Theories of Learning

by

ERNEST R. HILGARD
Stanford University

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Preface

Learning is a central topic within American psychology, and its problems have provided the occasion for hundreds of experimental studies. The science of learning remains in a state of flux, in part because we have not yet reached agreement upon the most appropriate concepts to use in stating our problems and in interpreting our data. This book represents an attempt to provide in one place an introduction to the major theories of learning which are current among psychologists doing research in this important field of study.

The aim is to see theory in relation to experiment. Each of the several theories is therefore illustrated by a selected topic within the field of experimentation. The topic chosen is in each case one actively studied by adherents to the theory. The theory can be judged both by its provocativeness in suggesting experiments, and by its success in dealing systematically with the data which emerge from such experiments.

No one author can be entirely judicious in the treatment of such a wide range of theories as are considered here. My biases have undoubtedly made themselves shown in places where I have thought the exposition to be matter-of-fact. I have approached the task with the desire to be friendly to each of the positions represented, on the assumption that each of them has been proposed by an intelligent and sincere person or group of persons, and that there must be something which each of them can teach us. I have tried not to let this desire to give each a fair hearing prevent pointing out such weaknesses as I have detected in each of the positions. The final chapter exposes my personal preferences, and may be used in part to interpret the blindnesses or excesses which appear in the earlier chapters.

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E. R. H.

Stanford, California

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Chapter 1

THE NATURE OF LEARNING THEORIES

Learning so pervades human activity that any curiosity about the nature of man and his behavior leads sooner or later to inquiry about how his habits are formed, how his skills are acquired, how his preferences and tastes develop, how his knowledge is obtained and put to use. Equally important is how he becomes enslaved by prejudice and bigotry and other learnings which lead to trouble instead of to a satisfactory solution of his problems.

WHY STUDY LEARNING?

Learning is a fact of nature requiring explanation. Scientists are characterized by insatiable curiosity about natural phenomena. The facts of learning, like the facts of growth, reproduction, or heredity, are in need of explanation if we are to understand the organism's relationship to its environment. What happens when an earthworm learns to choose one arm rather than another of a T-maze? When a dog learns to salivate to a ringing bell? When a pigeon learns its way back to its home cage? When a man forgets?

Scientists are characterized also by a faith that answers to such questions can be found through the familiar methods of empirical observation and experimentation. Aroused curiosity, and confidence in possibility of answers to the questions asked, are sufficient occasions for much of the research on learning.

Learning is practically important. We are all learners, and nearly all of us are teachers. Teaching is not limited to schoolrooms. Parents teach their children, hunters teach their dogs,

coaches teach athletes, skilled workers teach apprentices, sales managers teach salesmen, physicians teach their patients. The formal teaching agencies—schools and colleges—represent an enormous social investment. Any process which engages as many people for as many hours as teaching does surely deserves the most careful study in order to make the practices as effective and as efficient as possible. The understanding of learning is central to the problems of teaching and of training, in school and out.

Learning theory is crucial to psychologists' system-building. The study of learning does not belong exclusively to psychologists. Physiologists and bio-physicists have a legitimate interest in it; educators, animal trainers, and others faced by the practical problems of the control of learning often have their own approaches to these problems. But the field is one which belongs primarily to psychologists. One reason is historical. Psychology's claim to the field was staked in part by such pioneers as Ebbinghaus (1885),[1] Bryan and Harter (1897, 1899), and Thorndike (1898). Those who have followed in their footsteps have been primarily psychologists. Professional educators have welcomed educational psychology as a foundation science, so that studies in the psychology of learning have gone on concurrently in laboratories of general psychology and laboratories of educational psychology, with much interplay between the pure and applied fields. Under the circumstances, it is very natural for psychologists to feel that the study of learning belongs to them.

In addition to historical reasons, there is another basis on which to account for the psychologist's interest in learning. This is the centrality of the concept of learning in more general systems of psychological theory. A scientist, along with the desire to satisfy his curiosity about the facts of nature, has a predilection for ordering his facts into systems of laws and theories. He is interested not only in verified facts and relationships, but in neat and parsimonious ways of summarizing these facts. Psychologists with a penchant for systems find a theory of learning essential because so much of man's diverse behavior is the result of learning. If the rich diversity of behavior is to be understood in accordance with a few principles, it is evident that some of

[1] References cited can be found by author and date in the list at the end of the book.

these principles will have to do with the way in which learning comes about.

Many psychologists make explicit acknowledgment of the centrality of learning in their broader systems. Three examples may be cited.

In his definition of behavior as *molar* rather than as *molecular* (a distinction which lies at the very heart of his system), Tolman [2] lists docility ("teachableness") as the crowning characteristic of such behavior. All molar behavior exhibits docility. Hence learning becomes for Tolman an identifying character of that which he wishes to include as behavior.

