

## **Problems of Knowledge and Cognizing Organisms**

“ ... just as there was close at hand,  
and touching my frame, the land of Three Dimensions,  
thought I, blind senseless wretch,  
had no power to touch it,  
no eye in my interior to discern it...”  
Edwin Abbott (1884)

In the history of Western philosophy, questions as to how we come to have “knowledge” and how certain or “true” it might be, have been asked with extraordinary persistence. Thinkers have tirelessly pummeled and worried these questions throughout the centuries, loosening a thread here and there, but, on the whole, leaving them as solidly obscure as they were at the beginning.

In other fields it has occasionally happened that problems that seemed to resist any solution turned out to be pseudo-problems in that they arose from some basic misconception concerning the raw material from which they were first formulated. Could that have happened in epistemology? Could it be that the traditional theory of knowledge has been the victim of a perennial misunderstanding and that the problem of the “veracity” or “objectivity” of our knowledge is a pseudo-problem? -We tend to feel that is unlikely. It does not seem plausible that thinking men, for about a hundred generations, have barked up the wrong tree. On the other hand, it is also rather strange that thinking men in all that time have made no progress whatsoever. Yet, that seems to be the conclusion we have to draw today. As Thomas Kuhn has recently said, while the historical study of science shows that the classical paradigm of epistemology is a misfit, no “viable alternate to the traditional epistemological paradigm” has yet been produced (Kuhn, 1970, p. 121).

A comparison between the history of science and that of epistemology brings out yet another point: Scientists, at least since Kepler and Galileo, have never hesitated to redefine or even radically change the concepts with which they were operating, whenever such a change permitted them to construct a more comprehensive or more homogeneous theory. Not so the epistemologists. They are today juggling with the very same concepts and formulations with which Socrates approached the problem of knowledge. Indeed, it is almost as though there were a rule that anyone embarking upon an investigation of knowledge must start where Socrates

started -in spite of the fact that all the paths that epistemologists have since then trodden from that starting point have led them into blind alleys or into philosophical systems which have remained altogether alien to the empirical pursuits of Western Science.

This remarkable lack of success does, indeed, lead one to suspect that there was something wrong at the very start and that it might be worth examining how that epistemology that still pervades most of our sciences began, and how those persistent questions concerning our knowledge and its truth arose. What we shall argue here is that the very results that are today emerging from certain areas of science -particularly those focusing on the study of cognition -lead to a radical departure from this epistemology, a departure of which scientists in other areas are still largely unaware. The mutual fertilization of science and epistemology, in fact, has recently been championed by thinkers such as McCulloch (1965) and Piaget (1967) and, most definitively, by the later work of Humberto Maturana (1970 a, b, 1977); and there are few who would object in principle to such cross-fertilization. What is not generally realized, however, is that this development forces us to give up some of our most inveterate common sense ideas about the nature of reality and the function of knowledge. Giving up elementary ideas requires something of a wrench. In this case, we believe, it may be a help to examine how we came to have the ideas that we now must relinquish.

If we changed the names, adapted the idioms to contemporary usage, and toned down the general level of courtesy, much of Plato's Theaetetus could pass as a tape recording of a present-day seminar. Then as now the discussion as to what "knowledge" is turns at once to problems of perception and quickly establishes that things very often are not what they appear to be. Nothing is easier to show {31} than that our senses are unreliable and that what we perceive is subjective. Though the literature on illusions, field dependence, and perceptual integration was somewhat limited in his day, Socrates had no more difficulty in demonstrating the subjective relativity of sensory perception than any specialist in that field has today. In fact, Socrates goes on and on with this demolition of perception as the foundation of knowledge – almost as though he felt that if he left a stone unturned, someone would come sooner or later and resurrect a theory of verification based on the senses. What Socrates says about perception, however, establishes also another more elementary point:

When I perceive I must become percipient of something – there can be no such things as perceiving and perceiving nothing: the object, whether it becomes sweet, bitter, or of any other quality, must have relation to a percipient: nothing can become sweet which is sweet to no one. (Plato, 1949, p. 22) (1).

