AN INTRODUCTION TO THEORIES OF LEARNING

SEVENTH EDITION

B. R. HERGENHAHN • MATTHEW H. OLSON

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for
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Preface

As in previous editions, the four main goals of this textbook are to define learning and to show how the learning process is studied (Chapters 1 and 2); to place learning theory in historical perspective (Chapter 3); and to present essential features of the major theories of learning with implications for educational practices (Chapters 4 through 15). We have attempted to retain the best features of earlier editions while making revisions that reflect current research and scholarship. The most significant revisions include the following:

- An introduction to theory and applications in *Behavioral Economics* (Chapter 5)
- New research in the Pavlovian tradition including *learned irrelevance* and *superconditioning* phenomena (Chapter 7)
- Exciting developments in the neurosciences with implications for the "active brain" approach in Gestalt psychology (Chapter 10)
- Albert Bandura's "Agentic Perspective" (Chapter 13)
- Contemporary re-thinking about reinforcement centers in the brain and their possible roles in addiction (Chapter 14)
- Exciting developments in neural plasticity (ability to form new connections and even generate new cells in adult brain) (Chapter 14)
- Introduction to William Timberlake's "Biological Behaviorism" (Chapter 15)
- New developments concerning prepared learning of phobias in humans (Chapter 15)
- Updated research and references throughout
- Chapter 16 (Implications for Education) was deleted and important educational implications were integrated within each theorist's chapter

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Part One

Introduction to Learning

CHAPTER 1

What Is Learning?

Learning is one of the most important topics in present-day psychology, yet it is an extremely difficult concept to define. The *American Heritage Dictionary* defines learning as follows: "To gain knowledge, comprehension, or mastery through experience or study." Most psychologists, however, would find this definition unacceptable because of the nebulous terms it contains, such as *knowledge, comprehension,* and *mastery.* Instead, the trend in recent years is to accept a definition of learning that refers to changes in observable behavior. One of the most popular of these definitions is the one suggested by Kimble (1961, p. 6), which defines learning *as a relatively permanent change in* **behavioral potentiality** *that occurs as a result of* **reinforced practice.** Although popular, this definition is far from universally accepted. Before reviewing sources of disagreement over Kimble's definition, let us look at it a bit more carefully.

First, learning is indexed by a change in *behavior;* in other words, the results of learning must always be translated into observable behavior. After learning, learners are capable of doing something that they could not do before learning took place. Second, this behavioral change is *relatively permanent;* that is, it is neither transitory nor fixed. Third, the change in behavior need not occur immediately

following the learning experience. Although there may be a *potential* to act differently, this potential to act may not be translated into behavior until a later time. Fourth, the change in behavior (or behavior potentiality) results from *experience* or practice. Fifth, the experience, or practice, must be reinforced; that is, only those responses that lead to reinforcement will be learned. Although the terms *reward* and *reinforcement* are often used synonymously, there are at least two reasons why they should not be. In Pavlov's work, for example, a reinforcer is defined as any unconditioned stimulus, that is, any stimulus that elicits a natural and automatic reaction from an organism. In Pavlovian research it is not uncommon for stimuli such as a mild acid solution or electric shock to be used as unconditioned stimuli. It is accurate to call such stimuli reinforcers, but they can hardly be considered rewards, if rewards are thought of as desirable. The Skinnerians also oppose equating the terms *reinforcer* and *reward*. For them, a reinforcer strengthens any behavior that immediately precedes the *reinforcer's* occurrence. In contrast, a reward is usually thought of as something that is given or received only for a worthy accomplishment that required a considerable investment of time and energy or for an act deemed desirable by society. Furthermore, because such desirable behavior typically occurs long before it is acknowledged by reward, reward cannot be said to strengthen it. For the Skinnerians, then, reinforcers strengthen behavior but rewards do not. Skinner (1986) elaborated on these points:

