THE PSYCHOLOGY OF LEARNING

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PREFACE

In so far as a writer can account for his own opinions and prejudices this essay on learning is a natural development of the views expressed in a book, *General Psychology in Terms of Behavior*, which was written in collaboration with Stevenson Smith and published some thirteen years ago. Although Smith has had no direct part in the writing of the present book a history of some twenty years of argument with him over the lunch table makes the determination of responsibility for much of what is here offered quite impossible.

Like the earlier book, this essay is written in terms of behavior. My prejudice in favor of a behavioristic attack on the problems of psychology dates from the Christmas vacation of 1910 in which I heard Professor E. A. Singer deliver an address at Princeton on "Mind as an Observable Object." That address remains the most stirring event of my academic life. Singer's contention that a relatively objective method could be applied to the scientific treatment of mind revived an interest in psychology that was waning as the result of an excursion into the field of psychophysics.

The notions described in the following pages are not new. Most of them have been familiar for a generation and some of them for centuries. Associative learning has

been recognized in some form or other by every writer on psychology since Aristotle. What has been here attempted is an exploration of the field of learning to discover the nature of the phenomenon of association and the limits of its use in the explanation of learning.

Without a reading by Professor E. A. Esper and editorial comment full of "insight" by Professor Gardner Murphy many more faults would have been included than will now be made public.

Publishers who have very courteously given permission to quote from their publications include the Bureau of Publications of Teachers College, Columbia University, The Macmillan Company, Thomas Y. Crowell Company, Harcourt, Brace and Company, Liveright Publishing Corporation, Farrar and Rinehart, and the *Psychological Review* in which the chapter on Reward and Punishment appeared under the same title.

E. R. GUTHRIE

Seattle, July 27th, 1934

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Chapter 1

INTRODUCTION

PSYCHOLOGISTS nowhere depart farther from common sense than in their notion of the nature of minds. The man on the street acknowledges that minds are rather mysterious, but he is definitely sure that a mind is something that you either have or you haven't. Bricks haven't. He has, and knows that he has. Dogs also have minds. Angle-worms? Here he becomes a little doubtful. Angle-worms seem very definitely to resent indignities in a way that a brick does not. And their daily round of activity seems to have something of a plan and purpose behind it. A brick reacts to a kick by moving over, but there is a distinctly passive and helpless air about the brick's behavior. And the brick is so dependable; it does regularly the expected thing when it is disturbed. If it behaves differently on a second occasion we can find the occasion for the difference. It is a different brick. If it did not fall apart at one blow of the hammer, but now does fall apart when struck the second time with the same force we take for granted that the first blow cracked it. If a bridge timber gives way after years of use under a load that it has held up to the present moment, we assume that it is a different timber; dry rot has invaded it or past stresses have cracked it.

But do angle-worms have minds? Are growth and reproduction and defensive reaction enough to qualify the worm for that distinction? Plants also grow and multiply and defend themselves not only by their structures but in many cases by movement. Common sense is inclined to deny that plants have minds, for this is an opinion shared only by a very few detached sentimentalists.

What is it then that plants lack that is to be found in creatures which common sense endows with minds? Strangely enough, common sense will be found to offer a very good answer to this question. Growth and reproduction and defense reactions are life, but they are not mind. Mind is these and something more; it is growth and reproduction and reactions serving these ends plus something that common sense might call profiting by experience. The answer to the question of the angle-worm's status will be determined by the answer to the question: Does the worm respond always the same way to the same combination of circumstances, or does the worm alter its response as a result of its past experience?

Of course, a full worm and an empty worm respond differently to the world. This is not what is meant by profiting by experience. The altered behavior here is like the altered behavior of the bridge timber; it can be referred to differences in the present circumstances. The difference can be examined and the response understood on the basis of what is now the condition of the worm.

Now it happens that a psychologist has established

that worms can profit by experience. Yerkes placed earth-worms in a T-shaped maze and found that if a slight electric shock was always administered when the worm turned, say, to the left, ultimately the worm was in some fashion changed so that it more or less regularly turned to the right and avoided the shock.

The difference between a worm that has received this Harvard laboratory training and a worm that has not is a difference that can not be discovered by examining the worm. The training leaves no observable changes. All psychologists believe that differences accounting for the altered behavior exist in the worm's "brain," but it is doubtful whether we shall ever be able to examine these brain differences either during the life time of the organism or at a post-mortem. Such traits as an acquired liking for mince pie, or skill at chess, or an ambition to travel, which are all modifications of behavior like the right-turning habit of the earth-worm, are not by any present technique possible of demonstration at an autopsy. We may speculate concerning the nature of the brain changes that lie behind these habits, but that speculation will throw no light on the nature of the habits.

