The Theory of the Organism-Environment System: I. Description of the Theory

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Abstract—The theory of the organism-environment system starts with the proposition that in any functional sense organism and environment are inseparable and form only one unitary system. The organism cannot exist without the environment, and the environment has descriptive properties only if it is connected to the organism. Although for practical purposes we do separate organism and environment, this common-sense starting point leads in psychological theory to problems which cannot be solved. Therefore, separation of organism and environment cannot be the basis of any scientific explanation of human behavior. The theory leads to a reinterpretation of basic problems in many fields of inquiry and makes possible the definition of mental phenomena without their reduction either to neural or biological activity or to separate mental functions. According to the theory, mental activity is activity of the whole organism-environment system, and the traditional psychological concepts describe only different aspects of organization of this system. Therefore, mental activity cannot be separated from the nervous system, but the nervous system is only one part of the organism-environment system. This problem will be dealt with in detail in the second part of the article.

Man and Environment: Two Systems or One?

THE CONCEPTION OF HUMANITY in relationship to the environment has probably always been problematic and controversial. In spite of the fact that people essentially change their environment with their activities, the basic characteristic of human beings has usually been considered to be their inner life, their mental activity and consciousness. This is connected with the idea that man and nature stand against each other: man as a thinking subject, inhabitant of culture and user of knowledge, and nature as something rudimentary and vulgar—if some beautifully colored sunsets or quietly whispering mountain streams are not taken into account.

Moreover, the development of psychological theories has, from ancient times, been based on the idea that humanity and environment form two different and evenly opposed systems. Common-sense psychology—as well as many scientific theories about human behavior—starts from the assumption that the inner world of man, his thoughts, feelings, hopes, and needs, form the basis for his outer behavior which, however, is something trivial and eventually aims back at inner satisfaction, fulfillment of hopes, and feelings of happiness. The achievements of the human spirit may be seen, of course, in outer behavior or changes in the structure of the environment: as palaces, musical notes on paper, or colors on canvas. However, it is thought that what is essential is not behavior or these products as such, but the ability of the human spirit to reproduce and enjoy the ideas of science or the beauty of art in our own inner world. The environment may mediate such

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possibilities, but it is seen only as a passive set of elements in contrast to the active inner life of man. Such elements may, however, be filtered, processed, and refined by the human spirit. The importance of the environment cannot be neglected, but it forms only some sort of necessary and trivial background for the achievements of the human spirit.

Nowadays it is especially stressed that man should understand himself in order that his future continuity be assured. The President of the United States declared the 1990s to be the decade of the brain, probably in the hope that the answers to the problem of human behavior will be eventually found inside man, in his brain. This decade is almost over and no new answers are in the offing; not even the direction in which brain research may be heading can be detected. This may be due to the fact that when concentrating on himself, man has forgotten the most essential factor in his life—his environment. In studies of human behavior the latter has always been taken as self-evident and unproblematic; the main problems were seen within man himself, in the processing capacity of his brain or in his cognitive abilities. It is, however, not at all easy to say what really is the environment of man, what it consists of, what its relation to the past and future is, how it should be described, and how useful it is to abstract man from his environment in any study of human behavior.

Mental Activity and the Linear Processing of Environmental Stimuli

The separation of man and environment can be seen in modern psychological theories as the notion according to which mental activity is based on linear processing of information from the environment. In cognitive psychology—the mainstream of psychology during recent decades—sensations, perceptions, and mental activity in general, are regarded as "something" related to the inner processing of environmental information by the senses and by the brain. The senses receive the stimuli which then run along the nerve paths to the centers, analyzing the incoming information and creating interpretations of the events occurring outside the brain and body.

Originally, at the end of the nineteenth century, such processing was described as a reflex or stimulus-response connection, through which responses automatically ensue from the stimuli. During the last decades this connection has been conceived in so-called constructivism (see, e.g., Steffe and Gale, 1995) as an active event, the responses and mental activity being mediated by active interpretative processes in the organism. Knowledge, for example, is not now thought to be a direct copy of the environmental order, but is conceived of as a result of active construction processes. Although currently being presented as new, such ideas have existed in Western philosophy for centuries.

