METHODOLOGICAL POINTS FOR BEHAVIORAL SCIENTISTS

Francis Mechner
The Mechner Foundation

Explanatory Fictions in Science

Perhaps the most important skill of a scientist is to distinguish clearly between what is known and what is not known and to draw the boundaries accurately. The identification of ignorance is just as important as the identification of knowledge. In fact, one is not possible without the other.

That is why explanatory fictions should be avoided. In the behavioral sciences particularly, there is a widespread tendency to invent fictional constructs that purport to explain behavioral phenomena but are really just new names for the phenomena. Such fictional constructs tend to obfuscate the areas of ignorance and to conceal the questions that need to be addressed.

But not all constructs are explanatory fictions. A construct's explanatory power must be judged by its correspondence with phenomena that can be measured independently of the phenomena which the construct purports to explain.

Scientists tend to invent fictional constructs when faced with an unfilled time gap between an observed antecedent ("causal") event and a correlated subsequent event. Most scientists feel, with justification, that an explanation of any cause-effect relationship demands (a) explication of relevant parameters of the observed correlation, and (b) a detailing of the concatenated events that fill the time gap between the cause and the effect (Smith, 1990; Reichenbach, 1938; Thompson (Lord Kelvin), 1884; Skinner, 1974, pp. 236-237).

When unable to do (b), some scientists sometimes succumb to the temptation to fill that time gap with postulated fictional events. That practice is counter-productive when there is no honest expectation that those events will ever be measured independently of the events to be explained, or when there is no separate and independent evidence for the reality of those events. The sin is often further compounded when the scientist tries to disguise the explanatory sterility of the invention by giving it a plausible name (Baum, 1989, p. 169). This practice has been particularly insidious in psychology, in part because the real intervening events that fill the time gaps are so inaccessible. They take place inside the organism, mostly at a microscopic chemical and neurological level (Staddon, 1991). As Skinner stated,

> "...the temporal gaps between the actions performed upon an organism and the often deferred changes in its behavior ... can be filled only by neuroscience..."

This frustrating state of affairs creates a fertile terrain for pseudo-explanations.

A Motivation Unique to Behavioral Science

There is an additional reason, a sociological one, why explanatory fictions are more common in the behavioral sciences than in many other fields.

The functioning of any human society depends on the use of rewards and punishments. To justify their use within a framework of justice, law, or religious principles (perhaps to avert counter-control by the controlees (Skinner, 1953)), it is expedient to hold people personally responsible for their behavior. Holding people responsible in turn requires the concept of a "self" that has "free will" and is the causal agent of the behavior. The linked concepts of responsibility, free will, and self are instilled in most members of human societies from early childhood on. So deeply are these concepts ingrained that they have shaped even the structure of most human languages. They have also shaped cultural attitudes regarding what types of explanations of behavior are acceptable.

Behavioral scientists are no less subject to this indoctrination than other members of human societies. So, the concepts of self and free will normally shape the thinking of behavioral scientists too. Those who are thus indoctrinated, encounter a dilemma when faced with behavioral science's premise that the causes of behavior are physical and are to be sought in antecedent events or biological mechanisms, a premise that is logically incompatible with the concept of free will which identifies the self as the ultimate cause of behavior.

Many behavioral scientists resolve the dilemma by talking about the self (as the agent ultimately responsible for behavior) the way other people do, and to explain behavior they invent "homunculi" and other fictitious causal agents that are either equivalent to the self or agents of the self. That approach can often appear to perform the additional explanatory function of filling in the time gap between cause and effect. Perhaps the reason why explanatory fictions are so prevalent in the behavioral sciences is that they are able to perform this dual function, illusory though its true value may be.

Inventing explanatory fictions would be harmless if it did not obfuscate gaps in our knowledge of behavioral processes and mechanisms. The obfuscation creates complacency in the search for <u>real</u> explanations, with a resulting general retardation of the progress of behavioral science.

Skinner, aware of these dynamics, often admonished psychologists to resist the temptation to invent explanatory fictions (Skinner, 1938; 1950; 1953, 1974). It is possible that one of the reasons why many psychologists and philosophers find Skinner so controversial is that his admonitions struck home for them.

The Status of the Motor Program Construct

The concept of the motor program, though a construct, is not a fiction, nor an explanatory agent. Motor programs have a physical reality at the neurological level, and many aspects of their neurological and behavioral manifestations can be and are being recorded and studied. Motor programs have the same status as muscles and bones, and their function is the CNS counterpart of movement. Some of the experimental evidence for the existence of motor programs is summarized in Mechner (1995).

