REVIEW OF HULL'S PRINCIPLES OF BEHAVIOR¹

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When Professor Hull first approached behavior theory in earnest, more than a decade ago, the science of behavior was in a difficult position. Twenty years of the "natural science method" heralded by Behaviorism had failed to provide a consistent and useful systematic formulation. The commonest laboratory instruments were still the maze and the discrimination box, and experimental data reflected many arbitrary properties of the apparatus. Acceptable conclusions of any degree of generality referred to aspects, characteristics, or limiting capacities. While many of these were valid enough, few were logically compelling, and individual preferences had led to many individual "sciences" of behavior. Professor Hull saw the need for a logical analysis of the vocabulary of behavior, for an explicit definition of fundamental terms and an unambiguous statement of principles. He adopted the rather extreme procedures of "postulate theory," and proposed to put order into the science of behavior by carefully defining certain primitive terms and setting up a (necessarily rather large) number of postulates, from which thousands of theorems could be deduced and experimentally tested. It is clear from his early memoranda that he first regarded his postulates as in general not directly testable, a condition which gives point to the postulate method. Deduced *theorems* were to be checked against the facts, but the validity of a postulate was to be established by the success of the theorems to which it gave rise.

The cogency of the postulate method may be said to vary inversely with the accessibility of a subject matter. When a process cannot be directly investigated, its properties may often be inferred from a study of consequences. This condition prevailed in the field of behavior in the early 30s, and Hull's proposal was therefore justified. The situation was,

however, changing. The growing influence of Pavlov and other developments in the field at this time revealed the possibility of a direct attack upon fundamental processes which would lead to a different sort of analysis. Hull was one of the first to recognize this possibility and to encourage relevant research. Moreover, he was not insensitive to its bearing upon postulational procedures. In a memorandum of November 28, 1936, he confesses that "the 'geometrical' type of deduction does not permit the ready use of the calculus and thus has limitations not characteristic of the higher forms of scientific theory."

Instead of abandoning the postulate method and turning to the higher forms of theory appropriate to a functional analysis, Professor Hull attempted to salvage his program by combining the two methods. In 1937 he wrote that "the postulates of the theoretical constructs are to be the basic laws or principles of human behavior. These laws are to be determined directly by experiment, so far as feasible, in advance of their use in theoretical constructs. . . . The experimental determinations will be quantitative, designed to reveal functional curves of basic relationships. Mathematical equations will be fitted to . . . these curves; such equations will constitute the postulates of the system." This program, which he called "logical empiricism," proved to be an unstable blend of two widely different principles of analysis. Any demonstrated functional relation between behavior and its controlling variables is not a postulate but a law, and there is little reason to continue with the ritual of postulates. The resulting split in Professor Hull's thinking has left its mark on the present volume. At one time the author appears to be working within a formal postulate system; at another he is considering behavior as a dependent variable and relating it to controlling variables in the environment. These activities are not always supplementary; on the contrary they are often mutually harmful.

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The transition from "principle" to "process," or from aspect to functional relation, may be traced in the changing postulate systems which Hull has sponsored. He began, in the case of rote learning, with a selected set of current hypotheses, assembled for purposes of clarification and held together by a common relation to a field of research. By 1939 a rough precursor of the present set had been constructed. It revealed the new interest in functional analysis by referring to a group of basic processes (e.g., stimulus excitation, conditioning, motivation) in presumably an exhaustive way (the current Postulate 16 is said to *complete* "the statement of primary principles"). Some of these postulates were in effect inverted definitions; others described quantitative processes. The method was now being used, not merely for the logical rectification of existing principles, but for the isolation of a system of variables.

The new postulates proved embarrassingly un-hypothetical, however, and sometime after 1939 Hull retreated to a more speculative level of analysis—the neurological. This is a surprising change, for we are told that the *Principles* will remain at the molar level, as that term is used by Tolman. "The object of the present work," writes Professor Hull (p. 17), "is the elaboration of the basic molar behavioral laws underlying the social sciences." Yet Postulate 1 begins, "When a stimulus energy impinges upon a suitable receptor organ, an afferent impulse is generated . . .," and the other postulates hold essentially to the same level. Our author is not always at home in writing of neurology (as, for example, in the careless statement (p. 54) that in reciprocal innervation one muscle receives a neural discharge which is inhibitory rather than excitatory in nature), and we can scarcely explain the maneuver except by assuming that the author is determined to keep his postulates hypothetical at any cost. The exigencies of his method have led him to abandon the productive (and at least equally valid) formulation of behavior at the molar level and to align himself with the semi-neurologists.

The same pressure has led to a misrepresentation of many of his scientific procedures. His "deductions" are often concerned merely with showing that complicated instances of behavior may be analyzed into simpler in-

stances which have been, or are at least capable of being, studied experimentally. This is an unavoidable task in a science of behavior, but to regard the simple case as postulate and the complicated as theorem is to extend the postulational framework beyond its sphere of usefulness. In the case of the postulates which are merely quantitative predictions of processes yet to be studied, "deduction" often turns out to refer to a direct experimental determination, but this should not be confused with the testing of postulates *via* deduced theorems. To force simple scientific inferences into the postulative mold does not contribute to clarity, but rather to awkwardness and confusion.