We shall call these changes in behavior which follow behavior learning. 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." Another use, the theological or mythological notion of mind as a substance, as a mysterious hidden cause of ac-

tion, we may dismiss at once. Our interest is scientific, and we are dealing only with observable features of the world about us. Mind must be for us a mode of behavior, namely, that behavior which changes with use or practice, behavior, in other words, which exhibits learning.

Learning, as so defined, does not include all changes in behavior tendencies. Fatigue is, for instance, a change in behavior, but it is referred not to action primarily as its occasion but to altered chemical states in muscle and in the blood stream. There are other changes in behavior tendencies which might be included in the term "learning" if we were so inclined. When continuous pressure is exerted on a touch receptor, Adrian has recorded instances in which the receptor responds only for a brief period. Impulses from the sense organ are demonstrable in the sensory nerve only for a few seconds, though the pressure on the sense organ is continued. This is a change in behavior tendency, since the organism will no longer respond, though the stimulus continues; but this is a very temporary change and from it there is a quick recovery. Humphrey, in his interesting recent treatise on learning (1933), advocates using that term to include such temporary changes in behavior as fatigue and sense organ adaptation. I prefer to reserve the word "learning" for the more lasting effects of practice. Later in this book reasons will be offered for the belief that learning is normally permanent except in so far as it is in its turn altered by new learning. Transient changes like fatigue and sense organ adaptation disappear after brief intervals through physiological processes.

The definition of learning in terms of the lasting effects of practice is not a definition on which all psychologists would agree. There are other common meanings of the word. Common sense and many psychologists have used "learning" to refer only to those changes which contribute to the accomplishment of some end or purpose. In this sense learning always means learning to do something, learning to write, learning to skate, learning, in short, which results in an ability or a skill or a capacity for some achievement. This identification of learning with the attainment of a good result is all very well for common sense, but for a scientific understanding of human behavior it will not serve. And the reason that it will not serve is that in the same manner and in the same ways that human beings acquire skills and capacities they also acquire faults and awkwardnesses and even lose capacities which they once possessed. Since virtues and skills are acquired in the same way that faults and awkwardnesses are acquired, it seems unreasonable to limit the meaning of the word learning to achievement. It is true that the changes referred to as "learning" do generally turn out to be beneficial, that they are in the long run adaptive, and this must be looked into; but we have deserted the methods of empirical science if we assume that all learning is good, that every action has its goal. There are psychologists who believe this, not only of their own actions but of all the actions of all animals. The hen lays her egg, not because it has reached an embarrassing size, but because the species must be preserved. She is

aiming at motherhood and carrying a torch for her species, and not just laying an egg.

In this present account it will not be assumed that all learning is a progress toward betterment. Learning will be understood as change rather than as improvement. Our task is to understand the circumstances under which learning takes place and the nature of the changes that it involves. Our method should be to survey the experimental work on learning and to review what is common knowledge of learning and to try to discover any generalizations that can be made from our survey. Can we find any rule or uniformity in the phenomena? Can we describe any circumstances which regularly have a certain kind of outcome? Does the animal which has had one kind of history afterward tend to do certain things? *Under what circumstances do the specific changes in behavior we call learning take place?*

If we find such rules, they will not only be an adequate theory of learning; they will also direct the practical advice we give to persons who are guiding learning. Our rules, to be good theory, must be based on observation and verified by observation. This is one requirement. Another is that they shall be as concise and clear as we can make them. Our antecedent circumstances must be so clearly described that other persons can from our description recognize instances of what we describe; and this must also be true of our alleged consequences. If our descriptions are vague or ambiguous our rules can not be verified; nor can they be used for the anticipation and control of behavior. These are the

important requirements for psychological theory, and we may note that these would be the most important requirements for practical advice.

If we can find, on examining our common knowledge and the experimental work on learning, that certain describable, observable, and recognizable antecedent conditions enable us to predict certain describable, observable, and recognizable changes in behavior, we shall have discovered laws of learning. These laws will constitute our explanations of learning, for all scientific explanations are nothing more than generalized laws or rules which cover the event needing explanation.

The search for these laws has certain inherent difficulties. The first of these difficulties has to do with language. Putting events into words is never entirely satisfactory. Here are pupils in a class-room. The teacher gives them a spoken direction. How are we to describe this as a stimulus to the pupils? No two pupils see the teacher from the same angle or hear her voice from the same distance. No two pupils move their eyes alike, consequently no two have the same retinal activity. The optical properties of different eyes differ. What the pupils hear and what they see depends on the form of their present attention and on their previous experiences, which are various. We are forced to speak of the voice of the teacher as a stimulus, but we are forced to speak vaguely. We can never be sure that the stimulus of the voice does not affect different pupils in essentially different ways.

