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Chapter 8

INTENTIONALITY IS THE MARK OF THE VITAL

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ABSTRACT

Much of the philosophy of mind has been dedicated to reconciling the mental with the material. But to the extent that the "mental" is seen as equivalent to the "intentional" and the "material" as equivalent to the "biological," the project of reconciling the intentional with the material is unnecessary. Concepts exhibiting the special logical properties thought to be unique to intentionality are a commonplace in biology. Thus, the special problem of the emergence of intentionality in human evolution, in human conscious and language, and in human culture is neither special nor of problem: in the relevant logical respects, intentionality is, and—has always been immanent in the simplest of biological systems.

1. INTRODUCTION

Franz Brentano is often cited as the origin of the view that "intentionality is the mark of the mental," that is, that "all mental phenomena

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exhibit intentionality and no physical phenomena exhibit intentionality." (Dennett, 1981, p. xvii–xviii; Chisholm, 1967). For Brentano, and for the many philosophers and scientists influenced by his seminal *Psychologie vom empirischen Standpunkt*, mental events had a distinct form of existence and the distinguishing feature of that form was intentionality.

Much of what has been written in the philosophy of mind since Brentano has been dedicated to reconciling the mental with the material. For many, this project has been construed as reconciling the intentional with the biological, explaining how intentionality emerges in the course of the evolution toward the human species, in the operations of the human brain, in the development of the human individual, and in the meanings of human cultural elements. The goal of this essay is to demonstrate that, to the extent that the "mental" is seen as equivalent to the "intentional" and the "material" as equivalent to the "biological," the project of reconciling the intentional with the material is unnecessary because concepts exhibiting the special logical properties thought to be unique to intentionality are a commonplace in biology. Thus, the special problem of the emergence of intentionality in human evolution, in human conscious and language, or in human culture is neither special nor a problem: in the relevant logical respects, intentionality is, and has always been, immanent in the simplest of biological systems.

2. THE PROBLEM OF INTENTIONALITY

When Brentano used the word "intentional" he was using the term in a very special sense. In ordinary language, an "intention" is an idea of the future that moves us to action. In cognitive psychology, "intentional" is synonymous with "goal directed." Both of these understandings of "intentional" are valid within their own context, but neither is precise enough to make clear why Brentano's dictum had such an impact on psychology as an explanatory science. Brentano used the term "gerichtetsein" to mean "directed toward an object" or, one might say, "laden with about-ness" (Brentano, 1874; Dennett, 1987, particularly, pp. 271–2; Rosenberg, 1988; Dennett & Haugland, 1987). In the framework of Brentano's *Psychologie*, an intentional state must be "directed-toward," or "about" some object external to the state itself. An explanation is intentional in this logical sense if it accounts for events by reference to mental (and so, and thus, intentional) state as a cause. An intentional cause is identified by a verb of mention (explicit or implicit) that takes as its object and is specified by some proposition. Schematically, such an explanation claims:

A did D because A desired (wanted, believed . . .) that [x].

where [x] may be any proposition about the world.

Most intentional explanations attribute an event to some combination of intentional states, typically to an agent's desires for a state of affairs and its beliefs that some set of deeds will achieve that state of affairs. For example, The professor drank a glass of water because he wanted to clear his throat and he believed that drinking a glass of water would clear his throat.

Here, the desired state of affairs is a clear throat and the deed, drinking, is said to be caused by the combination of this desire with the belief that drinking water will effect it.

To the extent that psychologists and other social scientists invoke human beliefs, thoughts, and wants to explain human behavior, their explanations are intentional in this logical sense. This fact may be bad news for social scientists because explanations that are intentional in this sense have logical properties that are thought to alienate them from the natural sciences in general and from biology in particular.

For example, if you saw me drinking a liquid that you knew to be chablis, you would be entitled to infer both that some chablis exists in the world and that the beverage in my glass has the properties of chablis. From those inferences, you could develop a host of testable hypotheses whose corroboration could be easily connected to established physical laws. You could, for instance, conclude that the contents of my glass had a particular density, boiled at a particular temperature, and froze at a particular temperature. Suppose, however, that you do not know that I am drinking chablis, but only that I believe I am drinking chablis. Now the warrant for your previous inferences collapses. And in compensation for this lost set of testable empirical hypothesis, you are left only with questions: was the substance in the glass really chablis? Was it even a liquid? Was I even drinking? And even if you confirm that the glass actually did contain chablis, you will not be entitled to infer even that I believed it to contain white wine, since—from the facts stated—you have no way of knowing whether I know that Chablis is a white wine.