Because of the unsuccessful attempt to embrace a functional analysis, the book will hardly stand as an example of postulate method. Since the book is likely to be received primarily as an example of method, a few defects from a more strictly logical point of view may be listed. (1) There are no formal definitions, although Professor Hull originally recognized this responsibility. (2) Some postulates contain as many as five separate statements, so that references to a postulate during the course of a proof are ambiguous. (3) The symbols never "pay off" in convenience or progress. Six and one-half pages are needed to define them, but they are used only to paraphrase what has already been said in words. There is apparently no instance in the book of a productive manipulation of symbols. (4) Although the distinction between primary and derived principles is frequently invoked, there is no adequate discussion of the criteria of primacy or of the level of analysis of the language of the postulates. (5) The grounds for admission of a new postulate are not stated. Postulates are generally brought in when facts cannot otherwise be accounted for, but this is not always the case. The tendency is now toward a minimal set, but this is not explicitly discussed. (At least two postulates, which refer to "inhibition," could be dispensed with on logical grounds. Although they are carefully evaluated with respect to the status of inhibition as an "unobservable," no question is raised as to whether they are needed at all. Inhibition, as the obverse of excitation, requires no separate reference, and none of the facts in Hull's chapter demands the term in any other sense.)

Two postulates must be objected to on more

than general grounds. The Postulate of Afferent Neural Interaction asserts that the impulses generated by a stimulus energy are changed by each other into "something different." Since no provision is made for determining what this something is, the postulate may be adequately paraphrased by saying that it is impossible to predict behavior from the *physical* stimulus. This is a well-known difficulty in behavior theory, but we have come to expect from this writer something more than an explanatory fiction. Until the properties of the resulting psychological or behavioral stimulus are at least suggested, the postulate serves merely to account for failure to achieve a rigorous analysis and makes no positive contribution. The same objection applies to the Postulate of Behavioral Oscillation, which asserts the presence of an oscillatory "inhibitory potentiality" (it might as well have been "excitatory") which blurs "the concrete manifestation of empirical laws." This is another neural fiction, with the single negative function of accounting for failure to predict. In his introductory chapter Hull inveighs against certain traditional psychological ghosts, but it is doubtful whether any of them is quite so ghostlike in function as Afferent Neural Interaction or Behavioral Oscillation.

Predilection for a given method is not in itself objectionable. In the present case, however, it has unquestionably diverted the author from a frontal attack on crucial issues. The important task of formulating behavior as a system of variables is performed only indirectly. The "pivotal theoretical construct" is Effective Reaction Potential, which is said to be manifested by probability of reaction evocation, latency, resistance to extinction, and reaction amplitude. These measures do not, unfortunately, always vary together, and in the face of this difficulty Hull selects "probability" as the best single indicator. This notion appears very late in the book, and almost as an afterthought. It is not included in an earlier list of the manifestations of habit strength (where, incidentally, the lack of covariation of the other measures is dismissed as unimportant), yet these manifestations should be identical with those of effective reaction potential. Probability lacks the physical dimensions of latency, amplitude, etc., and might better be described as the thing manifested. Effective reaction potential could,

in fact, be usefully defined as the probability of evocation, although Professor Hull would doubtless wish to retain some reference to a physical substratum, the concept does little more than assert that the business of a science of behavior is to predict response. This prediction is to be achieved by evaluating the strength of a response (the probability that it will occur) and relating this to other variables, particularly in the fields of reinforcement and motivation ("emotion" does not appear in the index). Following Tolman, Hull prefers to fractionate this probability, identifying one part with reinforcement (which is then called "habit strength") and another with motivation (called "drive").

A similarly glancing and ineffective treatment of other current problems seems due to the same methodological difficulties. We expect something new and helpful in the analysis of conditioning, but are presented instead with three demonstrational experiments which are intended to reveal essential relations in learning. By using the complicated and unexplored motive of escape (which is likely to confuse eliciting and reinforcing stimuli), the book tries to steer a middle course between Pavlovian and operant conditioning. But his essential characteristics are admittedly difficult to find in the Pavlovian experiment, and the highly verbal resolution of this difficulty is unsatisfactory. Similarly the chapter on patterning is heavily methodological, but to no real effect, since the problem is virtually disposed of in the original definition, which limits patterning to the compounding of stimuli in the Pavlovian manner.

Although the book is not intended as a factual survey, the quantitative relations which the author would like to see in a science of behavior are extensively illustrated. Except for a certain autistic tendency to create appropriate data (one-third of the graphs represent hypothetical cases), the author shows his characteristic willingness to abide by experimental facts. The present volume probably sets a record for the use of experimental material in a primarily theoretical work. The heavy use of mathematics does not imply, as one might suppose, a more rigorous insistence upon a factual correspondence, for Bengt Carlson, who is responsible for the "complicated equations" at the end of many chapters, has been given too much freedom

in his curve fitting. The fact that he is able to find "simple growth functions" which approximate a number of selected sets of data offers little assurance of the ultimate usefulness of that function, since he has been allowed to use three constants to which fresh values are assigned at will. (In one instance (p. 276), Carlson describes three experimental points with an equation containing three constants!) The mathematics is also occasionally rather wishful, as, for example, when detailed instructions are given for "calculating habit strength," although no techniques have been discovered for making the necessary measurements.

In spite of an extensive period of development, the *Principles* reveals a program still in transition. There is every evidence that the postulate method is being sloughed off (compare the earlier *Mathematico-deductive Theory*), but Professor Hull has not yet made full use of an outright functional analysis. The uncertain theoretical position of the book will not lessen its stimulating effect in the field of behavior theory. More important, perhaps, is the research which will certainly follow. The book is wide open to experimental attack, and it is only fair to add that the author planned it that way.