"Certainly not!" answers the youth Theaetetus, and the discussion moves on. – Who would disagree? Neither then nor now would anyone in his senses consider something sweet that is sweet to no one. The more elementary point, however, is made in the preceding sentence: "When I perceive I must become percipient of something ... the object. .. must have relation to a percipient." This, too, seems, obvious, a downright commonplace. The way we conceive of "senses" and "perception" simply requires a certain arrangement of items and, by and large, we are no more

inclined to question that arrangement today than were Socrates and his listeners. It comprises a perceiver and something which he can perceive. That is to say, through his senses, which carry out a “mediating” function, the perceiver acquires a “percept” that is in some way caused by an “external” object. Once we accept that basic arrangement [and, since Socrates, there have been few who did not accept it (2)], we have landed ourselves a {32} problem that is indeed insoluble: since we have no access to the “external” object except through the process of perception, we shall never be ‘able to tell whether ours percepts are or are not an accurate or true replica of that object. Thus we have to live with doubts about the veracity of our senses, forever cut off from the “things as such,” dealing with “appearances,” and ultimately dependent on pious hopes such as that God could not have been so malicious as to equip us with unreliable senses. Clearly, this is not a happy situation. If anything can be called absolute, it is the impossibility of evaluating the goodness of match between that percept and the phantomatic external object that is supposed to have caused it. There simply is no way to compare the two, since the one by definition turns into the other whenever we get hold of it (3). Small wonder, then, that some rather strange ways of escape have been suggested, all of which, at some point, invoke faith, magic, or the helping hand of God.

What makes the dilemma so particularly awesome is its appearance of inevitability. Once we have instituted the senses as transmitters of “information” (no matter how we define that term), information that originates outside and ends up inside the perceiving organism, we simply cannot avoid asking just how good, how accurate, how reliable, or how “true” that information really is. Yet, the transmitting function of the senses seems an incontrovertible experiential fact, a fact that we find confirmed every time we observe a perceiving organism, be it a frog or a human. Thus it is not only easy to accept that basic arrangement of “objects,” “mediating senses,” and “percepts,” but it seems inevitable and unquestionable. The only way of escape may be to return to that point in our organization of experience when we first conceived of “perceiving organisms.” Let us try, for a moment, to be utterly naive (in the sense of inexperienced, rather than simple-minded) and ask the question: How do we come to have items such as, say, frogs or people of whom we could say that they perceive other things? Well, in order for a frog to perceive other things, it would seem, we must have a frog and we must have other things. That is, we tacitly assume that the frog must be in an environment. But since we are trying to be naive, we should take nothing for granted and should therefore ask not only how do we come to have a frog, but also how do we come to have it in an environment. Adding this further question, rather than make it more difficult makes it easier {33} to answer the first one. If we focused on the frog alone and pondered how it came to be as a thing in its own right, we could not help attributing to it some kind of independent existence; and as soon as we did that, we should find ourselves in that very same problematic position that Socrates described. That is, we would have assumed that the frog, as we come to know it, exists before we come to know it. In the philosopher’s jargon we would have attributed “ontological reality” to the frog. That is precisely the trap we want to avoid - and we can avoid it if only we start out by taking into account both the frog and its environment.

There is no good reason to assume that our experience begins with ready-made objects, animals, and people; Piaget (1937) for instance, maintains that it takes the child the better part of two years to assemble such items by coordinating much smaller elements of perceptual and concepted experience. In any case, all these items which we come to consider more or less permanent, must, at some point, have been isolated and “individuated” in the field of our experience. This isolating and individuating necessarily had to be achieved by us, for it is we who say that we are aware of them (4). That is, we must have differentiated and cut them from the rest of our experiential field -and, by very act of cutting them out, the rest of our experiential field became their environment. In terms of the actual operations performed by the experiencer, this act of cutting out may be different from an artist’s drawing the outline of a frog on a sheet of paper, but the two acts are the same in that they simultaneously produce a figure and its ground. Whatever specific item we focus our attention on (or talk about) is experienced within a perceptual (or conceptual) field which, explicitly (or implicitly), constitutes its environment. The dichotomy of figure and ground, of frog and environment, springs from one and the same set of operations (Le. focusing attention on and differentiating as repeatable unit a specific part of our experiential field); the two sides are conceptually connate, which is to say, we cannot have the one without the other (5).