In general, intentional explanations, even if they embody true propositions about beliefs, thoughts, wants or feelings regarding [x] entail nothing about [x]! This implicative opacity of intentional explanations comes in two forms—referential and existential. Both kinds of "opacity" involve an inability to "see through" a proposition to the "meanings or facts" that presumably "lie behind" it. (Rosenberg, 1988, 1967). "Existential opacity" (more commonly called "intentional inexistence" by philosophers) refers to our inability to infer the existence of a believed-in happening or object from the fact that somebody believes in it. People do, after all, believe myths. "Referential opacity" refers to our inability to infer even the content of the believed proposition from the fact that the proposition is believed, since the content of the proposition is dependent on what the believer "means by it." People do, after all, understand the words they use in very different ways.)

Most social scientists and philosophers have responded to the problems raised by intentionality in one of two ways. The first way, favored by Brentano, has been to accept the dualistic thesis that intentional propositions describe events in a very special, immaterial place called the mind. For some, this view has the advantage of immunizing human free will from material determination. But, for social scientists, it has the disadvantage that it irrevocably separates human psychology, and, perhaps, all human and animal behavior, from the causal laws and theories of the natural sciences. If intentional "causes" are immaterial, they can play no part in the casual system studied by the natural sciences. Nor can they be investigated by the natural scientific techniques which presume that system as their basis.

The other option, favored by some contemporary philosophers of mind, is to claim that mental states just "are" brain states. This "brain-state identity thesis" seems to reconnect mental states to the causal networks of the natural sciences, but it creates a new problem. Those philosophers who argue that intentional states just are brain states recognize that no particular combination of neural events is necessary for any particular intentional state. Thus, while a particular sequence of neural states may be said to constitute a particular intentional state, many other combinations of neural events may constitute the same intentional state. In fact, the number of neural states that are sufficient for a particular intentional state may be virtually infinite. Far from being daunted by this many-to one relation between neural and intentional states, some identity theorists have embraced it as the supervenience of the mental upon the neural.

In recent years, enthusiasm for the concept of supervenience has been formidable and authoritative (See, Sober, 1984; Depew & Weber, 1997, who use the concept to defend the concept of fitness from accusations of vagueness and circularity.) But for practicing behavioral scientists to embrace supervenience would be a serious error. For most scientists, statements asserting that "A causes B" are among the most heuristically fertile hypotheses available for investigation. Such a statement implies that A is antecedent to B and is necessary, sufficient, or both necessary AND sufficient for the occurrence of B. Because they have these meanings, statements asserting casual connections are heuristically pregnant with suggestions for experiments to determine contingencies between A and B.

Using the notion of supervenience to connect intentional events to natural causes, however, drains the claim that "A causes B" of its heuristic power: first, because A can never be more than one of an indeterminately huge number of neural states, no one of which is ever necessary for B; second, because tools adequate to determinately specify the structure of A are not and may never be available to practicing scientists; third, because—having putatively reduced intentional states to neural states—we are

methodologically discouraged from exploiting the interesting fact that people seem remarkably adept at recognizing each others' intentional states despite their complete inability to detect neural states. And finally, even if supervenience could specify exactly which neural states were responsible for intentional action, it would not have solved the problem of the origin of intentionality, since it does not tell us how neural states ever become intentional in the first place.

Fortunately, a third option is available, that avoids both the causal disconnection of dualism and the heuristic disconnection of supervenience, and that leaves us free to exploit our capacity to recognize intentional states in others. This third option is to treat intentional states, for the purposes of scientific investigation, as neither events in the organism's mind nor states of its brain, but, rather, as properties of the relation between the organism and its environment: i.e., as higher order properties of the behavior of the organism. On this approach, most "intentional explanations" are (as Hempel and Oppenheim concluded in 1948) not causal explanations at all; rather, they are, scientifically interesting and heuristically fertile descriptions of the objective design of an organism's behavior (Thompson & Derr, 1995). This third possibility is developed in this paper.

