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# Cause, Function, and the Analysis of Behavior

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In the development of any science, new discoveries are made and new approaches are fashioned to deal with old problems. As a part of this process, older ways of formulating problems are often discarded or simply forgotten. Sometimes the new approaches are better than the older ones in which case it is just as well that the old ones are scrapped. But many times the new approaches are merely different from the older ones in the sense that the new and old ways of formulating a problem are complementary and not mutually exclusive alternatives. In this case, it is a mistake to disregard the old approaches because they may still contribute to a better overall understanding of the problem at hand.

It seems to me that the analysis of behavior is in the latter situation today. Many psychologists are turning from asking traditional causal questions about behavior (questions about stimulus control or variables controlling schedules of reinforcement, for example) to asking functional questions about behavior (questions about whether behavior is optimal, for example). Insofar as these questions lead to a more well-rounded understanding of behavior, this change in direction is good. But some workers seem to feel that these new directions replace the old ones, and such an attitude can only be counterproductive. Even worse, it occurs more and more regularly that workers confuse functional and causal explanations and often talk as if what the behavior accomplishes actually causes the behavior to occur.

What I want to do in this essay is to clearly distinguish the types of questions one can ask about behavior. I shall emphasize that all types of questions are equally valid to ask, and that a full understanding of behavior requires answers to each type. I shall begin with some ancient philosophy.

Aristotle, in discussing physics and metaphysics, pointed out that one and the same thing could be described or explained in four different ways. These types of explanation have been called "causes" and are usually listed as: 1) material, 2) efficient, 3) formal, and 4) final. A standard example is the description of a chair: It may be made of wood (cause 1), have been manufactured in such and such a way by Mr. Jones (cause 2), have four legs, a seat, and a back arranged in a particular way (cause 3), and be used to sit in (cause 4). Each cause may be more or less elaborated, but, in general, all statements about the chair can be put in one of the four categories. The important point is that all the statements describe the same object, and no statement is inherently more or less importante than any other.

When individual chairs are classified as examples of the concept chair, however, a serious problem arises. Which, if any, of the descriptive statements is the one that will be used to judge whether a particular object is a chair? Chairs can be made of metal or plastic, can be molded or carved, can have arms, and can be used to stand on or to defend oneself against flying objects or to burn as firewood. What is the essence of a chair? There is no answer to this question, because the important features of chairs will vary according to the context in which the question is asked. A camp director arranging chairs for a fireside talk will imagine a different set of objects from an ambassador arranging chairs around a conference table. And an avant-garde furniture designer will call some objects chairs that neither the camp director nor the ambassador could imagine sitting in.

Now all this may seem to be a philosophical game of words because, in everyday practice, no one has any difficulty pointing to a chair, and almost everyone will agree. If one wants to make a scientific study of chairs, however, these matters of definition and classification assume great importance: One cannot state conclusions of general significance unless the objects under investigation have the same meaning for all concerned. One is reminded of the blind men who each felt a different part of the elephant and arrived at totally different conceptions of what an elephant is. And so it is with behavior. Unless all concerned have a clear understanding of how behavior is being described and classified, needless confusion is bound to arise.

A behavioral example should make this clearer. Suppose we observe a chicken pecking. There are literally hundreds of descriptive statements we could make about this behavior. We might say the chicken is eating; or it is reacting to the sight of small, round objects; or it is hungry; or it is showing displaced aggression; or it is moving its head toward the ground at such and such a speed, etc. Each individual statement could be true or false, but, in principle, it is possible to arrive at a set of statements all of which are true descriptions of a particular act of pecking. We might even wish to say that the more true statements we can assemble, the better is our description. One could raise the objections that the greater the number of statements, the more unwieldy and cumbersome our description becomes, but various kinds of economy are possible. For example, one could categorize each statement

as an instance of one of Aristotle's "causes". Alternatively, one could discard statements irrelevant for one's purpose: A farmer hoping to sell the chicken would be interested in some statements, a nutritional physiologist in others, and a behavioral scientist in still others. Nonetheless, in spite of these difficulties, there are really no basic or insurmountable problems in the description of a particular sample of behavior.

Serious problems do arise, however, when one turns to the classification of behavior: When is a particular behavioral act an example of a peck and when is it not? Is a chicken pecking when it doesn't eat? When there are no small, round objects in sight? When the angle its head makes with the ground is too large or too small? What is the essence of pecking? As before, this question cannot be answered because no set of statements that is true for one act of pecking is necessarily also true for another, and there is no single statement that everyone will agree is both necessary and sufficient to define pecking. Yet there must be an answer if we are going to have a science of behavior. So, in practice, it is necessary to make certain compromises. Before it is possible to understand these compromises, it is necessary to develop a common vocabulary for discussing these problems. I shall do this within the framework of Aristotle's four "causes".