> The strengthening effect [of reinforcement] is missed ... when reinforcers are called *rewards*. People are rewarded, but behavior is reinforced. If, as you walk along the street, you look down and find some money, and if money is reinforcing, you will tend to look down again for some time, but we should not say that you were rewarded for looking down. As the history of the word shows, reward implies compensation, something that offsets a sacrifice or loss, if only the expenditure of effort. We give heroes medals, students degrees, and famous people prizes, but those rewards are not directly contingent on what they have done, and it is generally felt that rewards would not be deserved if they had not been worked for. (p. 569)

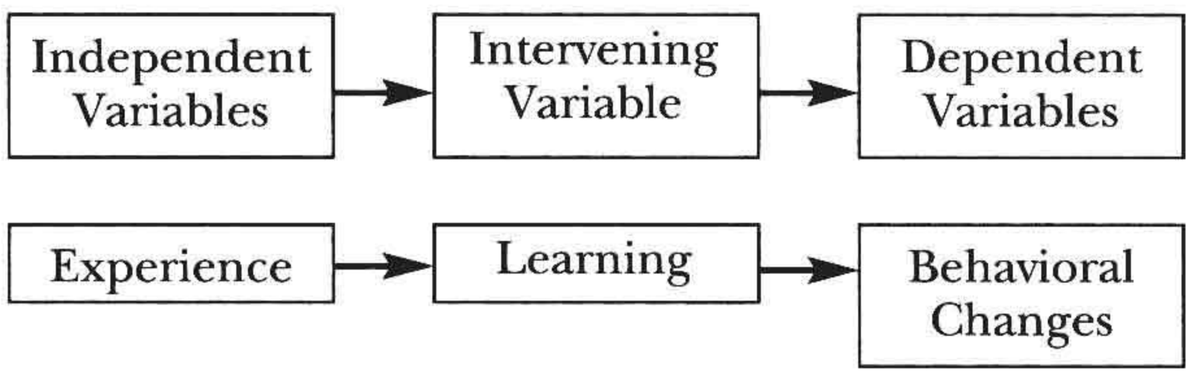
In this text we acknowledge the above concerns and do not equate the terms *reward* and *reinforcement*. Except where the term *reward* is appropriate as it is defined in Skinner's remarks in the preceding quotation, the terms *reinforcer* or *reinforcement* are used exclusively. Kimble's (1961) definition of learning provides a convenient frame of reference for discussing a number of important issues that must be confronted when attempting to define learning. We review these issues in the following sections of this chapter.

MUST LEARNING RESULT IN A BEHAVIORAL CHANGE?

As we see in Chapter 3, psychology has become a *behavioral* science for good reason. A science requires an observable, measurable subject matter, and in the science of psychology, that subject matter is behavior. Thus, whatever we study in psychology must be expressed through behavior, but this does not mean that the

behavior we are studying *is* learning. We study behavior so that we can make *inferences* concerning the process believed to be the cause of the behavioral changes we are observing. In this case, that process is learning. Most learning theorists covered in this text agree that the learning process cannot be studied directly; instead, its nature can only be inferred from changes in behavior. B. F. Skinner was the only theorist who took exception to this contention. For Skinner, behavioral changes are learning and no further process needs to be inferred. Other theorists say that behavioral changes result from learning. We have more to say about Skinner's antitheoretical point of view in Chapter 5.

Except for the Skinnerians, then, most learning theorists look on learning as a process that mediates behavior. For them, learning is something that occurs as the result of certain experiences and precedes changes in behavior. In such a definition, learning is given the status of an intervening variable. An intervening variable is a theoretical process that is assumed to take place between the observed stimuli and responses. Independent variables cause a change in the intervening variable (learning), which in turn causes a change in the dependent variable (behavior). The situation can be diagrammed as follows:



How Permanent Is Relatively Permanent?

Here we run into at least two problems. First, how long must a behavior change last before we say that learning has been demonstrated? This aspect was originally inserted into the definition to differentiate between learning and other events that may modify behavior, such as fatigue, illness, maturation, and drugs. Clearly, these events and their effects may come and go rapidly, whereas learning lingers until forgetting takes place over time or until new learning displaces old learning. Thus temporary states as well as learning modify behavior, but with learning the modification is relatively more permanent. However, the duration of the modification that results from either learning or temporary body states cannot be specified exactly.