3. INTENTION AND DESIGN

Both in their behavior and in their structure, organisms exhibit a property that corresponds to what we mean when we speak of the "design" of a building or of an automobile or of a computer system. This property is commonly and properly referred to as "natural design." The word "design" is sometimes used metonymously to refer to the process of designing, but we use it to refer exclusively to properties of a designed product.

Natural design properties are of a higher order than more conventional properties such as mass, color or shape. But applying the term "design" (adapted from engineering) to the behavior and morphology of animals does no more invoke vitalism or pan-mentalism than Darwin's use of the term "selection" (adapted from English animal breeders) invokes anthropomorphic creationism. Design properties are found in the complex relations among organisms and their surroundings; they are both objective and empirical. They posit no new realm of being, and they claim no exemption from the laws of the natural sciences.

Identifying design properties involves scientists in a process that is a mirror image of reduction. A concept is said to have been reduced when a theorist demonstrates that it can be entirely explained by lower-level (and often less glamorous) phenomena. We commonly think of reductions as

moving from higher to lower levels of organization, as when we say that adaptation is just a change in gene frequencies or when we say that motivation states are just states of the hypothalamus or that heat is just kinetic energy.

Since the description and study of natural design involves the scientist in precisely the opposite sort of conceptual movement, namely, a movement from a lower to a higher level of organization, the natural design approach recommended here might be thought of as "up-reductionism". From the natural design point of view, many biological and psychological terms that are construed as genetic or neural explainers of behavior can be reconceptualized as behavioral describers. For example, adaptation is reconceptualized as a property of the relationship between the form of organisms and their circumstances, rather than as just another name for natural selection. Motivation is treated as a property of the relationship between variations in behavior and the circumstances in which that behavior is deployed, rather than as just another name for a neural state specifiable only by its effects. Finally, development is conceived as a stable property of the relationship between a growing organism and its environment, not as the unfolding of some genetic program.

3.1. What Is Natural Design?

In the world of engineering, design is a systematic association between an array of structures and an array of circumstances in which those structures are deployed. In a design, the association between those arrays is such that no matter what the circumstance, if the structure associated to that circumstance is deployed, the result is constant.

For instance, consider the design of the wrenches in a mechanic's tool set. The set contains a series of specialized wrenches, each appropriate to one of the circumstances the mechanic encounters, each fitted to the form of a particular type of bolt or nut. Provided that the correct wrench is deployed, the result is constant: the bolt or nut turns. Watching the mechanic turn a bolt with a wrench, one might say that *THIS* wrench is well designed for turning this particular bolt. But the correct attribution of design implies more than the fitness of *THIS* wrench to turn *THIS* bolt. It means that there is a systematic relationship between the form of the many tools in the set and the many circumstances in which they are employed, such that when the "right" wrench is used on the "right bolt", the bolt usually gets turned. *THIS* wrench is exemplary of that relationship and so it is said, briefly, to be well designed. Thus, design is a holistic property: it can be attributed to one item in the array (the individual wrench) only because we recognize that item as an element in one of two coordinated arrays. And design properties, as properties of the relation between those arrays, are higher-order

properties than the mass, shape, or malleability of the individual wrenches or bolts in those arrays.

When the same holistic property is manifested by organisms or their behavior, it is called natural design. Natural design is an association between an array of organ forms, behaviors, or artifacts and the array of circumstances in which they are deployed. But because of the temporal and physical scale of these arrays, natural design becomes evident only when one applies a patient program of comparative analysis to natural phenomena.

For instance, to observe phylogenetic design, one might emulate Darwin and take a five-year cruise around the world on a small overcrowded warship with Lyell's principles of Geology as one's only light reading, get off the boat at every opportunity to escape seasickness and the moody fundamentalist with whom one is cabined, collect specimens of basically different creatures in similar environments and of basically similar creatures in different environments, taking careful note of their origins, and then pour over one's collections for 20 years looking for correlations between the form of organisms and their life circumstances.

To observe motivational design, one might like Tinbergen spend several years in the field observing members of a species, carefully prepare a catalogue (an ethogram) of behaviors performed, of the circumstances under which they are performed, and the consequences of their performance both for the actor and others, pore over your field notes grouping behaviors that occur under similar circumstances and produce related consequences, and then perform a series of experiments using the method of dual quantification to confirm your inferences.

