Conversely, if the number of elements dissonant with #1 or consonant with #2 increases, the magnitude of dissonance will decrease. In the first case, subjects may think that the quality of American servicepeople under the all-volunteer army has deteriorated and has placed the country in a dangerously vulnerable position. In the second case, they may think they are merely participating in an experiment and by writing the essay they are doing the experimenter a favor.

Increases in the magnitude of dissonance will result in cognitive effort on the part of the subject to reduce the dissonance. One way to do this is to change one's existing attitude towards a more favorable attitude. However, if there is external justification, then the latter in itself provides elements consonant with #2 and, to that extent, there will be no dissonance and, therefore, no attitude change.

Dissonance theorists have addressed several basic problems concerning affective functioning and its relation to cognition. The hypotheses most central to the theory are that dissonance is an unpleasant state and that it is this unpleasantness which motivates (causes) its resolution. Several authors have also presented evidence bearing on such problems as whether dissonance situations are arousing (Kiesler and Pallak, 1976) and whether it is the arousal or the unpleasantness of dissonance situations which motivates dissonance resolution (Higgins, Rhodewalt, and Zanna, 1979).

It is not difficult to see that dissonance theory is primarily a theory about factors that control or influence the functioning of the cognitive system—as opposed to one about the static organization of abstract mental structures. Chief among these factors are the concrete relations among the components of the ongoing mental content, awareness of ongoing mental phenomena such as the detection of inconsistency and its aversive character, and the dissonance-induced global activity (or arousal) in the nervous system. Seemingly, because of the relative vagueness of the concepts involved, but perhaps because of the wide-spread interest in the nature of abstract structures and long-term conceptual networks, the research based on dissonance and other consistency theories has not attracted the attention of many modern psychologists. Here, we defined dissonance at the genotypic neuronal level as well as at the phenotypic psychological level, and we specified its relationship with awareness valence and with the self. We also tried to show that the structural approach in current cognitive psychology is perhaps not the most natural way to think about human cognition and its relation to affect. It seems to us that the original hypotheses of dissonance theory—that inconsistency awareness and its aversive quality play a major role in mental functioning—may indeed be, regardless of their particular form, indispensable aspects of any investigation of the mind-brain causal loop that seems to be so central in the functional model.

Optimal-Level Theories

While dissonance theory concentrated on the ongoing interaction between one's cognitions and one's actions, optimal-level theorists have studied the interaction among subjective experiences, affect, and external stimulation. The main goal has been to uncover invariant determinants of an optimal-level of ongoing organismic functioning. Wundt (1874) was the first to propose a curve linking stimulus intensity and affective states. Stimulus intensity up to a moderate level was assumed to be pleasant, and beyond this optimal-level unpleasantness would increase with increments in intensity.

During the 1950's, evidence accumulated demonstrating that organisms often seek dissonance and prefer it (see, e.g., Berlyne, 1960). This evidence was difficult to explain in terms of the tension-reduction hypothesis of consistency theories. How could dissonance be pleasant and unpleasant at the same time? The inverted-U optimal-level function seemed to provide an answer. Building upon Wundt's original formulation, psychologists hypothesized that, in order to experience pleasantness, organisms would have to encounter something new (something different from what they were accustomed to) but not too new (e.g., Hebb, 1949, p. 323). Based on this formulation, dissonance or discrepancy, as it was called by Hebb (1949) and Haber (1958), was no longer exclusively negative. Rather, discrepancies up to an optimal level would be pleasant; those above it were assumed to be unpleasant.