According to the constructivists, the information processed in the organism is based on stimuli located outside the borders of the organism. When dealing with the reading process, for example, the stimuli may be anything from geometric points, lines, or edges to letters, from sentences to pages or pictures or even to another human being reading a book. The processing may be described by models which are often quite complicated, involving some sort of feature detection system, semantic analyzers, stored lexical units, memory stores, and so on. The ontological status of such components is usually not specified, although it is implicitly assumed that eventually these components are realized by some parts of the brain and may be "objectively" studied at the neuronal level. In any case, along this line of thought, man is no longer seen as a passively responding being, but instead as actively processing the input, choosing carefully in each contact with the outer world the necessary behaviors on the basis of his sensations, perceptions, and thoughts. Man is not

conceived of as a mechanical transducer of environmental stimuli or a computer, although much of human activity may be described by cybernetic concepts in terms of information processing or by computer modeling.

As an example we may look at how such a seemingly simple act as pressing a button in a reaction time experiment is described using modern psychological concepts. A short tone is presented, and the subject quickly presses the response button. What is actually happening in this situation?

According to present and widely accepted theory, the situation may be described as a linear sequence of events starting with the tone (see, e.g., Naatanen, 1990). The tone is located in the outer world and may be exactly defined by such physical terms as sound-pressure level and frequency, for example. The modulation in the sound pressure is produced, for example, by the vibrating membrane of the loudspeaker, transmitted through the air to the tympanic membrane of the ear of the subject, mediated as mechanical changes in the ear by the basilar membrane in the cochlea, where hair cells transform the signal into electrochemical changes manifested in trains of impulses ascending towards the critical place, the temporal cortex of the subject. Here the nerve impulses are analyzed, relevant information is sorted out and compared with models or representations stored earlier, and the connections to the motor side are established. Finally, this leads to neural activations in the motor cortex and motoneurons innervating the muscles needed in the button press. The muscles contract, the finger moves, and the experimenter is satisfied.

Thus, the whole sequence of events may be described as successive sets of activity started by the stimulus, being as such a passive part of the environment, and ending with the reaction (being the active influence on the environment). Somewhere between these two events the transformation should then change passive to active or physical features of the environment into active perceptions of these features. Mental activity is constructed somewhere between the stimulus and the reaction, but where?

As a matter of fact, as mentioned above, this way of thinking is not at all new, but such reaction time experiments dominated the beginnings of scientific psychology in the last century when psychology started to separate from philosophy to become an independent experimental branch of science. It is understandable that concrete research started from the easiest area, from the study of the reaction and from the events immediately preceding the reaction. Thus, already from the common sense point of view, we may realize that when a man or an animal is acting, the activity is usually preceded by changes in the environment which seem to have a causal relation to the studied activity. When the subject presses a button in the reaction time experiment, the activity is preceded by an event in the environment, defined earlier by the experimenter as an auditory stimulus—the tone. If the tone is made quieter the reaction time gets longer, and if the sound is weak enough no reaction is obtained. It seems thus self-evident that the stimulus is the real cause of the reaction, the behavioral act of the experimental subject.

However, in the research into the behavior of man and other animals in the last century, establishment of stimulus-response relationships was not the real aim of the study. The basic problems were rather related to the understanding of the adaptivity and flexibility of human and animal behavior (see, e.g., Jennings, 1906). How is it possible that different living beings are so adaptive and purposeful in their actions, how do they direct their activity in the search for food, and how do they avoid negative effects? How is their behavior modified so flexibly under varying circumstances? Biological research opened up surprising views about the development of animals and forms of adaptation and the goal-directness of their behavior in different environments.

The research was, however, complicated by the fact that it was difficult to observe more complicated forms of animal behavior, especially that of human beings. In the case of simpler animals it seemed to be relatively easy to follow the formation of behavior from certain environmental stimuli to their reactions. If, for example, the animal was presented with a threatening stimulus it simply tried to avoid this. However, even here there were some problems: if a frog was presented with a sudden tone it jumped away, but if it was swimming the response was to dive. The study of human behavior was particularly connected with special problems. Human behavior seemed not to follow so unequivocally from certain stimuli as that of other animals, but instead always included a large number of alternatives. The behavior of a hungry human subject was not as predictable as that of a hungry dog; the ways of human behavior seemed to be essentially more complicated than those of other animals. In addition, humans had consciousness: they could experience and report their thoughts and feelings—facts which seemed to escape all objective or scientific analysis.