To observe developmental design, one might like Piaget painstakingly observe the change in the behavior of children and the coordinated changes in the expectations of the world around them. From these observations, one might note patterns of correspondence between the child's behavior and the world's expectations. Associating these patterns with the typical ages at which they occurred, one might call them "stages."

These historical examples emphasize that natural design is not the sort of property detected by a single crucial experiment or highly focussed field investigation. In fact, the research programs that make important natural designs evident are so sustained and disciplined that they seem as much to be the result of character as of than method. Nevertheless, the result of such research is the discovery of natural design properties which, although located at a higher level of organization, are every bit as objective and empirical as mass, length, or valence.

3.2. How Is Natural Design to Be Explained?

The existence of natural design requires explanation. Most (but not all) natural designs can be explained as the product of control systems

(Bowlby, 1969/1982; Powers, 1973a, b). Over time, control systems generate an array of actions, each of which is associated with an element of an array of circumstances. The pairings of circumstance with actions all have the common feature of producing a common outcome: maintaining specific features of the circumstances near reference values.

Of course, not every natural process that tends to stabilize an empirical variable is a control system. Many natural feedback processes regulate variables but are not control systems. For example, the presence of slush on the ground tends to regulate the temperature of the air near the surface at around 32 degrees. At temperatures above 32 the ice in the slush melts, absorbing calories and cooling the air. At temperatures below 32 the water in the slush freezes, releasing heat and warming the air. Such feedback processes are not control systems because, although they do regulate a variable within certain fixed limits, they are not designed to regulate it: the relationship between the elements in the involved arrays can be exhaustively described and explained without the discovery or deployment of any higher-level design properties. Natural selection is such a natural feedback process.

Control systems are distinguished from simple feedback processes because they are designed to achieve their effects. A control system may be said to be designed when it is one of a set of integrated control systems each of which is deployed in a characteristic circumstance and all of which, working as a supersystem, achieve a common outcome for the organism or entity of which they are part. The organs of the human body display natural design in this sense: each of them regulates some physiological variable and all of them, collectively, maintain the life of the whole organism.

Organic control systems may exhibit natural design in another sense as well: the reference value guiding one control system can itself be the output variable of another control system. This kind of design is seen in the water regulation system of the human body: the system varies the tone of the blood in response to a reference value which itself varies with the long term availability of water (Jones et al., 1991).

In short, from the perspective of natural design, organic nature consists of a hierarchy of control systems, each a designer of systems or activities at a lower level and each designed by activities at a higher level. At the top of this hierarchy (on pain of avoiding an infinite regress), must be a process which is capable of producing natural design but which is not itself designed. That process is natural selection. In each generation, natural selection assesses a complex property of an organism, its "adaptedness", and adjusts that property in the next generation of the population of which that organism is a part. Because natural selection is itself a simple feedback system, it is a non-designed designer.

The term "non-designed designer" has a long history in cultural controversies over the relation between evolutionary science and religion,

controversies that are irrelevant to our present purposes. The claim that natural selection does not itself exhibit natural design is a scientific hypothesis. If true, it neither confirms nor refutes the theological hypothesis that natural selection exhibits (or is the result of) non-natural design. Both "Creation science," and "scientific atheism" seem to miss this elementary logical distinction.

4. CONTROL SYSTEMS AND INTENTIONALITY

The goal of this essay, you will recall, is to demonstrate that the problem of the emergence of intentionality in human behavior is no problem at all because intentionality ("about-ness" in Brentano's formulation) is imminent in the simplest of biological systems. We have so far argued that organisms have natural design properties and that these design properties are the consequence of the operation of control systems. If we can show that at least many of the natural design properties produced by control systems exhibit the logical features of intentionality, our argument will be complete.

To understand how control systems can engender intentionality, we have to examine control systems in greater detail. For ethologists, John Bowlby's account of control systems is most useful (1969/1982). Bowlby was concerned to construct a theory of parent/child interaction that replaced a behaviorist theory with one that was based in biology in general and ethology and control systems theory in particular. Bowlby's theory was particularly influenced by the manner in which infants respond to variations in their social environments. For example, once an infant has formed a relationship with a primary caregiver, that infant will suffer behavioral deterioration during a long term separation from the caregiver and then exhibit intense clingyness when the primary caregiver returned.