While optimal-level theorists agreed that there was an optimal level of organism-environment interaction, it was more difficult to reach widespread agreement "on the mechanism by which optimization proceeds" (Arkes and Garske, 1977, p. 149). Some argued that the individual tries to optimize the amount of arousal (e.g., Berlyne, 1960; Hebb, 1955). Some argued that the individual seeks an optimal degree of psychological complexity (e.g., Dorfman, 1965; Smith and Dorfman, 1975; Walker, 1973). Others argued for an optimal amount of deviation from the adaptation level (e.g., Haber, 1958; McClelland, Atkinson, Clark, and Lowell, 1953). And still others proposed an optimal level of congruity (e.g., Hunt, 1971). But regardless of their particular differences, all optimal-level theories, like the present functional model, were concerned with organismic and environmental causes of subjective experiences, especially those related to the experience of affect.

The discovery, made by optimal-level theorists, that organisms often seek external stimulation in the absence of any aversive biological or acquired drives and in the absence of any overt or covert goals laid the foundation for what is known as *intrinsic motivation*. The factors that optimal-level researchers viewed as being responsible for this were those involved, according to the functional model, in the ongoing functioning of the resolving or dissolving schema-of-the-moment, factors such as congruity, suspense, curiosity, interestingness, surprise, incongruity, fear, anxiety, and aversion. The fact that structural cognitive psychology has ignored these variables in the past two decades supports the contention that optimal-level research is more consistent with a functional than a structural approach.

Psychophysiological Theories

Psychophysiological models were concerned with the peripheral (or autonomic) and central (cognitive) causes of emotional experiences. James (e.g., 1884) and Lange (e.g., 1885/1922) defined emotions in terms of perceived changes in the activity of the sympathetic and motor systems. They suggested that we are angry because our legs start to shake and our hearts start to pound.

Evidence in support of the James-Lange theory comes from the research with paraplegic or quadriplegic patients. These patients report feeling less emotional after the damage to their spinal cord (Hohmann, 1966). They are only capable of getting thinking mad or afraid but not shaking mad or afraid.

In 1927, Cannon raised several arguments against the James-Lange theory. He noted, for instance, that the same physiological changes in the rate of functioning of the sympathetic or motor systems (rapid heart rate, etc.) occur during a variety of emotional experiences. Any theory based on merely these changes will fail to distinguish different emotions. Cannon hypothesized that the origin of emotional experiences must be sought primarily in the activity of the lower portions of the central nervous system.

According to a theory developed by Schachter and his associates (Schachter, 1971; Schachter and Singer, 1962), the functioning of the sympathetic arousal system and/or the activity of neurons located in the lower brain centers are not sufficient to account for various emotional experiences. Rather, the activity of other (cognitive) brain areas must also be considered. Based on this view, arousal is a general functional state which can be interpreted and labeled as different emotions depending on situational circumstances. Evidence for Schachter's psychophysiological theory comes from a controversial experiment conducted by Schachter and Singer (1962). In this experiment, the same physiological state of arousal, induced by injection of epinephrine, was interpreted by some subjects as "anger" and by others as "euphoria," depending on whether the subject watched a stooge act angrily or euphorically. Based on the results, Schachter and Singer were able to argue that the quality of emotion arises from cognitive operations and that it is, at least partially, independent of autonomic arousal.

Psychophysiological theories were perceived as being more consistent with a functional than a structural approach because of their concern for the localization of the sources of emotional quality in the nervous system, and because of their claim that one's awareness of the ongoing changes, especially in the activity of autonomic nervous system, plays a critical role in the experience of emotion—which suggests that awareness plays an important part in the functioning of the system.

Empirical Overview

The theories discussed above seem to lend support to the general conclusion that affect is a consequence of the functional interaction among the components of mental content (i.e., ideas, beliefs, etc.). The functional approach further argues that the causal loci for the generation of these content components are physically unitary, functionally autonomous, and distributed neuronal microsystems. Simultaneous and independent functioning of neuronal microsystems are responsible for the creation and unitization of content components.

