INDEPENDENCE: AN OVERLOOKED IMPLICATION OF THE OPEN SYSTEM CONCEPT[1]

REX MADISON COLLIER

Veterans Administration Hospital, Jefferson Barracks, St. Louis, Mo.

Behavioral sciences need basic, unifying concepts that lend both cohesion and perspective to experiment and theory. The search continues for those concepts that have this potentiality and provide, thereby, maximum inclusiveness in their general correlative function. In the last two decades the concept of energy system, borrowed from physics and engineering, has been used for this purpose with increasing frequency. Von Bertalanffy (15, 16, 17), Krech (11, 12), Miller (13), Goode and Machol (8), Herbst (10), and Coleman (7) are a few of those who have employed the concept of energy system for its general correlative value in the behavioral sciences.

Gordon Allport, who would "argue for the open system . . . but plead more strongly for the open mind" (3, p. 309), is extremely critical of the positivistic use of the open system theory in psychology. The danger of system theory in the hands of positivits, particularly with the emphasis of Miller's (13) general behavior systems theory, is the loss of concepts such as self and personality. Along with this loss goes also a reduction of respect for the very subject matter out of which we attempt to form a science. Psychology, which is rich in "facts" but poor in perspective, needs an extensive examination of its implied and explicit basic concepts of the living organism. A good basic concept of the organism can lend perspective to theory and experiment, and can contribute to frames of reference by which improved and more relevant judgements can be made on all problems in the field of psychology. As an approach to such an end, this article begins with the assumption that living protoplasm is an open energy system and points out how a closer examination of certain biological characteristics provides a basis for such concepts as degrees of independence or freedom, individuality, and self.

The Open System Concept and Degree of Independence

By the assumption that living protoplasm is an open energy system, it is implied that there are energy transactions between the system and its surroundings. This is one of the more obvious implications. Energy within the system is consumed by the various interrelated

[1]The writer accepts the definition of system given by Allport: "A system (any system) is a complex of elements in mutual interaction" (4, p. 28).

processes that go on, and new supplies must be admitted or absorbed from surrounding sources. There is, therefore, a necessary degree of dependence of an open system upon external resources of energy.

If the theoretician now goes immediately to the concepts and techniques of input-output relationships, he runs the serious hazard of overlooking an important characteristic of the protoplasmic open energy system. The purpose of this discussion is to offer a revision or correction of this type of oversight. From a closer look at the organism at this point, there appears an implication which in turn generates an approach that psychology seems seriously to need. This less obvious implication is that the open system of living protoplasm has also some degree of independence from surroundings. See Criterion 4 of Allport (3). Were this not so, then the open system would soon lose its identity or individuality. Non-living energy systems tend to break down with mutual impact from interacting energies and drift toward a maximum entropy or smoothing-out of differences. Under these conditions identity is not maintained. But the essential point is that the non-living system does not resist in the way that living systems do the invasions of external energy that often finally destroys its individuality. Living energy systems tend to maintain their identity by the following maneuvers: (*a*) selection of only certain types of energy resources that are compatible with the maintenance of the internal system,[2] (*b*) discharge of materials when further retention is incompatible with the system, (*c*) the transformation of admitted energy resources so that compatibility with the internal system is increased, and (*d*) the storing of reserves and their utilization when external resources are not immediately available.

All of these characteristics of the semi-open, living protoplasmic system indicate that, along with a degree of dependence on external energies, there is also a degree of independence from surroundings. This degree of independence of living protoplasm may be observed in many ways.

LIFE AND DEGREE OF INDEPENDENCE

A brief survey of a few living forms and their characteristics will illustrate the principle of degree of independence. A seed, such as an acorn, falls to the ground, rolls down an incline, and is deflected by a

[2]The concept of the open system should be modified to that of a semi-open system to be compatible with what is known about the living semi-permeable membrane.

rock into a small surface depression where it comes to rest. In all of this the acorn would appear to be passively dependent upon immediate surroundings. But it does not remain completely at the mercy of immediate energy characteristics since it has some potentialities of its own. When rootlets emerge and migrate into the ground, there is an extension of the range of moisture and chemical resources. As a stem grows higher and higher, there is an expanding range of air and light resources. The seed has shown a degree of motility and independence from the immediate surroundings where it first came to rest. This is obviously in contrast to a stone that passively remains in its position until it is moved, pushed, or rolled by some external force.

Attention may also be called to the seed, like the milkweed, which is equipped with a multitude of silken strands that flow out into the breeze and become an effective parachute. While the seed is carried along by whatever wind currents are in motion at the time, the very structure of this organism represents a degree of selectivity. The seed is more responsive to the wind than to other forces, such as gravitation. This type of selectivity of one energy resource more than another, represents, of course, a very rudimentary level of degree of independence of an organism.