Guthrie makes of learning the mark of mind. As he puts it:

> The ability to learn, that is, to respond differently to a situation because of past response to the situation, is what distinguishes those living creatures which common sense endows with minds. This is the practical descriptive use of the term "mind." [3]

Hull (1943*a*) in introducing his theory of the behavior sciences, finds it natural to devote the first volume of his series to learning theory. He scarcely distinguishes between a theory of learning and a theory of behavior, so important is learning in his conception of behavior.

Although not all psychologists give this same prominence to learning in their theories, the fact that others do makes it imperative for all to dispose of the problems of learning in one way or another. Hence the systematic aspects of learning theory have special importance to psychologists interested in more general theories.

The different reasons for studying learning lead to different emphases. If one is interested only in immediately practical outcomes, much of what appears to be hair-splitting may be ignored because alternative explanations often arrive at the same suggestions for practice. It is only if one understands the relationship of the theories to larger aspects of system-building that some of the verbal skirmishes can be understood.

[2] Tolman (1932*b*), pages 14-16.
[3] Guthrie (1935), page 3.

THE DEFINITION OF LEARNING

What learning includes. There are many activities which every one will agree count as illustrations of learning: acquiring a vocabulary, memorizing a poem, operating a typewriter. There are other activities, not quite as obviously learned, but which are easily included after a little reflection upon their nature. Among these are the developing of prejudices and preferences and other social attitudes and ideals, including the many skills involved in the social interplay with other persons. Finally there are a number of relatively useless and bizarre learnings, such as tics and mannerisms and autistic gestures.

Such a pointing to illustrations of learning serves very well as a first approximation to a definition. It is, in fact, extremely difficult to write an entirely satisfactory verbal definition. Improving with practice, profiting by experience, seem at first blush to cover the situation, but learning may be neither an improvement nor profitable in its consequences. To describe it as mere change with practice is to confuse learning with growth, fatigue and other such changes. The following definition may be offered provisionally:

> Learning is the process by which an activity originates or is changed through training procedures (whether in the laboratory or in the natural environment) as distinguished from changes by factors not attributable to training.[4]

The definition is unsatisfactorily evasive, and partly tautological, in leaving training procedures undefined. The intended meaning can be conveyed only by further discussion.

Maturation versus training. Growth is learning's chief competitor as a modifier of behavior. If a behavior sequence matures through regular stages irrespective of intervening practice, the behavior is said to develop through maturation and not through learning. If the training procedures do not speed up or modify the behavior, such procedures are not causally important, and the changes do not classify as learning. Relatively pure cases like the swimming of tadpoles and the flying of birds can be attributed

[4] The definition is modified from an earlier one by Hilgard and Marquis (1940), page 347.

primarily to maturation. Many activities are not as clear-cut, but develop through a complex interplay of maturation and learning. A convenient illustration is the development of language in the child. The child does not learn to talk until old enough, but the language which it learns is that which it hears. In such cases it is an experimental problem to isolate the effects of maturation and of learning. The ambiguity in such cases is one of fact, not of definition.

Work versus training. When activities are repeated in rapid succession, there is often a loss in efficiency commonly attributed to fatigue. Such changes in performance are called work decrements in the experimental laboratory. The units of a work curve are like those of a learning curve: performance plotted against trials or repetitions. Hence the experimental arrangements in obtaining a work curve are essentially those of a training procedure, and at first sight, it appears to be a form of question-begging to define the processes involved by the results obtained. It would be question-begging, however, only if we were to define learning or fatigue as the change in performance. Actually *both* learning and fatigue are *inferences* from the performances, and it is permissible to make such inferences as the obtained performances require or suggest. Work curves tend to show decreasing proficiency with repetition and recovery with rests. Learning curves ordinarily show gains with repetitions and forgetting over rests. These typical differences between learning effects and work effects are evident enough, but the inferences from performance are made on somewhat more complex evidence. It is because of the complexity of these inferences that it is difficult to state a concise definition of learning which will conserve the learning inferences from performance while eliminating the work decrement inferences. The problem is logically the same as distinguishing changes due to maturation and to learning. But again the ambiguity is one of fact, not of definition.

Learning always must remain an inference from performance, and only confusion results if performance and learning are identified. A clear illustration is provided by performance under the influence of drugs or intoxicants. The fact that learned behavior fails when the organism is in such a state does not mean that forgetting has occurred. When the normal state has been restored,

the performance may return to normal levels although there has been no intervening training.