We can now turn to the question: How do we come to say that an item, such as a frog, perceives things. As we have seen, both the frog and the environmental things it may perceive are parts of our, i.e. the observer’s, experience. As observers with the rational-scientific heritage of our Western culture we are {34} constantly trying to establish more or less permanent (or at least recurrent) relations between the more or less permanent experiential items we have individuated. Why we do that is a question we shall disregard for the moment. Let it be granted that establishing relations is one of the things we do in order to gain some sort of predictive or explanatory control over our experience. Among the relations that we usually establish with a certain amount of success are those we call “mechanical.” They account for very many “interactions” among very many items we individuate in our experience, but they do not account for all interactions among all items. In particular, there is a fairly varied collection of relatively permanent things which, beyond the interactions for which we can account by mechanical relations, prompt us to posit interactions of a different kind. An autumn leaf, for instance, that has landed on a smooth patch of ground, will take to the air again when a gust of wind blows hard enough to lift it off. A frog resting on the same patch of ground, on the other hand; may resist the gust of wind, but will take a flying leap the moment a sudden shadow falls upon its immediate environment. The frog, thus, counteracts (within certain limits) the mechanical force of the wind, whereas it vigorously reacts to a shadow in its environment, a change which, according to the regular mechanical relations we have established, should have virtually no mechanical impact on the frog. The interaction between the shadow and the frog does not easily fit our mechanical model and we therefore begin to look for another kind of relation which, once we have established it with some recurrence, we may call “perceptual interaction” or “sensory information processing.”

Thus, besides mechanical interactions, we come to have perceptual or informational ones, and the items that are actively involved in the second can be

considered a subclass of living organisms. In both the mechanical and the perceptual interaction however, it is we who observe the event. The leaf, the wind, the frog, and the shadow are all parts of our experience, and the events we describe, as well as the differences between them, are the results of the relations we have established between parts of our experience.

Hand in hand with the establishing of relations goes the effort to explain observed interactions in terms of specific causal relations, in terms of regular processes and functions, and, in some cases, in terms of specific organs that carry out {35} these processes and functions. In the case of the observed organism's perceptual interactions with their environment, this effort has been highly successful. In the visual perception of the frog, for instance, a scientific observer may isolate (in the observed frog) eyes that contain a retina with light-sensitive receptors that send electrochemical impulses into a neural network capable of adding, subtracting, and otherwise processing these impulses in such a way that, under certain conditions, they will trigger muscular activity which, in turn, will orient and propel the frog in a certain direction (Lettvin et al. 1959; Maturana et al. 1960).

On the basis of further observation, the observer may then decide that some of the links in the causal chain he has constructed are still too loose and he may attempt to insert additional steps: or, indeed, he may decide that parts of his analysis are inadequate for one reason or another. It may take the observer a long time to arrive at an at least temporarily satisfactory "explanation" of the frog's perceptual and behavioral interactions with items in its environment, but there is nothing mysterious about what the observer does: it is no more and no less than establishing relations between parts of his own observer's experience. Hence it is one thing for us, the observers, to say that an organism we are observing perceives, but quite another to say that we ourselves perceive. However, the more engrossed an observer becomes in establishing causal chains for the perceptual interactions between organisms and things in their environment, the more easily he will begin to think of his own experience as the result of similar or at least analogous interactions with an environment. This seems all the more plausible because he can observe eyes, retinas, and neural networks not only in frogs but also in experiential items which he categorizes as organisms of his own kind, which is to say, functionally similar to himself. Indeed, he even can isolate and individuate eyes in that particular experiential item which he has come to "know" as himself and as his own body. All he has to do is step before a looking glass, and there, as clearly as any other image, he sees the part of his experiential field that he calls himself and that other part which he calls his environment. And seeing it in what so plausibly seems an immediate fashion, makes it almost impossible for the perceiver to realize that what he now categorizes as his own environment has a relationship to him, the observer, that is {36} quite different from the relationship the frog's environment had to the observed frog. For what the observer now takes to be his own environment is still part of his experience and by no means lies beyond the interface that is supposed to separate the knower from the world he gets to know. That this has to be so, becomes clear once we realize that the mirror-self which, like the frog, is surrounded by an environment, is precisely what the observer experiences of himself and therefore cannot possibly be he himself as experiencer.

