

LETTERS

Guidelines for

DNA Hybrid Molecules

Those in attendance at the 1973 Gordon Conference on Nucleic Acids voted to send the following letter to Philip Handler, president of the National Academy of Sciences, and to John R. Hogness, president of the National Institute of Medicine. A majority also desired to publicize the letter more widely.

We are writing to you, on behalf of a number of scientists, to communicate a matter of deep concern. Several of the scientific reports presented at this year's Gordon Research Conference on Nucleic Acids (June 11–15, 1973, New Hampton, New Hampshire) indicated that we presently have the technical ability to join together, covalently, DNA molecules from diverse sources. Scientific developments over the past two years make it both reasonable and convenient to generate overlapping sequence homologies at the termini of different DNA molecules. The sequence homologies can then be used to combine the molecules by Watson-Crick hydrogen bonding. Application of existing methods permits subsequent covalent linkage of such molecules. This technique could be used, for example, to combine DNA from animal viruses with bacterial DNA, or DNA's of different viral origin might be so joined. In this way new kinds of hybrid plasmids or viruses, with biological activity of unpredictable nature, may eventually be created. These experiments offer exciting and interesting potential both for advancing knowledge of fundamental biological processes and for alleviation of human health problems.

Certain such hybrid molecules may prove hazardous to laboratory workers and to the public. Although no hazard has yet been established, prudence suggests that the potential hazard be seriously considered.

A majority of those attending the Conference voted to communicate their concern in this matter to you and to the President of the Institute of Medicine (to whom this letter is also being sent). The conferees suggested that the Academies establish a study committee to consider this problem and to recommend specific actions or guidelines, should that seem appropriate. Related problems such as the risks involved in current large-scale preparation of animal viruses might also be considered.

MAXINE SINGER

Room 9N-119, Building 10,
National Institutes of Health,
Bethesda, Maryland 20014

DIETER SOLL

Department of Molecular Biophysics
and Biochemistry,
Yale University,
New Haven, Connecticut 06520

Behaviorism and Feedback Control

Although there is much of value in the article "Feedback: Beyond behaviorism" by W. T. Powers (26 Jan., p. 351), it is based on an outdated and misconceived idea of behaviorism.

Behaviorism consists in the view that a scientific psychology must deal with the observable. From this proposition, it follows that psychology should be a science of behavior, and that explanations of observed phenomena should be couched in the same terms as the observations themselves, rather than invoking imagined autonomous entities ("explanatory fictions") as causes. Many, perhaps most, psychologists today are behaviorists.

Since its points are mainly methodological, behaviorism never has been wedded to any particular conception of behavior. Early behaviorists perhaps held views similar to the one Powers criticizes, but the inadequacy of describing behavior in terms of responses to stimuli was recognized over 30 years ago. With the recognition that behavior is affected by its consequences (the Law of Effect), open-loop descriptions began to pass away. Few behaviorists today would disagree with Powers's statement, "there can be no nontrivial description of responses to stimuli that leaves out purposes." Emphasis on purpose, in fact, has been the hallmark of modern behaviorists' thinking (1). The behaviorists' solution to the problem of purpose has been exactly the one suggested by Powers—selection by consequences. That behavior and consequences constitute a feedback system is taken as a basic premise (2). It is presented this way in at least one elementary text (3).

Powers covers familiar ground in two other points. In his discussion of acts and results, he actually reinvents Skinner's concept of the operant (4). One of Skinner's most important innovations was this conception of a unit of behavior consisting of the class of responses (Powers's "acts") defined by its environmental effect (Powers's "result"). As Herrnstein has pointed out (1), Skinner's approach to the problem of purpose was to define behavior in terms of its consequences. Also familiar is the notion of the hierarchical organization of behavior. Lashley (5) made the earliest clear statement of this view. He argued, as does Powers, for a hierarchy of goals and subgoals in behavior. It seemed the only way to account for organized sequences.

Although Powers's attack on behaviorism is misguided, and many of his ideas have been set down before, nevertheless the constructive aspects of the article deserve praise. The very lack of novelty itself shows that Powers, albeit unwittingly, is square in the mainstream of modern behaviorists' thinking about instrumental behavior. His discussion of feedback, therefore, is most welcome, because it helps define the direction in which we are moving.

WILLIAM M. BAUM

Department of Psychology,
Harvard University,
Cambridge, Massachusetts 02138

References and Notes

1. R. J. Herrnstein, introduction to J. B. Watson, *Behavior* (Holt, Rinehart, and Winston, New York, 1967).
2. The opening sentence of *Schedules of Reinforcement* by C. B. Ferster and B. F. Skinner (Appleton-Century-Crofts, New York, 1957) reads, "When an organism acts upon the environment in which it lives, it changes that environment in ways which often affect the organism itself."
3. H. Rachlin, *Introduction to Modern Behaviorism* (Freeman, San Francisco, 1970). See also D. J. McFarland, *Feedback Mechanisms in Animal Behaviour* (Academic Press, London, 1971) and P. van Sommers, *The Biology of Behaviour* (Wiley, Sydney, 1972).
4. B. F. Skinner, *The Behavior of Organisms* (Appleton-Century-Crofts, New York, 1938). See J. R. Millenson, *Principles of Behavioral Analysis* (Macmillan, New York, 1967) for a treatment in terms of set theory.
5. K. S. Lashley, in *Cerebral Mechanisms in Behavior*, L. A. Jeffress, Ed. (Wiley, New York, 1951), p. 112.

Powers briefly describes a closed-loop feedback model of behavior, with special reference to purposive behavior. The model is of interest and deserves serious consideration as an alternative to other behavioral models, but there are some points about the presentation that warrant critical comment.

First, as a model, the system can do no more than *represent* the phenomena in the domain encompassed. A model (of the type under consideration here) provides no explanations, except in the sense of intuition or analogy. Powers does not describe the theory to be associated with the model, and therefore no real explanations are provided.

Second, Powers asserts that no behavioristic model has been able to account for purpose; but in fact purpose has been adequately derived from such behavioristic constructs as the conditioned goal response (the fractional anticipatory goal response, r_g) and other mediational response. In Powers's system, "purpose" is like a template; its effect is not goal-seeking behavior but goal-maintaining behavior, and it is concurrently represented in