Learning and the nervous system. Some definitions of learning avoid the problem of performance by defining learning as a change in the central nervous system. So long as this change in the nervous system remains, temporary changes in state, such as those in fatigue and intoxication, affect performance but not learning. This definition asserts that learning is an inference, but it goes on to make a particular sort of inference about the rôle of the nervous system in learning. In view of the lack of knowledge of what actually does take place inside the organism when learning occurs, it is preferable not to include hypothetical neural processes in the definition of learning. We know that learning takes place. We should therefore be able to define what we are talking about without reference to any speculation whatever. This position does not deny that what we are calling learning may be a function of nervous tissue. It asserts only that it is not necessary to know anything about the neural correlates of learning in order to know that learning occurs.

Learning, problem-solving, and reasoning. After you have learned, there are many things which you are able to do. If you can add and subtract, you can solve many novel problems without learning anything new. Where the solution of problems is relatively mechanical (as in addition and subtraction), the problem may be thought of as merely the exercise or utilization of a learned bit of behavior. When, however, there is greater novelty, more putting of things into relationship, as in reasoning or inventiveness, the process is interesting in its own light, and is not to be described simply as the running off of old habits.

The question has been raised, especially by Maier (1931*a*), as to the appropriateness of including processes like reasoning within the same classification as other kinds of learning. My preference is for including them. Leaving them in does not prejudge their explanation. There may be new factors not found in simpler learning, but there is no assurance that all other kinds of learning follow the same principles. Leaving the doubtful processes in simply asserts that a complete theory of learning must have something to say about reasoning, creative imagination, and

inventiveness, in addition to what may be said about memorizing and retaining or about the acquisition of skill.

Definition not a major source of disagreement between theories. While it is extremely difficult to formulate a satisfactory definition of learning so as to include all the activities and processes which we wish to include and eliminate all those which we wish to exclude, the difficulty does not prove to be embarrassing because it is not a source of controversy as between theories. The controversy is over fact and interpretation, not over definition. There are occasional confusions over definition, but such confusions may usually be resolved by resort to pointing, to denotation. For the most part it is satisfactory to continue to mean by learning that which conforms to the usual socially accepted meaning which is part of our common heritage. Where distinctions have to be made with greater precision, they can be made through carefully specified types of inference from experimental situations.

SOME TYPICAL PROBLEMS CONFRONTING LEARNING THEORIES

The preferences of the theorist often lead him to concentrate upon one kind of learning situation to the neglect of the others. His theory is then appropriate to this situation, but becomes somewhat strained in relation to other problems of learning. A comprehensive learning theory ought to answer the questions which an intelligent non-psychologist might ask about the sorts of learning which are met in everyday life. A few such questions will be listed here, and then used later in appraising the theories which different writers present.

1. *What are the limits of learning?* Here is raised the question of the capacity to learn, of individual differences among learners of the same species and of unlike species. There are questions not only of persistent differences in capacity, but of change in capacity with age. Who can learn what? Are the limits set at birth? Do people get more or less alike with practice? These are the sorts of questions which it is natural to raise.

2. *What is the rôle of practice in learning?* The old adage that practice makes perfect has considerable racial wisdom behind it.

Surely one learns to roller skate or to play the piano only by engaging in the activity. But what do we know about practice in detail? Does improvement depend directly on the amount of repetition? If not, what are its conditions? What are the most favorable circumstances of practice? Can repetitive drill be harmful as well as helpful to the learner?

3. *How important are reward, punishment, or other motives in learning?* Everybody knows in a general way that learning can be controlled by rewards and punishments, and that it is easier to learn something which is interesting than something which is dull. But are the consequences of rewards and punishments equal and opposite? Is there a difference between intrinsic and extrinsic motives in their effect upon learning? How do goals and purposes affect the process?

4. *What is the place of understanding and insight?* Some things are learned more readily if we know what we are about. We are better off as travelers if we can understand a time-table or a road map. We are helpless with differential equations unless we understand the symbols and the rules for their manipulation. But we can form vowels satisfactorily without knowing how we place our tongues, and we can read without being aware of our eye movements. Some things we appear to acquire blindly and automatically; some things we struggle hard to understand, and can finally master only as we understand them. Is learning in one case different from what it is in the other?

5. *Does learning one thing help you learn something else?* This is the problem of formal discipline, as it used to be called, or of transfer of training, to use a more familiar contemporary designation. Some transfer of training must occur or there would be no use in developing a foundation for later learning. Nobody denies that it is easier to build a vocabulary in a language after you have a start in it, or that higher mathematics profits from mastery of basic concepts. The question is really one of how much transfer takes place and what its nature is.

6. *What happens when we remember and when we forget?* The ordinary facts of memory are mysterious enough, but in addition to familiar remembering and forgetting our memories may play peculiar tricks on us. Some things we wish to remember are forgotten; some things we would be willing to forget

continue to plague us. In cases of amnesia there are often gaps in memory, with earlier and later events remembered. Then there are the distortions of memory, in which we remember what did not happen, as is so strikingly demonstrated in testimony experiments. What is taking place? What control have we over the processes involved?