Thus, when observing a frog, one may indeed ask, for instance, how its retinal reception and neural networks “respond” to a shadow in the environment. Such a question makes sense from the observer’s point of view, because, as observer of the frog, one has independent access to the experiential item one calls “shadow” and one can, therefore, legitimately invest it with the capability of causing a perceptual event in another experiential item which one calls “the frog’s visual system.” When observing oneself, however, one is no longer in that privileged position. What we ourselves perceive, whether we call it frog, landscape, or mirror image of ourselves, is simply what we perceive: and since we have no way of looking at ourselves and our environment from outside our own experience, we have no possible independent access to whatever it might be that, by analogy to the frog, we would like to hold causally responsible for our perceptions.

In the struggle to organize and systematize our experience, of course, it has seemed quite natural to assign to the active experiencer a location within the part of our experience that we categorize as our body, and, then, in turn, to assign to that body a location within that other part of our experience which we categorize as our own environment. These categorizations seem natural because we make them in analogy to those that proved so successful in isolating and individuating things and organisms in our field of experience (where we have access to things which are outside these organisms). Though the analogy is logically quite illegitimate, because it confounds the experiencer with what he experiences as himself, the world view to which it inevitably leads has proven almost irresistible. It is the view that ascribes to a ready-made world the responsibility and “causes” of our perceptual experience. As Socrates put it, “when I perceive I must become percipient of something.”

The Western world has accepted this scenario almost unquestioningly. Nearly {37} all thinkers who have pondered problems of epistemology have explicitly or implicitly adopted the view that the activity of “knowing” begins with a cut between the cognizing subject and the object to be known (6). That is, they assume an existing world, an ontological reality, and once this assumption has been made, it follows necessarily that the knower will have this world as his environment and it will be his task to get to know it as best he can. Knowing, thus, becomes an act of duplicating or replicating what is supposed to be already there, outside the knower. The senses become the indispensable mediators that convey “information” in the basis of which the knower can represent to himself a replica of what “exists” – but, literally, only a God could know whether man’s replica is a replica or a fiction.

Yet, if what we have said so far has any consistency at all, it should now be clear that the first cut, the most elementary distinction (Brown, 1969) an experiencer can make, may be the intuitively satisfactory cut between himself qua experiencing subject on the one side, and his experience on the other. But this cut can under no circumstances be a cut between himself and an independently existing world of objective objects. Our “knowledge,” whatever rational meaning give to that term, must begin with experience – such as, for instance, the cut we make between the part of our experience that we come to call “ourselves” and all the rest of our experience, which we then call our “world.” Hence, this world of ours, no matter how we structure it, no matter how well we manage to keep it stable with permanent objects and recurrent

interactions, is by definition the “subjective” world of our experience and not the ontological reality of which philosopher have dreamed.

It is by no means easy to adopt this “radical constructivist” way of thinking (von Glasersfeld, 1974, 1975). Twenty-five centuries of epistemological efforts directed at demonstrating a correspondence between “knowledge” and an ontological reality are deeply ingrained in our languages and have been foisted on us from the moment we were born. From the theological thinkers of the Middle Ages to the iconoclastic children of our time, the claim has been “to tell it like it is” rather than to explain how we come to see it the way we do see it. The tradition is strong, often overpowering. Even in one’s own thinking, no matter how determined one may be to break away and start afresh, one inadvertently {38} falls back into the conventional track and sees problems where there is no problem (Ceccato, 1966, p. 22). In almost every case, these problems stem from a confusion: Traditionally we are supposed to play the role of discoverers who, through their cognitive efforts, come to comprehend the structure of the “real” world. Thus we are always prone to revert to some form of realism and to forget that what we are thinking or talking about is under all circumstances our experience and that the “knowledge” we acquire is knowledge of invariances and regularities derived from and pertaining to our experience.