*Material "cause"*

What is the stuff of which behavior is made? There are probably two major ways in which people have tried to answer this question. In the first, behavior is usually considered to be what an animal does, and what it does consists of muscular contractions and glandular secretions. Some workers might wish to exclude some, if not all, glandular secretions, and others have specified that only certain muscular contractions be included in the definition. In general, however, most behavioral scientists have not been much concerned with distinctions based on the matter of behavior. One important exception is Skinner (1938) who distinguished between the activity of skeletal muscles and smooth muscles. He suggested that behavior based on different kinds of muscles was subject to different laws.

A second way people have specified the matter of behavior is to talk about the activity of the mind. Mind, of course, is a very difficult concept, but it is often invoked in order to include reception, cognition, emotion, and even consciousness as well as overt action in the realm of behavior. Although I am sympathetic to this solution, I prefer a more corporeal concept. Therefore, I shall define behavior as the activity of the nervous system, which may be manifested as activity in muscles and glands. This definition will strike many as preposterous, but it seems to me to be the only logical definition that can include all the phenomena that one intuitively feels belong to the world of behavior. How successful this definition will prove to be can only be judged by the reader. I can point out, however, that this definition is not

as radical as it may seem in that Tinbergen (1951, p. 112) has defined the concept of instinct in terms of the central nervous system, and my conception of behavior is in fact closely related to his.

There are two points I wish to make here about this definition. First, a definition of behavior as the activity of the nervous system does not imply that the study of behavior involves neurophysiology. The study of behavior is the study of the functioning of the nervous system and must be carried out at the behavioral level, using behavioral concepts. Physiology in general and neurophysiology in particular may provide useful insights into the functioning of the nervous system, but it is the *output* of the nervous system, manifested as perceptions, thoughts, and actions, that is the major concern of behavioral science. It is my opinion that perceptions, thoughts, and actions can never be meaningfully understood in neurophysiological terms.

My second point is that the various organisms that have no nervous system would seem not to behave according to the definition. It is possible, of course, that the movements of such organisms really are based on principles different from those that apply to organisms with a nervous system. It seems more likely that similar principles will be seen to underlie movement in both cases. Whether similar principles do apply is an empirical matter.

*Efficient "cause"*

In Book II, Chapter 3 of *Physics,* Aristotle defines efficient "cause" as "the primary source of the change or coming to rest; e.g. the man who gave advice is a cause, the father is cause of the child, and generally what makes of what is made and what causes change of what is changed" (1947, p. 122). With respect to behavior, this definition translates into what I shall call the causation of behavior; and in the remainder of this essay I shall use the terms cause and causal, without quotation marks, to refer to Aristotle's efficient "cause". The causes of behavior include stimuli, the internal state of the animal, various types of experience the animal has had during its development, as well as the genes with which it is endowed. Understanding the mode of action of these causal factors including their interaction with each other is the primary goal of a causal analysis of behavior. Here it is useful to distinguish among three types of causation in terms of the type of effects that are of interest.

The first type of causation is *motivation* in which the immediate effects that causal factors have on behavior are of primary interest. An electric shock causes the rat to jump, hunger causes the chicken to eat, certain advice causes the man to spend his money in a particular way. Note that the term motivation is being used here in a much broader way than is often the case in that it refers to external as well as internal causes of behavior. In fact, I use the term in its original sense to refer to that which causes motion. In the present context, it means anything that affects the activity of the nervous system.

cognitive capacities and organization of an animal belong in this category, as well as questions about what stimulli will be reinforcing to this particular species or individual.

*Final "cause"*

Why did the chicken cross the road? To get to the other side. This answer specifies the goal, purpose, or function of the behavior. Other answer of the same sort would be: To get food; to avoid being run over; to increase the likelihood of passing on its genes to successive generations. Notice that neither the question nor the answers indicate either the form of the behavior (did the chicken walk, run, fly?) or the causes of the behavior (was the chicken hungry, was a car approaching, what was the developmental history of the chicken?). To describe questions and answers such as these, I use the terms function and functional. Because these terms have been used in different way by different workers, I shall expand upon my meaning here.

First is the problem of time scale, which we have already met when discussing the causes of behavior. The function of pecking may be to close a microswitch in a Skinner box, to enjoy the performance of pecking itself, to reduce hunger, to provide the nutrients necessary for egg production, or to increase fitness. Closing a microwitch and enjoying the activity are goals or functions that are immediate consequences of performing the behavior, hunger reduction takes many minutes, producing eggs takes hours or days, and increasing fitness can only be measured over generations. Time itself is no more satisfactory a criterion to distinghish among functions of behavior than it was to distinguish among causes of behavior, and a better criterion is the type of causation being studied. Thus, one could distinguish motivational functions, developmental functions, and phylogenetic functions depending on the question of interest. Eating functions to reduce hunger, to reinforce a stimulus-response association, and to ensure that an animal passes its genes to future generations.