Under these circumstances it was understandable that the research situation was so simplified that at least some changes in the environment and characteristics of human behavior could be measured and controlled. The accessible environment was limited to an exactly defined stimulus, and the behavior of the subject was predetermined; only a simple movement, a pressure of the reaction button, was allowed. In this way the experimental stimulus was created: an environmental change under the exact control of the experimenter which stimulated a certain sense organ and to which the subject had to react in a predetermined way. Sometimes also reports of subjective feelings were allowed; in fact, introspection was originally one of the basic methods of experimental psychology. It was, however, not at all easy to relate such subjective data to the observed reactions and, therefore, such recordings slowly disappeared from the repertoire of experimental methods. This kind of approach was strengthened as it produced results: reproducible regularities between the stimulus and the action of the experimental subject could be found. When the stimulus intensity was increased the reaction time got shorter, and if the stimulus was decreased to the perceptual threshold there was no reaction. Thus, the first steps in the scientific explanation of human behavior and its prediction had been taken.

In fact, the dependence of the reaction time on the intensity of the stimulus was in the last century one of the first findings of the laws of human behavior. The correlation between the changes of the behavior of the subject and the changes of the stimulus characteristics supported the conception that the stimulus was the immediate cause of the reaction. It was then only natural to start to search for intervening mechanisms leading from the stimulus to the response. This became the task of the newly developing neurophysiological research.

On this historical basis it is understandable that stimulus and reaction have had—and continue to have—a central role in the experimental study of human behavior. Underlying this way of thinking is the idea that the organism is a mechanism which is separated from the environment and the study of which is, in principle, possible in the same way as that as of any other device, say of a car or a thermostat. Such a device may be examined by separating the parts and looking at their functioning and at their dependence on discrete features of the environment without taking into account the machine and its environment as a whole. The basis for this kind of scientific analysis was laid several centuries ago by the French mathematician and philosopher René Descartes, who conceived living beings as no more than complicated machines. It was Descartes who pointed out that the study of living beings is possible by using as a unit of analysis a linear connection between the stimulus and reaction, the reflex.

Nowadays many kinds of events between the stimulus and response, or input and output, may be proposed, such as analysis of the stimulus features in the neural networks, integration of incoming signals with stored models, or the choosing of motor programs, but the type of the analysis is always sequential and linear: the events proceed from the stimulus to the reaction, and the reaction is explained on the basis of the stimulus plus inner operations upon this preceding event. In addition, the stimulus produces mental activity like perception, but in fact this activity has no functional role in the analysis, or at least its ontological position is unclear. It may be identified with circumscribed neural activity or it can be thought of as some sort of epiphenomenon following from the neural activity. However, in neither case has it any significance for the behavior of the organism. Consciousness or personal experience may be excluded from such an analysis.

During the present century new methods of research for the activity of the nervous system (recording of the activity of single neurons and the activity of the brain) have to a large extent increased our knowledge about the possible mechanisms—physical, neural, chemical, and even genetic—between the stimulus and the reaction. Thus we have a better understanding of the propagation of the different forms of energy, mechanical and neural changes in the receptors, generation of nerve impulses, interaction between the neurons, selection of stimuli, influences on the activity of sense organs, processing in the central nervous system of neural models of stimuli, and so on. Psychological theoretizing has supported this development by describing mental activity as information processing, as the construction of inner models, or as the formation of cognitive maps and schemata of the environment.

However, this huge amount of research and vast number of results reported in the contemporary journals has not much helped us to understand the regulation of human behavior, its purposefulness, adaptivity, or even the generation of the most simple perception. As a matter of fact, this type of scientific study of human behavior seems effectively to destroy all the coloring, features, and nuances essential for human behavior, which we experience all the time in the everyday world and of which we may learn more through reading good novels and poetry than textbooks on psychology. Psychological or neurophysiological research has, in fact, produced no well-grounded theory about the connection between the stimuli and responses and associated subjective experiences, to say nothing about the possibility of understanding on this basis more complicated human activities, like the role of emotions in behavior or the development of culture. Why do we have such an awkward situation despite vast investments in research? Why is the understanding of human behavior so difficult?

This situation is certainly not due to the low quality of the research carried out by experimental psychologists or neurophysiologists. On the contrary, methods have been developed and experiments planned to analyze very carefully all possible events in the organism associated with the presentation of the stimuli or selection of the reactions. In addition, tremendous efforts and huge sums of money have been invested in the development of methods for the exact physical measurement of all possible characteristics of the stimuli and the recording of all possible changes in the experimental subject.