A Phylogenetic Approach

For another example, note through a microscope the field of a droplet of water where small particles are suspended in the solution. If the stage is tapped lightly, these particles are seen to oscillate briefly with the vibration and then return to rest until the stage is tapped again. These particles appear passively dependent upon their immediate surroundings. Then one may note an object that comes spiraling into the field and moves about in sharp contrast to the particles that seem motionless until moved. Here is an object that expresses a degree of independence from surroundings, and the observer immediately judges this object to be alive. The criteria for this judgement are simple, commonplace, and widely used, but even so their significance should not be overlooked.

Again, consider the myriad forms of life found in the sea.[3] These variations of life forms within a relatively homogeneous environment indicate a degree of independence from those surroundings. While sea water varies in temperature, mineral content, light, pressure and depth, there is still a high degree of homogeneity over large areas.

[3]The term sea is used to designate both fresh and salt water media.

Were life passively dependent upon the energy characteristics of immediate surroundings, then forms and functions would tend toward as great a degree of similarity as there is homogeneity of surroundings.

Both form and motility may be seen as functions of a protoplasm's degree of independence from immediate surroundings. Patterns of growth and development are more directly related to the internal patterns of metabolism than to the external energy distribution. For organisms, such as sea plants and the less motile sea animals like Hydra or the crinoid or even the anemone, the main requirement for their maintenance is relative constancy of surroundings. These animals need a continual supply of sea water from which they select those energy supplies that are compatible with their particular protoplasms. Having selected and admitted to their systems the energy resources needed, they then transform these supplies into compositions that help maintain that specialized protoplasmic form. Many variations of life forms may, therefore, be found in relatively homogeneous surroundings.

Less consistency of immediate surroundings is required for more motile forms that may swim. Here the animal, by its increased range of movement, may increase its chances of selecting both physical environment and nutritional environment that maintain its own system. The increased motility provides the animals with a greater degree of independence from the energy pattern of any immediate set of circumstances.

For the simpler life forms with reduced ranges of motility, close contact of cells with sea water is a basic necessity for life maintenance. For example, the body wall of Hydra, a Coelenterate, is only two cells in thickness with both ectoderm and endoderm bathed by sea water. The structure of Porifera tends also to allow all cells to be in close proximity to the sea water. The larger, more complex, and more motile animals begin to carry their supply of sea-water type of fluid with them in the form of lymph and blood. It can be noted that the Echinoderms which have a water-vascular system must remain in contact with the sea-water supply while other organisms, such as the Annelids have a self-contained vascular system that is maintained within the organism. With the development of self-contained circulatory systems, the animal may maintain a high degree of internal constancy. Since such animals are able to carry with them a constant internal environment, they are enabled to enter external environments of greater variety. Such an animal has won additional degrees of

freedom from dependence upon the energy characteristics of immediate surroundings.[4]

Further degrees of independence are added when skin, scales and hair contribute to insulation from sudden changes in temperature. Dramatic increases in range of motility and degree of freedom occur when the animal acquires lungs for land survival along with homeostatic temperature control and legs or wings to increase range of movement. And now man has added instrumental devices of all kinds that increase his degrees of freedom from passive dependence upon the immediate. He moves not only on land and sea but takes to the air, and is about to move into outer space. These degrees of independence from the energies of immediate surroundings are all related to the principle of the open or semi-open system of living protoplasm that maintains some degree of consistency or identity in spite of being a semi-open system.

As protoplasmic systems increase their spatial range of activity, there is a concomitant increase in the specialization of receptor devices that increases the range and variety of information from surroundings. Because of olfactory, gustatory, visual, tactile and vibratory sense organs, the organism has not only become more accessible to stimulation but also has extended the range of sources from which information may be derived. A cluster of concomitants which seem necessarily related are motility, metabolic complexity, and sensory diversification. As motility increases, metabolic devices or mechanisms develop which tend to preserve a required degree of constancy of internal chemical environment along with a characteristic pattern of growth and development. Moreover, survival in an increasingly complex external environment is associated with an increase in the sources and types of information that are utilized. The variety of substances that may be admitted into the organism as food, increases rapidly as a function of the radius of travel. While some of these items are conducive to the maintenance of a given protoplasmic system, others would be detrimental or even lethal. Selectivity is essential to survival. Sensory equipment commensurate with the environmental complexity produced by additional degrees of motility becomes instrumental in selective behavior.

All protoplasmic forms have their enemies in other living forms.

[4]Cannon (5) has referred to the homeostatic mechanisms as giving the organism additional amounts of freedom to pursue objectives not directly concerned with the immediate issues of life maintenance.