In Bowlby's control system analysis, infant and mother form a system in which the infant uses various behaviors (e.g., crying) to control the proximity of the mother. The control of proximity, in turn, makes it possible for the infant to control its access to food, warmth, and protection from harm. In Bowlby's analysis of attachment, there are two control systems at work: one is the system that controls maternal proximity; the other is the meta-system that monitors and evaluates the effectiveness of the proximity-control system. During long term separation, both systems fail; hence, when child and mother are reunited, the infant must reestablish, and test both the proximity-control system and the meta-system. The re-calibration of this meta-system is what the parent experiences as "clingyness."

The model for Bowlby's work was a biological control system. In Bowlby's terminology, all control systems, have the effect of moving some

variable toward a set point. Bowlby uses the term "set-goal" for set point, defining it as

Either a time-limited event or an ongoing condition either of which is brought about by the action of behavioural systems that are structured to take account of discrepancies between instruction and performance. In this definition, it should be noted, a set-goal is not an object in the environment but is either a specified motor performance, of short or long duration, between the animal and some object in or component of the environment. Thus the set-goal of the peregrine's stoop is not the prey stooped at but interception of that prey. In the same way, the set-goal of some other behavioral system might be the continuous maintenance by an animal of a certain distance between itself and an alarming object in the environment. (Bowlby, 1969/1982, p. 69)

In Bowlby's theory, the operation of a biological control system is always related to a particular environment in which that system evolved and to which it is adapted. He writes:

In the case of biological [control] systems, structure takes a form that is determined by the kind of environment in which the system has in fact been operating during its evolution, an environment that is of course usually, though not necessarily, much the same as that in which it may be expected to operate in future. In each case, therefore, there is a particular sort of environment to which the system, whether manmade or biological, is adapted. This environment I propose to term the system's "environment of adaptedness." Only within its environment of adaptedness can it be expected that a system will work efficiently. . . . It is important to recognize that an environment of adaptedness exists not only for each species but for each single system of each species; . . . (*op cit*, p. 47)

In its environment of evolutionary adaptedness, the operation of a biological control system will produce a predictable outcome. Because of specific features of that environment of evolutionary adaptedness, achieving the set-goal normally brings about just those particular consequences for which the behavior has been selected. Thus, Bowlby's theory makes a sharp distinction between the set-goal of a behavior (the set of effects that the control system tends to bring about, such as the maintenance of a constant distance from a threatening object) and the function of a behavior (those effects for which the behavior has been selected, such as the avoidance of predation).

The distinction between the set goal and the function of behavior systems has remained as a foundational principle in the field of ethology, and has been called "The Law of Short-Sighted Striving" or "Lorenz's Law" (Thompson, 1986a). Konrad Lorenz (1935/1957) played an important role in further explicating the curious disjunction between the goals of an animal's behavior and the functions of that behavior. He attacked MacDougal's (1921) concept of instinct precisely because it seemed to imply

that animals were aware of the good they did for themselves by pursuing their goals. Many of the phenomena so memorably described by Lorenz and the other classical ethologists—the English robin that would display to a bit of red fluff on a wire, the goslings that would follow Lorenz in his hip-waders, the goose that would retrieve a giant egg, the stickleback that would display to a postal van—are clear evidence that animals will strive to achieve a particular set goal even when that set goal has been decoupled from the functional situation.

But Lorenz's Law is an example of a more general principle regarding control systems. To respond to a perturbation in the variable it regulates, the system must assess that variable in some way. And characteristically, the system does not directly assess the variable that it regulates, but instead assesses another variable, the cue variable, that is coupled to it (Powers, 1973a,b). For instance, a household heating system uses the bending of a bimetallic strip as a cue to assess (indirectly) the temperature of the house. A home heating system is a control system that regulates air temperature to a preset temperature by controlling the operation of a furnace. The bending of the bimetallic strip works as a cue because, within the range of temperatures that corresponds to our environment of evolutionary adaptedness, the bending of the strip is closely correlated with temperature of the air around the strip. The system's reliance on this cue can be demonstrated by mechanically bending the bimetallic strip: by applying slight pressure to the strip, one can induce the furnace to turn off before the ambient air temperature has reached the setting on the thermostat. Similarly, the body's respiration system uses blood acidity as a cue to blood oxygen content (Fulton, 1958). The system regulates the level of oxygen in the blood to a stable value by controlling the breathing rate of the organism. The cue, blood acidity, works because the metabolic conversion of oxygen to carbon dioxide acidifies the blood. The reliance of the blood-oxygen control system on this cue can be demonstrated by manipulating blood acidity directly. For example, the administration of very large doses of antacid tablets often reduces the air hunger of persons with high altitude pulmonary edema.