No, the problem is certainly not here. It may be that there is a much more profound problem. Experimental work and theoretical development have consistently been based on the idea that organism and environment form two separate systems and that mental activity is located in the organism, that it is an inner and private activity of the organism. It is this basic starting point which seems to lead up a blind alley. Could it be that this basic assumption is simply not correct?

How far is the explanation of behavior possible with the two-system assumption? Most of the dramatic changes in the history of science have appeared with changes in the basic assumptions of people about the characteristics of the world. The assumption that the earth is the centre of the universe was based on common-sense experience. From this assumption it follows that the planets must circulate around the earth. Their orbits, however, look somewhat strange with the earth-centered assumption, because the planets seem to move backwards every now and then (epicycles). Thus it was necessary for the Greek astronomers to assume two kinds of physics: mechanics on the earth and mechanics in the heavens. This complicated physics was simplified when it was realized that the basic assumption had only a limited use and was based on our earthly point of view. It was shown by men like Copernicus and Kepler that no separate heavenly physics is needed if we assume that the earth is moving with the planets and the sun is fixed. When we start with this assumption we may coherently explain many more experiential facts than when using the earlier assumption. This, however, does not change our experience of sunrises and sunsets.

Just as with the earlier astronomical models, the starting point of most explanations for human behavior is based on our everyday experience. This may be summarized as follows: there is a human being which we may see and an environment in which this being is acting. Thus we have basically two different and separate objects: man and environment. This separation seems to be so self-evident that we usually do not see any reasons to doubt it; actually it would be strange to maintain anything else. There is the physical environment, the world surrounding any organism, and there is the organism with its private inner world (which we may of course doubt in the case of animals, sometimes even of other human beings). The border between the two worlds or systems seems to be clear; it may be located somewhere close to the skin. The two systems are, of course, not separate in the sense that they are in continuous interaction. The organism acts on the outside objects, and these objects exert influences on the organism which reacts through its inner processes.

All this seems to be simple, and it is not surprising, therefore, that not only cognitive psychology, but most of modern psychology, and especially neurophysiology, is based on this general scheme. In this model, however, there are some fundamental difficulties which are related to the problem of definition of the border between the organism and the environment and to the scope of application of psychological concepts. These difficulties are probably also the basis of the situation that psychology finds itself in in that even nowadays it is thought to be methodologically problematic and in general a disorganized science.

Why should it be so important to be able to define the border between the organism and the environment? Maybe this was not so important during the time when psychology and neuroscience were living relatively far from each other, when the recording methods of brain activity were crude and the neural basis of mental processes could only be hypothesized. Nowadays we are, however, in a new situation, because the new recording methods may give us a relatively good picture of the processes going on in the brain during behavior. The crucial problem in the future will then be: are the mental processes to be found in the brain or not? Thus, the problem of localization of mental activity has become an important question for neuroscience because the answer to this question will direct the search for the neural basis of mental activity, and especially of human consciousness, which has recently aroused much interest in neuroscience (see, e.g., Churchland, 1986; Dennet, 1991; Searle, 1992).

Furthermore, in all psychological and neurophysiological research it is essential to understand the kinds of systems with which we are dealing when we try to explain human

behavior. If we start with the notion that the organism and the environment are two separate systems, it is quite reasonable to suppose that mental activity is the characteristic of the organism system, and the formation of knowledge, for example, is based on transmission of information or knowledge from the environment to the organism, and on the construction of models of the environment in the organism. In order to be able to move and control its activity in appropriate ways, the organism must know parts of its environment. Such knowledge may be formed through some kinds of mental pictures or representations of the environment within the organism system.

What are, however, these inner pictures or representations, and where are they located in the organism? Are they, in fact, identical to neural activity, or are they somehow separate from this, belonging to some other reality like a mental or social world? If they are located in the brain, are they in the neurons or in systems of neurons or in some interneuronal spaces? Do they actually exist at all; are they only some sort of metaphor or epiphenomenon? Such questions have been asked for centuries, and the answers have varied depending on the basic philosophical attitude of the researchers. These questions logically follow from the separation of man and environment. This, however, presupposes that we may unequivocally determine where the border between the organism and environment is located. Otherwise we could not say what is inside and what outside the organism.