One advantage of the functional perspective is its explanatory power. With only a few basic assumptions, it traces such psychological phenomena as attention (broad or focused) and awareness (explicit or implicit) to the same biofunctional causes, namely, specialization and simultaneous or independent functioning. Another advantage of the model is that it can offer solutions to traditionally controversial problems. As an example, consider the question of localization of mental functions in the brain. Early investigators tried to locate separate neural centers for such complex behavior as reading English or French (Hinshelwood, 1900). Lashley's (1929) classic experiment with rats demonstrated that it was the *amount* of brain tissue destroyed, and not so much the destruction of specific areas, that correlated with the animal's behavior. This led to the conclusion that the brain acts as a mass and all areas are equipotential. More recent neurophysiological research (e.g., Heath and Gallant, 1964; Heath, 1964; Olds and Milner, 1954) has provided evidence supporting finer localizations.

If the functional view is correct, there can be no isomorphism between complex mental or behavioral phenomena and localized neural structures in the same fashion that one would not expect to find individual genes or unique gene combinations for complex bodily organs such as the lungs, for instance. Even the simplest psychological patterns are created by the functioning of many neuronal elements located at various areas of the brain. (For a discussion of how long-distance communication among neuronal elements can take place, see Iran-Nejad and Ortony, 1982). This view suggests that the removal of a particular element or a particular local group of elements would not be expected to eliminate any complex behavior and *only* that behavior. Rather, removal of brain tissue should have a gross effect on a host of behaviors.

Finally, we will try to illustrate some empirical consequences of the functional approach for research concerning the nature of intrinsic motivation. Many psychologists have maintained that affective valence (pleasantness/unpleasantness) is the primary motivational factor. Consistency theories, for instance, believe that resolution of inconsistency is motivated by the unpleasantness that it generates. Optimal-level theorists have assumed that there is an optimal level of organismic functioning that is the primary motivational source by virtue of its effect on the functioning of the pleasure/unpleasure system. The functional view extends these predictions and implies that the most direct sources of intrinsic motivation must be sought in the simultaneous or independent functioning of *distributed* neuronal constellations. This is because such functioning is the causal origin of subjective interest, attention, the inherent self, and the acquired concept of self.

One reason why independent and simultaneous functioning are the most direct causes of intrinsic motivation is that they are the sole perpetual creators of the inherent self—the totality of the awareness experience of the moment. Without independent functioning the inherent self ceases to exist; that is, the organism goes to sleep. And the only time this can happen is when endogenous and exogenous conditions are right for the organism to do so. Otherwise, independent functioning must take place to keep the inherent self alive and, ideally, "happy." And, since endogenous sources of initiation of functioning are often inadequate for continued promotion of independent functioning, the only other real option for the organism is to engage in active or passive exposure to external sources of initiation.

Another reason is that it is through independent functioning that the organism can become explicitly aware of the components of the acquired concept of self (i.e., the immediate or long-term concerns and goals). Recall that it is through independent functioning that interaction between the system as a whole and its components (including those involved in the acquired concept of self) is possible (see the secion on the combinatorial aspect). No independent functioning of a particular component would mean no explicit awareness of it and, consequently, there would be no way of "determining" the extent to which that component is, for instance, consonant or dissonant with the self. Thus independent functioning is essential for the maintenance of both aspects of the self. It is, therefore, reasonable to assume that it is the primary motivational mechanism.

If independent and simultaneous functioning are as important as the functional view implies, then they must somehow manifest themselves in mental experience. Are there any psychological experiences that could be assumed to correspond to them? Surprise, excitement, suspense, and curiosity seem to be candidates, depending on the type of schema-of-the-moment (i.e., resolved, resolving, etc.). There may also be others such as the so-called "click" of comprehension. All of these seem to possess the attention catching/holding, or the interest-provoking quality they are expected to have. Furthermore, they all seem to correlate with awareness as independent or simultaneous functioning would necessitate. Therefore, they may indeed be psychological manifestations of the functioning of distributed neuronal elements.