Cues play a similar role in the behavioral control systems that so fascinated classical ethologists. For instance, for male English robins, the configuration, "red-tuft-on-wire" is a cue that regulates territorial defense behaviors. The cue works because, in the natural evolutionary environment of a male robin, the only stimulus corresponding to the pattern "red tuft on stick" is another male robin. The reliance of the male robin territorial behavior on this cue can be demonstrated by inducing territorial behavior with a "red-tuft-on-wire" cue that is decoupled from its normal accompaniment, a male robin. For instance, by providing a tuft of dried cotton mounted on a twist of straight brown wire, one can induce defense

behaviors in a territorial male robin. Similarly, one can inhibit a male robin's defense of territory against another male robin by dyeing the feathers of the intruder green. (Tinbergen, 1951; Lack, 1953) The clear theme that runs through all these examples is that the cue variable of a control system "stands in" for the functional variable that the control system regulates. Thus, to know that C is a cue to F, we must not only show that C and F are correlated in the relevant evolutionary environment, we must also demonstrate that in the operation of specified control systems, C "stands in" for F. This means that the cue relation is not a simple relationship between objects in the world (C and F), but a second order relationship between (i) the relation of C and F in an environment, E, and (ii) the relation of an organism or system to that same environment. Thus, the minimal statement required to specify a cue relation is: Variable, C, is a cue to functional variable, F, for the System, S, in Environment E.

The fact that the cue relation requires reference to a control system for its specification has the important consequence that certain kinds of statements about cue variables will exhibit the implicative opacity of intentional propositions. If you know that a male robin inhabits your garden, you can reliably infer that you have a living bird in your garden and that the bird can be expected to behave in certain ways. But if you know only that cues to the presence of a male robin have been found in your garden, you cannot reliably infer that any object in your garden is a male robin or will behave like a male robin or even that male robins have not gone extinct. As classical ethologists often demonstrated, the cues to biological events are not infallible predictors of the events itself.

The implicative opacity of the cue relation becomes particularly dramatic when we consider a situation in which the same object provides a cue for two different control systems. Imagine a situation in which a cat is stalking a male robin that is, at the same time, intruding into the territory of a second robin and displaying at that robin. And imagine further that we can observe the cat and the second robin, but not the first. For the territorial male second robin, the intruding first robin provides a cue—red tuft on brown wire—of the existence of an intruder. In some sense, we would like to say that the cat responds to the same first male robin; but for the cat, both the cue variable and functional variable are different. For the cat, the first robin provides a cue—twitchy small object—of the existence of a prey object. Thus, while both the cat and the second robin are responding to cues provided by the first robin, which inferences we are privileged to make depends on which of the two "observers" we consider. If we see the cat, then we are entitled to believe that the cat is responding to a small twitchy thing. We are not entitled to any inferences about red breasts. If we see the second robin, we are entitled to infer that it is responding to the

configuration "red fluff on wire." We are not entitled to any inferences about twitchiness. And in neither case can we infer, with certainty, the existence of the first robin.

Thus, to determine the implications of a cue attribution, we have to see the world from the point of view of the specific control system of which the cue relation is part. This would not surprise Jakob von Uexkull (1934/1957), who claimed that every biological process, no matter how elementary, approaches the world from a "point of view," that is, selects from the array of all possible physical stimuli only those few that are relevant to its interests, and then acts to alter the world in ways favorable to those interests. A "point of view" in von Uexkull's sense is an objective property defined by the variables to which the control system of an organism responds and the variables which the system attempts to manipulate in the interests of that organism. A "point of view" is both intentional AND objective.

5. SO WHAT IF INTENTIONALITY IS AN OBJECTIVE CHARACTERISTIC OF ALL BIOLOGICAL SYSTEMS?

In the course of their evolution, a social predator (such as a lion, a wolf or a human being), will survive and reproduce largely to the extent it can anticipate the behavior of other organisms, such as conspecifics, prey, and rival predators. The work we have done so far in this essay gives us a simpler way to identify the skills of a wise predator. Such a predator would be greatly aided by knowing the intentions of the other organisms with which it must deal. But this doesn't mean that it must somehow intuit some image of the future that lives in some non-material mind space of the other. It means only that it needs to know, for at least one of the control systems of the other, what cue variable that system reads and what behavior it is designed to regulate.