Thus, if we want to study the supposed two systems, man and environment, we should be able to define unequivocally those elements of which the systems consist. It is important to know with which system we are dealing when we study any element and its significance in the explanation of human action. This is essential when we try to define even such basic concepts as the behavior of the organism.

For illustrative purposes we define man—or any other multicellular animal—as an organized and integrated living system consisting of cells and tissues. The environment we may define as another system located outside the former system. The environment may consist of living and inanimate parts. Thus, we may speak of social parts (other humans), of biological parts (other living systems), or of physical parts of the environment (inanimate parts).

How do we define behavior in the two-systems theory? All behavior of the organism presupposes some kind of movement; thus, behavior could be simply defined as a change of the relation between the two systems. What does this mean? Apparently it is not necessary to have both systems in complete motion in relation to each other as behavior could be realized also as a movement between a few elements of the systems, e.g., when I move my hand towards a pencil to grasp it. However, this clearly presupposes that we are able to define unequivocally the elements of the two systems. Otherwise we would not know whether we are dealing only with intrasystemic changes when some movements occur. Upon this depends whether we can define what we mean by behavior and from this, furthermore, whether we at all know what we are trying to explain when we are explaining behavior. Thus, an unequivocal definition of behavior presupposes the possibility of exact determination of the elements of the organism and environment systems, and this is possible only if we know where the border between the two systems is located.

Is it possible to establish the border between the systems? Is it possible, however, to define separately the elements of the organism and environment systems and the border between the two systems? Let us try to define the border between the two systems when looking at such behavior as drinking coffee from a cup, for example. This is certainly behavior which has physical, physiological, and mental aspects. Is it possible to separate these aspects in the description of the behavior and to determine to which system each of them belongs?

The events in this piece of behavior may be described according to the modern psychological conception. Let us start with the cup on the table. The cup of coffee is a physical part of the environment and clearly outside the organism system. It may be thus defined as an element of the environment or as a stimulus. The human being is sitting at the table and has the need to drink coffee. This could be described as a physiological process within the organism, but there is also its mental aspect, which could correspond to some state of the brain, for example. The environmental stimulus (reflection of light from the cup) sets off a process in the organism eventually leading to the movement of the hand, one element of the organism, towards the cup. This is clearly overt behavior because there is a change in the relation of the two elements, one belonging to the environment and the other to the organism. So far, so good.

Now our subject grasps the cup; the hand holds it. Thus the hand is immobile in relation to the cup, but both the hand and cup (which contains coffee) move in relation to the environment (and mouth). Is the cup now part of the organism system or environment? Probably we should include it in the organism system because the critical functional relation exists between the cup and coffee; it is just the environmental coffee that the subject is bringing to the mouth when "drinking coffee."

However, the cup was earlier on the table and it was then clearly part of the environment. Now it has changed into a part of the organism. This would mean that elements of the environment could change to become elements of the organism system and vice versa. Thus, we could not unequivocally decide whether an element belongs to one of these systems simply by looking at the properties of these elements.

But can we somehow define at any instant a clear border between the two systems? The coffee in the cup is clearly part of the environment, and when the subject is drinking it it becomes a part of the organism system—or does it? Is it possible to say when the coffee is in the organism? When it is in the mouth? Or in the intestines? Or when the chemical parts of the coffee are in the blood? In fact, it is impossible to define any exact border which should be exceeded so that we could on this basis unequivocally determine whether the coffee has moved from the environment into the organism. The same is true in general of metabolism and, especially, of breathing. When is the breathed air outside and when inside?

Or what about spectacles? On the table they are certainly part of the environment; on my nose they are part of the organism just in the same sense as is the lens of the eye. At what point in the air is the "border" between the two systems exceeded when I move them from the table to my nose?

It is just as difficult to define the movement of one part of the environment to a part of the organism as it is to carry out the task in the reverse direction. For example, from the point of view of the visual system, certain parts of the body are "outside" just in the same sense as the coffee cup on the table. My hand is, of course, part of me, but it is not within me or inside me; from the point of view of the eye it is certainly outside. If from the point of view of perceptual activity it is outside, where is the border between the inside and the outside?

But even if we cannot define any exact border between the organism and the environment, we should be able to define unequivocally the organism itself, shouldn't we? The body consists of cells and tissues; aren't these clearly separable from the environment?