If, on the other hand, we do keep in mind that all invariances and regularities are our construction, this awareness necessarily alters our idea of what is called “empirical investigation” and, indeed, our idea of science itself. We shall come to pay attention to the structure of our concepts and the origin of the categories, rather than assume that any structure and any categories have to be there as such. This, of course, runs counter to the common sense view of the world. But, in fact, it merely modifies our concept of knowledge in exactly the same way as the theory of evolution has modified our concept of living things. Accordingly, knowledge is true and valid as long as it manages to “survive,” that is, as long as it is not demolished by experience. This is the very solid ground for Popper’s insistence on “falsification” as the actual goal of scientific investigation. But a surviving organism cannot be considered to manifest a description of the environment in which it happens to be viable, because an infinite variety of other and different organisms would be just as viable. And, similarly, the regularities, rules, and laws that constitute our knowledge at a given time cannot be said to depict or describe an ontological reality, because an infinite variety of other and different regularities, rules and laws might be just as viable in the “environment” of our experience. This, in a sense, is no more than an amplification of the well-known and long-accepted adage that, though we can sometimes disprove an hypothesis, we can never prove one no matter how often it happens to work out right. The trouble is, when an hypothesis does ,work out right, we often speak of “confirmation” and begin to believe that we have managed to entrap a piece of ontological reality.

A case in point is the problem of “other minds.” If, as a constructivist. I maintain that what I call my world is no more and no less than the result of my {39} particular way of organizing my experience, it appears quite natural to ask how it comes about that that world of mine is peopled with other organisms constructing worlds of their own, and that their worlds seem to be independent of my construction. This does indeed become a problem if, succumbing to the pressure of conventional assumptions, I am misled into attributing ontological reality to those particular constructs that I

categorize as “other people.” Though that may be an intuitively desirable attribution, there is no logical justification for making it. The particular parts of my experience that I come to categorize as “other people,” remain parts of my experience and their status cannot be different from that of any other experiential item. That is, I isolate and individuate them on the basis of the invariances and regularities that I establish, in the same way in which I have isolated and individuated all the other more or less permanent items in my field of experience. Owing to certain regularities of interaction (i.e. relations which I have established) between frogs and shadows, for instance, I was led to attribute “perceptual” capabilities to the items I call frogs. Owing to other regularities of interaction, I am led to attribute goal-directed activities to certain items I call organisms. Finally, my continual endeavor to establish invariances in my experience leads me to attribute cognitive ability i.e. the ability to construct a world, to other organisms which I then call “other people.”

In this last step of delegating an autonomous constructive potential to items within one’s experience, it is easy inadvertently to introduce an ontological element. Before attributing a constructive ability to others, therefore, we should make clear how we came to attribute it to ourselves. On the face of it, it would seem that the ability precedes any construction of an experiential world. Cognitive construction presupposes an experiencer, because we see this construction as an activity that is carried out by a subject. The most elementary distinction an experiencer can make, we said earlier, may be the cut between himself qua experiencing subject on the one side, and his experience on the other. – Taken as an ontological statement, i.e. a statement of “fact,” this is obviously nonsense since it implies that there is experience prior to the entity that does the experiencing, and that this entity, the experiencer, creates itself by making that elementary cut. But we resolved at the outset to avoid ontological statements. Hence, even though our traditional habits of thinking make it difficult, we must take the {40} statement as a statement about our cognitive construction – even if, to use the phrase Abbot (1884) put in the Flatlander’s mouth, we have no eye in our interior to discern it.