Reactions are just as hard to describe and name. Popu-

lar names for most acts are names for end results which may be accomplished in an indefinite variety of ways. Accepting an invitation, going to market, attending a dinner, playing a tune, catching a fish, all name acts, but the acts they name are left indefinite. It is only because the acts we name have a rough practical equivalence that we are able to undertake their prediction. Under these handicaps our forecasts of action are bound to be inaccurate and we must be resigned to finding exceptions to all our rules. We shall be dealing with tendencies and not with certainties.

A second difficulty in codifying the laws of learning has been introduced by psychologists themselves. Experimenters in the field of learning have failed to make clear to the public or to themselves that two fundamentally different kinds of research have been in progress. Some psychologists and physiologists have been interested in the prediction of movement or glandular secretion without any reference to the utility of the movement or to its consequences. Pavlov, for instance, is interested in discovering the circumstances under which a dog will secrete saliva in response to stimuli which were previously ineffective. The ability to secrete saliva at the sound of a bell or at a touch on the flank is of no use to the dog after the experiment, though similar conditioning in natural conditions may be useful. Pavlov is interested in the phenomenon of conditioning, not in its utility. Tolman, on the other hand, records the fact that the rat in the maze reaches food, its goal, and is not concerned about the movements by which the goal is

reached. The psychologist whose interest is in the goal-reaching capacities of animals will make goal-attainment the entry in the record, and not the means used, which may be varied. One experimenter like Pavlov is interested in the process; other experimenters are interested in the results. It is to be expected that the two types of workers will discover very different laws of learning. The conditions under which goals are reached are not at all the conditions under which habits are stereotyped. A day-old chick will peck at grains and capture a certain percentage of them. Its percentage of success increases rapidly with practice, but if the chick formed a stereotyped habit of pecking in one direction and with a fixed reach it would retrieve very few grains.

The differences in the results announced by different psychologists arise from differences in the modes of behavior that they are intent on predicting. Their findings are not contradictory. Empirical studies, if they are honest, can not be contradictory. Pavlov's question, under what circumstances can a stimulus not previously the occasion of a response become a substitute cue for that response will have one answer, while the question, under what circumstances will a man or a dog acquire a certain skill or ability will have another. It is, of course, this second question that has the more practical interest. To it the later chapters of this book will be devoted.

Two sources of difficulty in the formulation of laws of learning have been mentioned, the difficulty of fitting language to the description of the confused and intricate flow of behavior, and the failure of experimenters to

record the same features of behavior. There is a third difficulty. We can not record or control all the conditions under which our experiments are made, or record all the details of any sample of behavior. The physicist is less embarrassed by this obstacle. He does not concern himself about the recent night-life or the childhood experiences of the bit of metal whose density he is determining, whereas such items of history may lead to very bizarre results in the psychological laboratory. Even with this advantage we find that the physicist tends to flee from reality into a dream world of "ideal" gases and liquids, because these are the only ones that will obey the laws of physics. Boyle's law that in a gas with temperature held constant the product of pressure and volume is a constant is not true of any real gas. And when the physicist turns engineer and undertakes to predict the behavior of actual things in a real world, he protects himself with safety factors of 600 to 1000 per cent to allow for any shortcomings in his predictions.

The psychologist must resign himself to the fact that no psychological event is ever really repeated. The second repetition of a stimulus is only roughly and for practical purposes equivalent to the first; his laboratory subject is only substantially or approximately the same person who sat in the chair the day before. Since that time he has slept, eaten a little, learned a little, and this will alter his response no matter what precautions have been taken to have conditions the same. No two responses are alike. Two trips through a maze, two conditioned salivary reflexes may be substantially the same,

but they are always the same with a difference. As a result of this indescribable complexity of events we are limited to prediction with a high degree of error. We can attach only probabilities to expected events and the probabilities may be very slight. Our comfort lies in the fact that even slight probabilities in the expectation of human conduct may be better than complete ignorance.

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Chapter II

PSYCHOLOGICAL EXPLANATIONS

PROFESSIONAL explainers regularly forget that there are two parties involved in an explanation, the one who offers the explanation and the one at whom it is directed. An explanation that does not make clear the event to the person seeking information is no explanation at all. It is not the explainer who must be satisfied but the listener.

There are now current several kinds of psychological explanations of human and animal behavior which all satisfy their inventors, but the rest of us are left in some confusion. There are no true explanations and false explanations, but only successful and unsuccessful explanations, acceptable explanations (acceptable to us, the hearers) and unacceptable explanations. If we believe in fairies, events can be explained to us as the actions of fairies. The explanation will be unscientific only because the scientific tradition is not acquainted with fairies and scientific men have discovered that they can get on well enough without recourse to spirit agents of just this sort.

An explanation of any event consists in stating the rule or generalization of which the event is an instance. Scientific explanations have placed upon them at the start a severe restriction. They are directed at the prediction