Unfortunately not. Take, for example, tissue. It is a structure consisting of cells and interstitial spaces, the environment of the cells. But where is the end of this inner environment, and where does the outer environment start? Does sweating, for example, occur

inside or outside? If we consider it to be outside, then we simultaneously extend the inner environment to outside the body. In this connection we may also ask what it actually means to have an "inner" environment. Whom or what is this environment environing? Or what about the sense organs? Are the receptors inside or outside? For a visual receptor, for example, part of its environment consists of electromagnetic radiation from outside and part of the connective tissues and fluids of the body. Is there any possibility of defining the border between these two?

In conclusion, these considerations show that any attempt to develop an explanation of human behavior on the basis of an assumption of two systems meets considerable difficulties right at the beginning. In contrast to our common-sense impression, critical scrutiny shows that we cannot define unequivocally any of our basic concepts on this basis. We cannot simply define whether any object which we study is part of the organism or part of the environment. This follows from the fact that we are not able to show any absolute border between the organism and the environment. Consequently, we cannot define behavior as a change of the relation between the organism and environment systems and, therefore, we do not know what we are looking at when we want to explain behavior.

How can we then maintain that, for example, information is moving from one system to the other or that it is processed within the organism? Or, how can we say that some of the events which we have described before, like mental activity, representations, maps, or models are in the organism and not in the environment? Or maybe somewhere between these two?

The Assumption of Only One System: The Theory of the Organism-Environment System

If the definition of a separate organism system and an environment system is so difficult, if not impossible, why do we insist on the idea that there are two systems instead of only one? Is the basis for our conception of the organism and the environment as separate systems only and exclusively in our everyday experience and our common-sense thinking, exactly in the same way as it seems correct to think that the sun is revolving around the earth?

What would happen to the conceptual difficulties described above if we decided to reject the idea of the two systems and, against our common-sense thinking, assume that the organism and environment form from the beginning only one system, an organism-environment system? This idea in itself is not a new one. In fact, several lines of thinking in philosophy, psychology, biology, and even physiology have started with the idea of unity of the organism and environment.

The General Outline of the Theory

The theory of the organism-environment system (Järvilehto, 1994, 1995) starts with the proposition that in any functional sense organism and environment are inseparable and form only one unitary system. The organism cannot exist without the environment and the environment has descriptive properties only if it is connected to the organism. Although for practical purposes we may separate organism and environment, this common-sense idea leads to problems which cannot be solved and therefore cannot be the basis of any scientific explanation of human behavior. Therefore, in the theory of the organism-envi-

ronment system we define living organisms as systems consisting of integrated cells and tissues and of specified parts of the environment, with which they form a system.

Thus, behavior is realized in the organism-environment system. Behavior does not mean movement or interaction of two systems, but action of only one system, reorganization of this system, or change of the relations between its elements. All organismic processes include processes both inside and outside the body, in the nervous system and in other necessary parts and in the environment. An organism exists as an organism only together with its environment, and both are bound together in behavior.

The key concept in the analysis of the organism-environment system is the result of behavior. To continue its life process every organism must achieve positive results. Thus, the general architecture of any organism-environment system corresponds to the result, and its systems dynamics may be understood only by taking a historical perspective and looking at the development of the necessary conditions for the achievement of the certain result. The structure of the organism-environment system can only be understood in terms of the result of behavior. The result is therefore the factor to which all the organization of the system is related. The result may be defined as such a reorganization of the system that makes a new act and development of the system possible. The result is reflected in concrete products like paintings or books, but the result as such means only transition from one act to another, and these concrete products are only indicators of the result. In the result, in this transition from one act to another, culminates the preceding organization of the system and it also contains the elements for future behavior and future results.

From the one-system point of view there is no asymmetry between the organism and environment. In relation to the achievement of the result all parts of the system are active. Therefore, environment is not something passively surrounding the organism, but an active part of the system leading to the results of behavior. Subject and object are also inseparable and represent only points of view into the organization of the organism-environment system.

From this follows a radical new conception of mental activity: as all parts of the system are active in relation to the result, mental activity is not something located in the organism but extends into the environment. All concepts referring to mental activity—like perception, emotion, memory, etc.—describe only different aspects of the organization and dynamics of the whole organism-environment system. Therefore, mental activity cannot be localized in any part of the organism; it is not an activity of the brain, for example, although it may not exist without the brain. Neither is it possible to divide mental activity into separate mental functions because all such "functions" are only aspects of the same process of organization and reorganization of the organism-environment system.