Imagine the problem of a lion trying to figure out how to catch a gnu. One afternoon the lion is returning to its den after finishing off the remains of a small impala. It encounters a gnu on the path near the water hole, but, not being hungry, it does not give chase; it merely notes the fact that drowsiness following its consumption of the impala has preceded the presence of gnus at water holes.

Suppose now that the next time the lion passes by the remains of an impala (or the next time it is drowsy), it starts looking for a gnu. Such a lion will soon starve because it would be using impala remains or lion drowsiness as incorrect cues to predict the gnu's presence. What the lion needs to know is what cue variable the gnu uses to regulate its approach to the water

hole. And this variable presumably has nothing to do with lion drowsiness or impala remains.

How is the lion to discover this variable? By observing gnus. The lion should retire to the top of a kopje overlooking the water hole and note the comings and goings of gnus. He should engage in a kind of comparative analysis, analogous on a small scale with what an ethologist does when he tries to discover what the goal of a behavior is. He should note the conditions that obtain each time the gnu comes to the water hole and which of those conditions also occurs when the gnu doesn't come to the water hole. By this method the lion can isolate which factors within the EXtension of "gnu-comes-to-the-water-hole circumstances" constitutes its INTension from the point-of-view of the gnu.

The advantages of such observation may explain why predators, such as lions, sometimes observe their prey when they are not hunting. The well designed lion will get the gnu when he, the lion, has discovered the intention of the gnu's coming to the water hole . . . say, to cool off in the heat of the day. Presumably, he has done so by evolving some sort of a cognitive module designed for intention-detection—a device that compares and contrasts the concomitants of prey movements until it isolates the cues for those movements which are used by the control systems of the prey animals themselves. Thus, the fact that intentionality is a property of control systems—and therefore of animal behavior—should lead us to expect that animals who associate with other animals will develop elaborate cognitive devices for detecting this property in their associates.

Like lions, human beings are highly evolved design detectors. As a consequence of our evolutionary history as hunters, as prey, as members of social groups, and as warriors against other social groups, we have evolved to be especially good at detecting natural design properties in the behavior of other systems. Detecting designs in others helps us adapt our own behavior to those designs or take action to change the designs of those systems. (Inflicting rewards and punishments are two techniques by which we often redesign the systems with which we interact.)

Of course, dealing with designed and non-designed systems requires entirely different strategies. If you are dealing with a non-designed system, a change in your behavior is likely to get you a change in result. But if you are dealing with a designed system, particularly a system that is designed to deal with you, each change in your own behavior is likely to be met by an appropriate change in the organization's behavior. Thus, one reason to be a good design detector is to recognize those systems for which ordinary variations in your behavior are unlikely to produce a different and favorable result for you. Discovery of such an entity will lead either to the design of "extraordinary" variations to deal with the design responses of the other or to breaking off contact.

The reader may now suspect that we are blundering toward a biological theory of mind. Encountering a creature that detects and responds to the intention of a single control system in another creature might not inspire attributions of a theory of mind to the detecting creature. But encountering a creature that detects cues to which of several control systems is active in another creature and responds appropriately might tempt one to the view that the first creature uses a theory of mind to predict the behavior of the other creature. And this would seem to imply that many animals have and use "theories of mind" even if they do not necessarily have "a mind" in which to hold their mind theories (cf. Whitten, 1996).

For the present, the notion of Brentano and others that intentionality is a unique property of human language or the human mind or the human brain has been shown to be false. Every organism or part of an organism that is designed to regulate a variable displays the "object-directedness" (*gerichtetsein*) of intentionality. This result solves a flock of problems that have bedeviled bio-behavioral analysis. It shows how we may safely deploy attributions of mental activities to other creatures as descriptors of high-order patterns of relation between those creatures and their environments. It distinguishes the mind (the suite of the higher order patterns that characterize a creature's behavior) from the body (the physiological mechanisms that co-ordinate and organize those patterns) without entangling us in endless metaphysical disputations. Finally, it suggests the value of the systematic description of the behavioral organization living creatures—the very program that ethologists and ethnographers once took as their highest calling.

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