A related problem is more serious. A number of psychologists have turned their attention to a phenomenon called **short-term memory** (see Chapter 14). They have found that if unfamiliar information, such as a nonsense syllable, is presented to human research participants who are prevented from rehearsing the information, they will retain the material almost perfectly for about three seconds. In the following fifteen seconds, however, their retention drops to almost zero (Murdock, 1961; Peterson & Peterson, 1959). Despite the fact that the information is lost over such a short period of time, we would hesitate to say that no learning occurred.

Accepting the qualification of "relatively permanent" in a definition of learning will also determine whether the processes of **sensitization** and **habituation** (see Chapter 14) are accepted as crude examples of learning. Sensitization is the process whereby an organism is made more responsive to certain aspects of its environment. For example, an organism that may not ordinarily respond to a certain light or sound may do so after receiving a shock. The shock, therefore, sensitized the organism, making it more responsive to its environment. Feeling "touchy" or hypersensitive following an upsetting experience is a form of sensitization with which we are all familiar.

Habituation is the process whereby an organism becomes less responsive to its environment. For example, there is a tendency for an organism to attend to novel stimuli as they occur in its environment. This tendency is referred to as the orienting reflex, and it is exemplified when a dog turns in the direction of a sound that suddenly occurs. After attending to the sound, however, the dog will eventually ignore it (assuming that it poses no threat) and go about its business. We say, in this case, that the dog's response to the sound has habituated. Similarly, Sharpless and Jasper (1956) found that a tone, when first presented, will arouse a sleeping cat. With repeated presentations, however, the tone loses its ability to arouse the cat. Again, we say that habituation has occurred.

Learning and Performance

As previously mentioned, what is learned may not be utilized immediately. Athletes, for example, may learn how to play their positions by watching films and listening to lectures during the week, but they may not translate that learning into behavior until game time. In fact, some players may be prevented from actually performing for a prolonged period of time because of an injury or an illness. We say, therefore, that the potential to act differently resulted from learning, even though behavior was not immediately affected.

This type of observation has led to the very important distinction between **learning** and **performance,** which is considered in detail in Chapters 6, 12, 13, and 14. *Learning* refers to a change in behavior potentiality, and *performance* refers to the translation of this potentiality into behavior.

Why Do We Refer to Practice or Experience?

Obviously not all behavior is learned. Much simple behavior is reflexive. A **reflex** can be defined as an unlearned or innate response in reaction to a specific class of stimuli. Sneezing in response to a tickling in your nose, producing a sudden knee jerk when your knee is tapped sharply, or instantly withdrawing your hand when it touches a hot stove are examples of reflexive behavior. Clearly, reflexive behavior is unlearned; it is a genetically determined characteristic of the organism rather than a result of experience.

Complex behavior can also be innate. When complex behavior patterns are genetically determined, they are generally referred to as examples of **instinct.** Instinctive behavior includes such activities as nest building, migration, hibernation, and mating behavior. For a while psychologists explained complex behavior

patterns by referring to them as instincts. Thus, we said, birds and fish migrate because they possess a migration instinct; birds build nests because of a nest-building instinct. Because the term *instinctive* was offered as an *explanation* of behavior, we now tend to use the term *species-specific behavior* (Hinde & Tinbergen, 1958) because it is more descriptive. Species-specific behavior refers to complex, unlearned, and relatively unmodifiable behavior patterns engaged in by a certain species of animal under certain circumstances.

Controversy continues, however, over whether species-specific behavior is completely determined by the makeup of the organism or whether some learning is involved. Do birds fly instinctively, or do they learn to fly? Some say that the young bird learns to fly through trial and error while falling to the ground from a tree. Others say that the birds respond reflexively to falling by flapping their wings and therefore fly without learning to do so.