Re-interpretation of the Reaction Time Experiment

Now we may return to the explanation of our earlier example, the reaction time experiment. How would the description of events look if we examined the situation in terms of the theory of the organism-environment system? It is important to note that we should be able to explain all earlier findings based on two-system abstraction, to show that the conception of the unity of the organism and the environment is a genuinely new and broader concept than the traditional one. This means that we should be able to reinterpret the ordinary stimulus-response situation as well as explain why the concept of the separation of organism and environment is so self-evident and strong from the common-sense point of view.

From the present point of view the whole way of explaining events in the stimulus-

response paradigm is awkward. When we are interested in understanding the behavior of the organism we should start with those events that are most important for them. The essential question for any organism in its life process is not whether stimuli or responses exist, but whether its responses lead to such results as make its survival possible. From the point of view of the organism the different forms of behavior have meaning only in relation to the obtained results; for the experimenter any aspect of the behavior may be significant as an object of study (therefore s/he separates stimulus and response, for example). The stimulus is a separate part of the situation only for the experimenter, because s/he has created it and s/he is studying events in the experiment in relation to only this factor. From the point of view of the subject the disturbance in the environment ("stimulus") allowing the response is an integral part of the behavior leading to the result.

What then is the real significance of the stimulus in explaining the behavior of the subject in the reaction time experiment? When the subject presses the button in a reaction time experiment, the button press is a result of behavior organized already long before the appearance of the stimulus. The subject must have undergone a certain phylo- and ontogenetic development. S/he must have acquired ears, fingers, and finger muscles. S/he must have come to the experiment. S/he must sit during the experiment in a certain way, listen and remember the instructions of the experimenter, and so on. In other words, even before the appearance of the stimulus there are a tremendous number of elements which must be organized such that the result, the pressure of the button, is realized. Only the coordinated and integrated organization of all these elements makes the required result possible. Thus, when the stimulus finally appears it is only one and perhaps a quite trivial factor in this complex process of organization of the organism-environment system. The stimulus is not causally related to the button press, but is only one of the elements necessary in the achievement of the result.

What, therefore, is the explanatory role of the "stimulus" in the reaction time situation? As a matter of fact, the situation is quite the opposite of what it is thought to be in a superficial stimulus-response way of thinking. The reaction of the subject does not appear because a stimulus is presented, but the stimulus itself is a result of the action of the subject, and it is possible only therefore that the subject is organized to act in a certain way. The stimulus exists as a stimulus because a preorganized system defining some environmental change as a stimulus is present before this change appears. When the stimulus is finally presented it does not cause any "processing" because this "processing" has been carried out before its appearance, in the sense that the organism must have a system into which this environmental change defined by the experimenter fits. The subject is not "reacting" to the stimulus, but the behavior of the subject defines the changes in the environment which may act as "stimuli" and are needed as a part of the organization necessary for the achievement of the desired results.

From these considerations follows a principle which is of utmost importance for all psychophysiological and neurophysiological research. The events appearing after the stimulus in the brain (or in behavior) are the result of organization preceding the behavior; they do not reflect any processing of the stimulus, nor do they indicate any processes started by the stimulus per se. Every stimulus in a way closes a system, the whole activity of which leads to the result of behavior. In addition, the perception of the stimulus is a result of the preceding organization. Thus, the perceptual process is not produced by the stimulus, but is going on before its presentation. A stimulus means the possibility of acting; there is no causal relationship between the stimulus and perception because the stimulus is only one element in the system realizing perceptual results. Every perceived change in the environment means a change of behavior, and new possibilities of realizing the results of behavior.

The formation of the result of behavior and the role of the "stimulus" in this process could be exemplified by the process of constructing the picture in a jigsaw puzzle. One must search for the pieces of the picture and put them together in a specific order to construct the picture. When only one piece is left we have in the picture a hole into which only this last piece may be fitted. After placing this last piece we have our picture. Can we now say that our picture is in a causal relationship to the last piece of the puzzle, and that it was just the last piece which produced the picture? In the stimulus-response approach this is exactly what is maintained. Moreover, the approach implies that we may find out precisely why and how this picture was generated by studying the relationship between the last piece and the produced picture.