Humberto Maturana (1970b) warned us that “anything said is said by an observer.” In our present context I want to extend that warning to: Anything known is known by an experiencer. If “to know” is to make distinctions in experience and then to set up relations between the parts of experience that have been distinguished, it follows quite inescapably (1) that we can know ourselves only to the extent to which we experience ourselves, and (2) that the self we do experience and incorporate into our cognitive structures, by that very act of construction, ceases to be the self that does the experiencing. This constructive interdependence between observer and observed has not seemed palatable to the Western mind. Since the Greeks, circular arguments have always engendered a sort of *horror infinitatis*. Aquinas spoke of vicious circles. Yet, in the light of the preceding discussion, it should be evident that the shift in epistemology we have outlined also requires a proper rehabilitation of circularity or self-reference so that they can be included as legitimate ground in rational thinking.

As we all know, the formal proscription of self-reference as unacceptable came with the work of Bertrand Russell and Alfred Tarski at the turn of the century, when circularity caused a dramatic crisis in the foundation of mathematics. Insofar as mathematical description is a minor of the kinds of description used in science, the

way the circularity crisis was resolved is very telling. The Russell-Tarski approach was to set up a hierarchy of descriptive types, where some atomic elements are given, but such that they do not affect operations of a higher type. The basic assumption, then, was that initial grounded elements can be identified and operated on to constitute more complex constructions. For the working mathematician, the hierarchy of types was satisfactory enough. The linguist and the philosopher were not so happy: circularities crept in again and again, because language does seem to be more like the kind of network that Wittgenstein tried to deal with, i.e. a network in which no initial grounded elements can be found. In spite of several attempts by logicians and philosophers to cope with circularities in language, little has been achieved to clarify the {41} issue (cf. Martin, 1970).

Thus, in order to deal with circularity, it seems necessary to depart more radically from our basic ontological commitments (Quine). The state of affairs in logic goes hand in hand with the Western preoccupation in epistemology to exclude the observer from observation: Subject and object are considered in opposition and mutually exclusive. Only few thinkers (Gunther, 1967; von Foerster, 1974) have recently pointed out that the problems of observer/observed, of cognition, and of self-reference are one and the same and that this problem looks so formidable because of the grounds (ontological commitments) that Western logic has decided to stand on. In order to incorporate the observer into his descriptions, says Gunther, we must give that interrelation a logical locus. This, as we have discussed elsewhere in detail, can be done (Varela, 1975; Varela and Goguen, 1976, 1977). The rehabilitation of circular rationality rests on two departures from the previous, purely logical attempts, and it is relevant to the issues discussed here as well as to empirical research. First, the question of circularity is examined on the ground of the very basic act of indication (discussed above as the “first cut” made by a knower) and the laws of its forms (Brown, 1969, Varela, 1975). Second, we take a “naturalistic” view of self-reference, that is, we look for its pervasive operations in empirical situations beyond language. This point is crucial. We are not considering circularity as an abnormal variant of some standard forms of expression, but as a valid descriptive domain in itself, that, in language, is only weakly reflected in statement such as the liar’s. On the contrary, our epistemological attitude posits circularity as a central notion rather than a nuisance. It is taken as a necessary tool for research, rather than as an idiosyncrasy of formal speech that can be amputated.

This point of view, in fact, is implicit in modern science. The most typical paradigm for circularity is the idea of feedback or, more generally of recursive computations. In these cases, circularity is, of course, unraveled as a temporal process through the concatenation of cause and effect involving a delay. But, beyond such simplified patterns, it is now clear that the coherence or totality we can see in natural systems of all kinds, be they cells, nervous systems, or societies, hinges on the closely knit interdependence of their components. Such interdependence, in fact, gives the system its identity. For example, a cell is a network of interconnected chemical processes forming a large number of recursive loops in many dimensions. If one takes this circularity of organization seriously, some interesting consequences follow. Consider for a moment the question: How does a molecule, say a hormone, become a message for a cell? Surely not by any specific property of its molecular configuration.

Such properties allow it to interact in a physical sense with the cell. Yet from this physical contact dramatic changes in the dynamics of the cell may ensue, and we usually refer to such events by saying that the hormone molecule carries “information.” However, this “informative” quality of the molecule is a quality determined and specified by the dynamics of the cell as a unit, that is, by the circular network of its chemical productions (8). In other words, the cell’s circularity specifies a categorical classification of the events in the cell’s environment -and such a classification amounts to establishing a cognitive domain in which a hormone molecule is endowed with significance in contradistinction to other equally independent items or events. The fact that certain very precise molecular structures are of significance for some cells provides a way for these cells to be viable in their environment, but it says little about the particulars of the molecule itself. Metaphorically we may say that through the operation of their circular organization the cells “construct a reality.”