Increasing the range of motility provides both the capacity to flee from an enemy and an increase of chances to encounter an enemy unless advance information can be obtained and an encounter avoided. Hence sensory equipment becomes of survival value in managing relationships with dangerous situations.

An Inconsistency in Psychological Theory

The organism's degrees of freedom from immediate surroundings have been shown to increase with increasing motility and increasing complexity of internal metabolic devices. The sensory equipment and, of course, the associated neural processes should contribute to these general gains in degree of freedom. Acceptance of the point of view this far, should allow one to consider additional steps in theory development.

However, a curious inconsistency with some aspects of psychological theory appears. The transfer of attention from the more obviously metabolic processes of the organism to the stimulus-response (S-R) aspect may arouse questions about consistency of approach. Perhaps one might be quite willing to accept the argument for a degree of organismic independence derived from the principle of a semi-open protoplasmic system that maintains its identity in the midst of a surrounding energy pattern. But, does the approach hold when attention shifts to S-R relationships? There are those who would insist that now we have something different, that the stimulus is all important in the production of behavior, and finally that the environment is the great regulator of the behaving organism. Hebb (9) suggested that this concept of sensory dominance of behavior was being outmoded even a dozen years ago. However, the movement to replace the peripheral concept with a concept of central dominance has not gone as rapidly as might have been anticipated at the time Hebb wrote his *Organization of Behavior*. The argument has been offered by others that any response could be traced to a series of neural events, these in turn to events within the body, and these finally to circumstances or stimuli outside the body (14, pp. 28-29). For this type of S-R theory it would seem that the sensory dominance concept regresses the organism to dependence upon immediate surroundings. Either the earlier part of this discussion is in error, or this concept of behavioral dependence upon immediate surroundings is in error.

Living forms of protoplasm often present strange and difficult problems. However, it would be surprising indeed if the self-regula-

tory principle that seems to be so obvious on the metabolic level suddenly breaks down and must be cast aside when the organism interacts with his surroundings on a behavioral level. Again, it would be strange if these two so-called levels are finally functionally separable except for some specific purposes of description or experimental convenience.

Child recognized a continuity between the metabolic and the behavioral. After pointing out that reactions of organisms that involve movement and changes of relations with environment constitute only part of the behavior of organisms, he says more specifically, "Reaction to environmental factors by change in rate or kind of metabolism or in rate or course of development is just as truly behavior as the motor reaction of an animal to light or the movement of pursuit following the sight of prey by a carnivore" (6, p. 1). This quotation indicates that for this biologist there is no loss of continuity between these two aspects of organismic function. Later in his book Child makes the case even stronger by placing the S-R aspect of function in the matrix of total organismic pattern. He says, "There can of course be no doubt that in general terms organismic pattern constitutes the basis on which the excito-motor behavior patterns of an organism are built up; in other words, organismic pattern is the general framework within which such behavior occurs" (6, p. 70).

The necessary implication is that the S-R capacities of the organism in no way violate the principle of increasing degrees of independence from immediate surroundings as organismic complexity increases. It is rather that the development of neural tissue and progressive cephalization have significantly increased this very capacity for additional degrees of independence. Among the various capacities of nervous tissue there is one that makes nervous system somewhat analogous to circulatory system. Simple organisms can live because the direct contact with sea water brings to the cells the chemical necessities of life; the circulatory system of blood and lymph of complex organisms provides for the continued maintenance of these primitive sea-water conditions. Thus, as the organism carries its sea water with it, the range of motility can be greatly increased. In a comparable way the nervous tissue enables a more effective storage of experience and information so that response patterns may both become more variable and also increase chances of wider ranges of response relevance and thus adaptability. Were the organism's response patterns simple and invariable, it would be limited to the narrow

range of conditions in which that type of response is appropriate for survival. Thus the organism would be as space-bound on this basis as is the simple organism whose cells must be fed directly from the immediate sea water. But, when the effects of experience can be stored and utilized at an appropriate later time, the organism is less dependent upon a region where conditions have a narrow range of variability. The wider the range of conditions to which adaptive response can be made, the greater the degree of independence the organism has from immediate surroundings. Thus it is proposed that S-R concepts should be reorganized to fit the frame of reference that has been outlined.

An Ontogenetic Approach

The energy system of the mammalian prenatal embryo or fetus is not only an open one but also dependent and parasitic. The embryonic system absorbs energy only from the host system. A break in the connecting placenta would result in the loss or death of the dependent system. Birth is obviously a dramatic moment when the developing system demonstrates an added degree of independence. The metabolic pattern of the sub-system has become more self-sustaining and has entered a larger and more complex environment. Motility has increased and sensory intake has broadened.