We need not be fazed by the fact that we cannot yet "read" the registrations of motor programs in the CNS in full detail. We are only now beginning to learn in what forms they are encoded and registered and how they are triggered. Even as our understanding of the physical properties of motor programs advances, we can continue to learn a great deal about motor programs by a combination of behavioral and inferential methods, just as we can learn a great deal about computer programs without needing to read the microscopic magnetic traces that constitute a computer memory's storage mode. After all, a great deal was learned about genetic phenomena by phenotypical and inferential methods before there was a technology for "reading" genes and even before it was known in what form genetic information is encoded and registered. Similarly, a great deal was learned about chemical reactions before molecular structure was understood and before there were electron microscopes for looking at molecules.

The motor program construct, in conjunction with new data from neuropsychology, enables us to generate many important new hypotheses, predictions, and explanations regarding behavioral phenomena. Here is how B.F. Skinner saw it in 1974:

> The physiologist of the future will tell us all that can be known about what is happening inside the behaving organism. His account will be an advance over a behavioral analysis, because the latter is necessarily "historical" — that is to say, it is confined to functional relations showing temporal gaps. Something is done today which affects the behavior of an organism tomorrow. No matter how clearly that fact can be established, a step is missing, and we must wait for the physiologist to supply it. He will be able to show how an organism is changed when exposed to contingencies of reinforcement and why the changed organism then behaves in a different way, possibly at a much later date. What he discovers cannot invalidate the laws of a science of behavior, but it will make the picture of human action more nearly complete.

The Use of Computer Technology As a Model

When attempting to understand a complex system about which we know little, it is often good heuristic strategy to look for potentially useful models. The best candidates for such models are systems (a) about which we already know something, and (b) that have some evident points of similarity with the system to be understood.

Once we have a candidate model, the first step is to explore how it is similar and how it is different from the system we are trying to understand. When similarities are discovered, they can run surprisingly deep. This tends to be especially true when the properties of the two systems are constrained by similar mechanical, biological, chemical, or organizational imperatives. For example, due to mechanical and spatial constraints, stick-and-ball models of molecules have some of the same geometric properties as real molecules. That is why stick-and-ball models have often led to detailed new predictions about chemical phenomena. The process of extending the parallels of models as far as possible, until they break down, often generates productive hypotheses that would not have been generated otherwise.

Psychologists have sometimes used the computer model in attempting to understand complex performance learning. At first, those models focussed mainly on the hardware aspect. More recently, the exploding field of computer software technology has emerged as a fruitful new source of models of performance learning. As we explore the properties shared by systems of computer programs and systems of behavior programs, it turns out that some rather detailed and technical aspects of computer programming technology can indeed serve as a source of non-trivial hypotheses for how performance may be organized and managed at the CNS level.

Assuming Biological Continuity

The biological sciences also have available to them a source of models and hypotheses not available to other scientific disciplines, a source that flows from biological and evolutionary continuity.

For example, evolutionary continuity is the basis for biologists' and psychologists' willingness to do much of their research on infra-human species. They expect that the knowledge so gained will be applicable to the human species to some extent, and will be a fruitful source of hypotheses (Hayes, 1989, Gould, 1985).

Another example of the use of evolutionary continuity as a source of hypotheses is the observation that certain anatomical and chemical human characteristics are vestigial remnants of homologous infra-human characteristics (like the appendix), while others are adaptive and functional elaborations (like the cerebral cortex).

The term "homologous", which can loosely be defined as "biologically related," can refer to corresponding structures or mechanisms between species, between the sexes of the same species, and between embryological and adult structures. Attention to homology is a fruitful heuristic for generating hypotheses in the biological sciences, including psychology.

Finally, there are the numerous instances of analogous and similar structures and mechanisms within the body of each individual. Some obvious examples are the reciprocal adduction/abduction or agonist/antagonist relationships of the muscles that operate all the joints; analogous agonist/antagonist relationships between most endogenous hormones; the numerous analogies between the anatomy and physiology of arms and legs; the similarities between different types of cells; the similarities between the functioning of neural networks and ganglia in all parts of the body; similarities between the ways different neurohumors function; analogies between the registration of genetic information and certain other information (via RNA); the fact that the same or very similar principles of learning apply to many different types of behavior and different motivational modalities; etc.

Methodological Options Provided by Biological Continuity

In general, when confronted with a question regarding a biological mechanism, the biologist's first step is to look for analogous known mechanisms to serve as candidate models. The second step is to postulate mechanisms that are analogous to the mechanisms that operate in the model, and to determine whether such postulated mechanisms contradict any of the known facts. If they don't, the third step is to use the model to generate new hypotheses that lead to the delimitation of the model's range of applicability, and to test those hypotheses experimentally.

A methodological no-no is to invent a brand new mechanism for which there is no plausible model, like a metaphor, and to give that invention a name that may produce complacency regarding the need to answer a question.

The use of biological continuity as a basis for generating models and hypotheses in uncharted waters is consistent with the general bias of scientific method toward theoretical parsimony.