We have to conceive of ourselves, *mutatis mutandis*, as in a similar state of affairs: Whatever we interact with, we will do so relative to the coherence of our organization and, on the cognitive level, through the recursive organization of our nervous system (Maturana, 1970b, 1977). There is one fundamental difference, however, in this second-order circularity. Unlike the case of the cell, where both the observed cell and the hormone molecule are parts of the observer’s experience, we do not have simultaneous access to both our environment and our information of it. All we have is our “representation,” which is inescapably our construction. Thus, the most that an observer can say about his own environment is that it renders his experience viable.

According to the point of view we have outlined in this paper, our models of cognizing systems have quite literally come of age. Although we seem unable to visualize it as an image, we can begin to map in a rigorous formal fashion and as operative process that peculiar elusive relationship between the subject and the {43} object of the act of cognition. It is a relationship of total interdependence in which relative stability is achieved and maintained through the circularity of interaction that provides closure. The knower constructs the world he knows and, in doing so, he determines his way of knowing. Thus, in retrospect, we are now beginning to see that the age-old dichotomy between the knower and an ontological reality-to-be-known was a rather dangerous illusion. It has led both philosophy and science into the attitude that has persistently kept man, the constructor of philosophies and sciences, out of his own construction, fostering the belief that, in the last analysis, man was not responsible for the world he came to know and to manipulate.

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## Notes

1) The split between observer and observed is suggested already in some of the pre-Socratic fragments (e.g. fragments 7 and 9 of Democritus). From Plato, however, we have the first extensive discussion of it.

2) The two most conspicuous dissidents published their ideas, unbeknownst to each other, in the very same year 1710: George Berkeley in Dublin his *Treatise Concerning the Principles of Human Understanding*, and Giambattista Vico in Naples *De Antiquissima Italorum Sapientia*. A more recent philosophical school that also takes a different view is phenomenology, including the rich field of cultural hermeneutics. For a lucid comparison of these continental developments with the more empiricist Anglo-Saxon tradition, see Radnitzky (1973). Unfortunately phenomenological hermeneutics has had only a moderate influence, and that as a predominantly European style in the pursuit of social sciences: the bulk of the scientific community has so far ignored it. An even more recent and equally disregarded dissident is Silvio Ceccato

(see references) who not only dismantled epistemological dogma but also elaborated the alternative of operational construction, a methodology to which the first author of this paper owes much of his thinking.

3) As Kenneth Boulding (1956, p. 165) put it: "...image can only be compared with images. They can never be compared with any outside reality."

4) It is important to stress that even in the realist view, the knowing subject's representation of the "existing" world is necessarily a composite of sense data or sense impression and therefore, a (re) construction on the part of the knower.

5) We can, of course, have our perceptual field without a frog or indeed any other organism in it: but in that case it would be nonsense to call that perceptual field "ground" or "environment," these terms are appropriate only if we have cut the field into one part which we differentiate and call, for instance, "frog," and another part, i.e. what is left, which we may call the frog's "environment."

6) This is valid even for those philosophers of science, notably Sir Karl Popper, who have criticized the common sense realism in science and proposed more sophisticated interpretation of scientific validation.

7) For a somewhat similar view of science, see the work of Paul K. Feyerabend (e.g. 1970). 8) Giambattista Vico (1710) noted that, among other epistemological hints to be found in language, the word "fact" undoubtedly comes from the Latin *facere*, which means "to make." In a similar vein, we should like to point out that "information," quire literally, can be understood as "to form inside."

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## Abstract

The authors examine from a constructivistic point of view the cognizing processes of biological organisms. Their analysis emphasizes the basic aporias and errors of the traditional theory of knowledge, whose historical genesis is briefly outlined.

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