Development of the individual can be characterized by progressive increases in degrees of independence or freedom from the energy pattern of immediate surroundings. For the human child there are many illustrative examples. From being held to the breast or having a bottle placed to his mouth he progresses to holding the bottle himself. Then comes feeding himself with a spoon, and later he climbs to the proverbial cooky jar or runs to the store with his own money. He also acquires the skills to dress himself, to find his way to school, to talk back to his parents, and eventually perhaps to think for himself. These skills represent positions along a scale of increasing degrees of independence from the energy patterns of immediate surroundings.

The input-output paradigm can be used at any of these stages and would most certainly have its relevance. The hazard of the input-output concept in the study of protoplasmic forms is in the loss of perspective. Too frequently the implied invitation is to focus upon a cross section of immediate performance and thereby remove those observations from the context and meaning of metabolic pattern and developmental sequence. The same criticism was made of Titchenerian structuralistic methodology many years ago, wherein elaborate

analyses were made of mental-content cross sections without the context of temporal and developmental sequences. It seems odd that those who would be most active in rejecting an old mentalistic approach would commit a methodological error characteristic of the earlier school.

With the perspective proposed in this essay there is the possibility of preserving the values emphasized by the positivistic approaches while at the same time saving a place for the central and self-regulative processes. From this reorientation there would be legitimate place for concepts of self and personality. And, when Allport refers to the manipulations of oversimplified input and output approaches, it would no longer be necessary for him to insist critically that in such a setting, "Personality thus evaporates in a mist of method" (3, p. 303).

Instead of personality disappearing into a ghostly vapor to be denied a place in reality by traditional positivism, the present approach provides a firm basis for the concept. The core concept of the living organism is composed of the very characteristics that give rise to individuality which stems directly from the following capacities of living protoplasm: (*a*) to maintain itself as a unified organism, (*b*) to be self-regulating, (*c*) to achieve a degree of independence from immediate surroundings, and (*d*) to maintain a degree of identity. These characteristics are shared in some degree by all living organisms. The concepts of self, ego, super-ego, the Adlerian life style or "individual form of creative activity" (1), and Allport's proprium (2, 4) are all superstructures peculiar, of course, to human beings but having common roots in these protoplasmic capacities. No theory of the self can be complete nor can it have adequate perspective without a clear recognition of these biological backgrounds and continuities. Thus, a basic concept of the organism becomes a most important frame of reference in psychological theory construction.

RECAPITULATIONS WITH SELECTED IMPLICATIONS

In condensed form the thesis may be presented as follows:

1. Living protoplasm may be conceptualized as an open or semi-open system of energy. This approach, which is contributed by general behavioral systems theory, has extensive potentialities both for systemizing current theory and for enabling additional developments.

2. Living protoplasm tends to maintain its identity of form and function even though it is an open system. The observation that

metabolic pattern is basic to the maintenance of identity is necessary before moving on to input-output concepts and techniques; otherwise the results of input-output studies will be interpreted without adequate perspective.

3. The open system that maintains identity in spite of energy transactions with surroundings has some degree of independence from the energy characteristics of these immediate surroundings.

4. The animal series may be seen in phylogenetic array along a rough continuum representing increasing degrees of independence from immediate surroundings. The same continuum may be applied to ontogenetic development.

5. With this perspective attention is focussed upon the organism as an organizer and as an energy resource more than upon stimuli or sensory characteristics. This is primarily a matter of relative emphasis, but the accentuation is important, for starting from a positivistic approach there is discovered a systematically legitimate place for a psychology of the self and for personality.

6. Finally, an approach is established whereby a basic concept of the organism may be developed which can have a resystemizing effect on several aspects of psychology. Of equal importance are the potential effects upon methodology and methodological philosophy. Whereas methodology has had little to do with a concept of degrees of freedom except in a technical, statistical sense, this type of concept must have a broader adaptation to behavioral problems. Only in this way can an experimental approach remain compatible with what appears to be essential as a beginning toward a basic concept of the organism. The concepts of prediction and control cannot escape reexamination for their connotations and appropriateness.

Both phylogenetic and ontogenetic approaches seem to indicate a dominant urge of living protoplasm to achieve additional degrees of freedom and liberation. No psychology of individuality or personality can be complete without evolving a methodology that adequately recognizes this aspect of organismic potentiality. The old dichotomy of freedom *vs.* determinism should be replaced by a continuum conceptualized as degrees of freedom. Only a midportion of this continuum should be considered realistic in terms of empirical tangibility. As one approaches the extremes in either direction, the fictional quality increases. Thus, as one attempts to build a basic concept of

the organism with implications stemming from the organismic potentiality for some degree of independence from immediate surroundings, he finds both an enriched approach to personality and a need to look critically at traditional methodology.

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