These six questions will serve as useful ones to ask of each of the major theories. They suffice to illustrate the kinds of questions which give rise to theories of learning.

BASIC ISSUES ON WHICH THE MAJOR THEORIES DIVIDE

In the chapters which follow there will be paraded a great many theories. Lest the array of theories be too confusing, they have been grouped into two main families.

The two main theories may be designated *association* theories, on the one hand, and *field* theories on the other. Any naming in this way does some violence to the individual theories, but nevertheless the typical American theories of functionalism, connectionism, and behaviorism have a common underlying logic which permits them to be grouped together, and the other theories, stemming chiefly from gestalt psychology, have in turn a contrasting common ground. The theories here classified as association theories have been labelled *reflex arc* theories [5] and *stimulus-response* theories.[6] The field theories group together various varieties of *gestalt*, *neo-gestalt*, *organismic*, or *sign-significate* theories.

The distinctions between the families are not always sharp, and there are agreements and disagreements which cut across lines. That is, on some specific issues it would be possible to find association psychologists on opposite sides of the fence, paralleled by field psychologists divided on the same issue. But the total picture does not present such confusion. Although association psychologists do not comprise a single harmonious family, still any one adherent to that position tends to offer explanations more like those of another than like the explanations of any one

[5] Tolman (1934).
[6] Spence (1942*b*).

in the field group. Correspondingly, the members of the field psychology family have in common their opposition to associationist conceptions. It is important to understand this basic cleavage, because there are profound differences in outlook, despite efforts of eclectics and mediators to harmonize the opposing camps.

The differences in systematic outlook may be summarized around five issues: environmentalism-nativism, the part-whole problem, emphasis upon reaction or cognition, the selected physical model, and the problem of historical versus contemporary explanation. These are differences not confined to learning theory, but they lie behind some of the cleavages reflected in learning theory. At the outset it should be stressed that the differences are matters of preference in the interpretation of a much wider range of data than those of learning. They are preferences in the interpretation of natural phenomena in general. Again, it is not that one of the contrasting preferences is exclusively right and the other exclusively wrong. Rather, each group believes that its point of view is scientifically the more fruitful.

1. *Environmentalism versus nativism.* The organism is born with sense organs, muscles and glands, and integrating structures. How its muscles and bones and sense organs and nervous elements function is closely related to their structure. But how they function is rapidly modified by learning. Because the evidence is often somewhat ambiguous, there is room for two interpretations of behavior, one which leans toward natural endowment as explanatory of behavior possibilities, and the other which attributes behavioral outcomes largely to learning.

The preference of associationists past and present has always been for environmentalism, that is, for attributing as much as possible to learning. In the field of perception, for example, the associationist makes much of Stratton's (1896) experiment in which, with experience, he became accustomed to the world as viewed through reversing lenses. The topsy-turvy world came to look all right and to provide cues for ready action. Hence the time-honored question as to how we could see the world right-side up when it is upside down on our retinas is solved by saying that we learn to use what visual cues we have to order our experiences of external reality. Gestalt psychologists (who may be

taken as representative of field psychologists for this comparison) have a preference for nativism, in the sense that they account for the interaction of organism and environment largely in terms of the way in which the organism is made. In perception, for example, it is argued that seen motion, third dimension, and other such features attributed by associationists to learning are instead functions of contemporary arrangements, independent of prior experience.[7]

It would be false to carry this distinction to extremes, for associations do not usually accept the extreme environmentalism of a Watson (1925), nor do field psychologists go along with instinct psychologies like McDougall's (1923). However, the preferences are found to hold in intermediate and ambiguous cases, when associationists give "the benefit of the doubt" to learning, gestalt psychologists to the nature of the organism as it interacts dynamically with the environment. These preferences are sufficiently strong to show themselves repeatedly in the controversial writings between association and gestalt psychologists.

2. *The nature of wholes and of parts.* Parts may be thought of as the substances out of which wholes are made. Houses are made of bricks and wood and plaster (or their modern equivalents in glass, metal, and plastics). The whole is composed of all its parts so conceived—no more, no less. Alternatively, a whole may be thought of as a unique pattern or organization of the parts, in which case the whole has properties beyond those of its parts, or is "more" than its parts. Thus a house has an architectural unity which is "more" than the materials of which it is composed. These alternatives—considering wholes according to their composition or according to their organization—represent a second difference in preference between association and field theories.

Association theories tend to consider wholes in terms of their composition. Complex habits are combinations of simpler habits. Complicated skills involve many "bonds" or "conditioned responses." Habit tendencies interact algebraically, so that several tendencies acting at once lead to greater or less vigor of response, depending upon the strengths and the signs of the tendencies. (Some tendencies have negative signs relative to others, that is,

[7] Koffka (1930).