If interestingness, for example, is to be defined as an inherent consequence of biological functioning, such a definition must be consistent with what is known about the concept of interestingness. For instance, it is generally agreed that both positive and negative experiences can be interesting. To the extent that this is the case, one would expect manipulations of independent functioning to be interesting regardless of whether they involve positive or negative components, that is, regardless of whether they are liked. Preliminary data we have recently gathered seem to support this hypothesis.

By identifying and defining factors representing biofunctional activity, the self, and subjective qualities (i.e., awareness, valence, consistency/inconsistency detection), we hope to have provided the basis for a plausible characterization of affect and its relation to cognition. These factors and mechanisms (e.g., valence, independent and simultaneous functioning, specialization, resolution and dissolution) are independent of particular knowledge structures and are, therefore, candidates for (or manifestations of) domain-independent universal principles. This functional view of cognitive/affective universals may be contrasted with the structural approaches that hypothesize domain-specific universals such as universal story schemata (e.g., Mandler, Scribner, Cole, and DeForest, 1980). To be sure, people from different cultures may share some sort of a schema for stories; in the same way that people from most modern cultures may share a schema for vehicles. However, we believe such domain-specific structures are not suitable candidates for cognitive universals. People who lived more than a hundred years ago had a perfectly normal cognitive system without schemata for such novelties as the television, the telephone, or modern vehicles. By contrast, pathological conditions could be suspected if the components of an individual's neuronal system were incapable of demonstrating independent or simultaneous functioning at the genotypic neuronal level, or if a person were unable to experience curiosity, suspense, or awareness at the phenotypic psychological level. It might be argued that pre-existing schemata or plans are necessary for the experience of curiosity or suspense. But such psychological experiences can be explained at least as clearly in terms of the internal consistency of the content components of the schema-of-the-moment, determined by the functional properties of the participating elements.

Finally, we must say something about the role of structural analysis in a functional model. In recent years, significant achievements have been made in the analytic approaches to language and knowledge structures. The direct goal of this research has been to develop structural representations, consisting of abstract frames and transformations.

The functional approach assumes that attempts at the analysis of cognitive structures with the aim of building structural representations of psychological validity can serve only at the expense of operating at the wrong level of specificity. Knowledge structures are unanalyzable and cannot be specified to the extent that a finite set of precise algorithms (of the nature of multiplication rules, for instance) would require in order to allow construction of a formal structural description. This is especially true of global affective structures.

In the functional approach, structural analysis is only an intermediate tool. It takes the form of semi-arbitrary heuristic, rather than precise, algorithmic analyses. While such heuristic rules may even have indispensable practical value, they are never attributed psychological status. Their value is determined to the extent that they serve to clarify the nature of independently specified functional properties of the nervous system. Functional analysis and structural analysis go hand in hand, but the former comes first.

Summary and Conclusions

This paper presented a point of view on affect that starkly contrasts with structural theories of emotion. The functional view maintains that emotional experiences must be described in terms of functional properties of underlying neuronal elements and not in terms of properties of abstract emotional structures.

Structural theories have been particularly slow in dealing with the problem of affect. We argued that this may have been because they cannot do so. This argument was supported by the fact that the majority of existing theories of emotion are essentially functional and by the fact that the recently emerging structural theories of affect often choose to ignore this rich wealth of theoretical and empirical knowledge.

While few psychologists would doubt that the nervous system is the actual site and the creator of our thoughts and emotions, there is a great deal of reluctance in psychological theorizing to get involved with concepts bearing on the nervous system. It is often argued that we do not know enough or we must solve simple problems first. But how do we know when we know enough or what is simple? In 1884, William James criticized psychologists for ignoring affect, pointing out "that the matter lay for them among the problems of the future, only to be taken up after the simpler ones of the present have been definitely solved" (p. 188). In 1980, Minsky found it necessary to warn again that "feelings and viewpoints . . . [may actually be] the simpler things" (p. 118).

We feel that what currently separates psychological and neurological concepts is the absence of a plausible language to bridge the gap. We think that the functional approach has the potential for providing this language.

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