It is to phylogenetic question that some workers prefer to restrict the term function. In this context it is used synonymously with survival value: How do the effects of behavior influence an individual's fitness –i.e., the probability that its genes will be relatively better represented in succeeding generations? One could use terms such as feedback, reinforcement, and function to refer to the different classes of functions, but it is relatively unimportant what words are used as long as the meaning of the words remains clear. I find it useful to have a single word to refer to the various aspects of Aristotle's final "cause", and I prefer to retain the word function for that purpose. The important point is that any behavior has a function only in relation to the question being asked.

It is worthwhile to mention here that Aristotle's example of his meaning of final "cause" is that "health is the cause of walking about. ('Why is he walking about?' we say. 'To be healthy. . .')" (1947, p. 123). This example

A second type of causation is *development* (or ontogeny) in which the cumulative effects over time that causal factors have on behavior are of primary interest. What effects does the presentation of a small red cube to a young chick have on its behavior when it grows up, and how do those effects come about? Will the adult chicken prefer to mate with the red cube rather than with a conspecific? The causal factors in development are the same stimuli, etc. that are of importance for motivation, but one is primarily interested in their longer term effects. The red cube certainly affects the behavior of the young chick when it is presented, as does the father of the child affect the behavior of the mother at the time of conception, but it is the origins and course of development of adult sexual behavior or of the child one wishes to explain.

It should be noted that distinguishing between motivation and development on the basis of time scale (e. g., Tinbergen, 1969) is really incorrect because a more basic distinction is whether the changes brought about by the causal factor are reversible or permanent. The increase in gonad size in some birds and fish as a result of increasing day length is generally considered to be a problem in motivation whereas one-trial learning to avoid electric shock in a rat is a problem in development. The former changes occur over days or weeks whereas learning occurs in a few seconds. On the other hand, reversible and permanent are themselves relative concepts and in any particular example the two can fade into each other. Thus, it is best to consider that motivation and development focus on questions that often reflect a different time scale, but that more basically reflect underlying causal mechanisms that are more or less reversible.

A third type of causation is *phylogeny* in which changes in behavior over generations are of primary interest. Here the causal factors of interest are essentially genetic —for example, gene recombination and mutation— because in most species only genes can be passed on from one generation to the next. However, in species in which specialized modes of conspecific communication have developed, as in man, there is no reason to exclude culturally transmitted information as a causal factor in the phylogeny of behavior. To continue the line of argument used above, the causal factors in phylogeny are the same factors we have already considered, and these factors have motivational and developmental effects. It is the question we are asking that is different.

*Formal "cause"*

Form refers to the relations among the parts. A chair consists of four legs, a seat, and a back arranged in a particular way with respect to each other. By analogy, one can also describe the form or structure of behavior. There are several problems involved in such a description, the most difficult being the identification of the parts or units: One cannot describe an arrangement until one has something to arrange. What are the legs, seat, and back of behavior? In some ways, this is the most important question we can ask

because both causal and functional analyses of behavior presuppose particular units of behavior to be analyzed. Questions about the sensory, motor, and implies that an outcome that has not yet occurred (health) is causing behavior (walking about). In other words, the future seems to be determining the present. It is possible to avoid this problem by various kinds of restatement. For example, the man believes that walking about promotes health, and he wants to be healthy; therefore he walks about. In this restatement, it is a belief and a desire –both occurring in the present– that are causing the behavior. Whether walking about actually functions to keep the man healthy can only be determined sometime in the future. This point is extremely important because this is the way that causal and functional analyses are most often confused: *The outcome of behavior can never determine its occurrence.* At best, the outcome of behavior can be one of the determining (causal) factors of future occurrences of similar behavior.

*Conclusion*

The purpose of this brief essay has been to distinghish among the different kinds of question that one can ask about behavior. In some ways this is a reworking of ideas that Tinbergen (1963) expressed: Tinbergen distinguished among causal, functional, ontogenetic, and evolutionary question. Those question remain in my categorization, but some additional distinctions have been made as well. Further, I have tried to indicate some of the relationships among the different question. The main point I would like to make from all this philosophizing is that there are many different aspects of behavior one can study, none of which is inherently better or worse or more or less important than any other (cf. Lehrman, 1970). It is the question asked by the investigator that determines which aspects of behavior are important.

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