It should be now clear that the last piece of the puzzle fits in its place only because all other pieces of the puzzle have been placed in a particular way. It is just this joining of the other pieces, their coordinated organization, which leaves a certain kind of hole into which this last piece can be fitted. Thus it is just this organization of the other pieces which defines a possible last piece with which we may finish the puzzle. In exactly the same way a stimulus is present only if there is an organization into which this stimulus may be fitted.

In conclusion, in the reaction time experiment the subject is in fact not "reacting" at all, and traditional psychological and neurophysiological research based on the two-system theory is in fact studying only trivial aspects of this situation. If there is no direct causal relationship between the stimulus, the neural processes occurring during the "reaction time," and the button press, then all research attempting to show the mechanism leading from the stimulus to the reaction has simply an impossible task. Instead of concentrating on the assumed linear sequence of events the research should be directed towards the conditions necessary for producing the result. Furthermore, if the mental activity is not just an epiphenomenon correlating with a sequence of neural processes or identical with them, but refers instead to some aspects of the organization of the whole organism-environment system, then psychological research should be directed toward the study of whole organisms in their behavior instead of the examination of some mystical inner processes occurring in the experimental situation with the manipulations of the experimenter. Although the change from the two-systems view to the one-system theory may in the beginning seem to be only a matter of taste, it has far-reaching consequences for both the interpretation of the tasks of experimental work and the practical understanding of human and animal mental processes.

Conclusions

Many textbooks on psychology start with the statement that man is a psychophysical whole whose behavior is essentially socially determined. Thereafter this whole is usually divided in different chapters of the book into the nervous system, perception, memory, consciousness, emotions, and social behavior, all of which are such aspects or "functions" of the human being which seem to operate as separate entities. The reader may go through the book with the hope that at the end it is shown how all these separate parts make up the promised whole, but usually the book ends before the promise is fulfilled. The considerations above indicate that the difficulty of describing man as an integrative whole in traditional psychology is due to the fact that right at the beginning man is separated from the environment and from the results of his behavior.

The theory of the organism-environment system opens up quite new views in several fields of study. It has far-reaching consequences in all fields dealing with human behavior.

In philosophy the theory indicates new solutions for many basic philosophical problems. Here we may only mention the ancient contradiction between materialism and idealism. Materialism is based on the stressing of the environment, and idealism the organism. From the point of view of the organism-environment system theory this kind of contradiction is dissolved. If we want, we can say that both ways of thinking are in their own way correct. In addition, the ancient dispute between rationalism and empiricism can, on the basis of the theory, be put in a new light, because all epistemological philosophical problems become changed in character if there is no transmission of knowledge from the environment to the organism, but knowledge is instead formed in the organization of the organism-environment system. Related ideas in this field have earlier been presented, for example, by Dewey (1922) and Whitehead (1925).

In biological studies the theory makes it explicit why no organism can be thought of without an environment. The organism as a skin bag is no system at all; it may be a system only together with the environment. We cannot define even a single cell as a system when separated from the environment, because the basic character of the cell is metabolism, and the elements of metabolism necessarily include metabolites both in the cell and in its environment. Metabolism is a continuous cycle which may not be limited only to inside the organism. Furthermore, in biology such ideas are not new and were represented much earlier by Haldane (1917) and v. Uexkull (1932), for example, and nowadays by Maturana and Varela (1992).

For neurophysiology the above considerations mean that the nervous system as such is not a "system," but it exists as such only when bound up with the environment. Neurons do not react to environmental stimuli, neither do they process any stimulus information, but they are organized so that the activity of the organism may produce useful results. Mental activity is not located in the nervous system; what is located there are the neurons which must take care of their metabolism. Such ideas were developed during this century by Bethe (1931) and Anokhin (1978), for example, and nowadays by Edelman (1987) and Freeman (1995).

In psychology the theory of the organism-environment system makes possible the definition of mental phenomena without their reduction either to neural or biological activity or to separate mental functions. Mental activity cannot be separated from the nervous system, but the nervous system is only one part of the organism-environment system. Mental activity extends to the environment and its different forms refer to different aspects of the organization of the organism-environment system. Here we may also avoid all kinds of soul or homunculus assumptions which necessarily follow different kinds of representation, picture, or map models of mental activity. In psychology such ideas are still in the minority, although they have been developed during the last century by many researchers (e.g., Brentano, 1874; Dewey, 1896; Merleau-Ponty, 1962; Gibson, 1979; Michaels and Carello, 1981; Reed, 1982; Still and Costall, 1991).

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