A few examples, however, seem to demonstrate complex behavior that is clearly not influenced by learning. For example, many species of the cuckoo bird lay their eggs in other birds' nests, and the young cuckoo is raised by its foster parents. Because each adult cuckoo behaves in this way regardless of the foster parents' species, it is very difficult to imagine how such behavior could be learned.

Another example of what appears to be unlearned behavior is the nut-burying behavior of squirrels. Even when an infant squirrel is raised in isolation from other squirrels and sees a nut for the first time, it attempts to bury it. This nut-burying pattern of behavior occurs even if the nut is presented to the squirrel on a bare wooden floor. The squirrel makes scratching motions on the floor as if to dig a hole, tamps the nut with its nose in an apparent effort to push the nut into the floor, and then makes covering movements with its paws (Brown, 1965). Other research supports the contention that some species-specific behavior is both learned and innate (Hess, 1958; Lorenz, 1952, 1965, 1970; Thorpe, 1963). Lorenz found, for example, that a newly hatched duckling would form an attachment to any kind of moving object and follow it as its mother, provided the object was presented at just the right moment in the duckling's life. Lorenz demonstrated attachments between ducklings and a wooden box on wheels, a human being, and a bird of a different species. The formation of an attachment between an organism and an environmental object is called **imprinting.** Imprinting was found to occur only during a **critical period,** after which it was difficult, if not impossible, to imprint the duckling on anything. With imprinting, we have a combination of learned and instinctive

Konrad Lorenz and a group of ducklings that have imprinted on him. (Thomas McAvoy/Time-Life Picture Agency/Time Life Syndication.)

behavior. It appears that the animal's genetic endowment causes it to be maximally sensitive to a moving object for a short period of time, during which it can learn the strong habit of following a specific object. If the learning does not occur during that interval, however, it may never occur. Furthermore, the strong habit of following an object does not seem to be built-up over time with practice. Rather, the habit seems to be learned at full strength in a single trial. We have more to say about one-trial learning in Chapters 8 and 9.

Studies about imprinting raise a number of questions. The kind of learning, if any, involved in species-specific behavior and to what extent it is involved must be determined by future research. The main point to emphasize, however, is that to attribute a behavioral change to learning, the change must be relatively permanent and must result from experience. If an organism engages in a complex behavior pattern independent of experience, that behavior cannot be referred to as learned behavior.

Does Learning Result from a Specific Kind of Experience?

According to Kimble's (1961) definition, learning results from reinforced practice. In other words, only reinforced behavior will be learned. On this point, there is widespread disagreement among learning theorists. Theorists disagree not only over what constitutes reinforcement but also over whether it is a necessary prerequisite for learning to take place. In a sense, this book is an attempt to review various interpretations of the nature and importance of reinforcement. This is a subject, therefore, to which we return often.

Gregory A. Kimble. (Courtesy of Gregory A. Kimble.)

A Modified Definition of Learning

It is now possible to revise Kimble's (1961) definition of learning so that it would be neutral on the matter of reinforcement, thereby making it more widely accepted: *Learning is a relatively permanent change in behavior or in behavioral potentiality that results from experience and cannot be attributed to* **temporary body states** *such as those induced by illness, fatigue, or drugs.*

Such a definition still stresses the importance of experience but leaves it to the theorist to specify the kind of experience the theorist feels is necessary for learning to take place, for example, reinforced practice, contiguity between a stimulus and a response, or the acquisition of information. It also reminds us that

experience can cause events other than learning that modify behavior. Fatigue is one such event.

ARE THERE DIFFERENT KINDS OF LEARNING?

Learning, as we have seen, is a general term that is used to describe changes in behavior potentiality resulting from experience. **Conditioning,** however, is a more specific term used to describe actual procedures that can modify behavior. Because there are two kinds of conditioning, **instrumental** and **classical,** many theorists conclude that there are at least two kinds of learning or that learning ultimately can be understood in terms of classical and instrumental conditioning. Although both conditioning procedures are discussed in detail later on in this book, we summarize both procedures briefly.

Classical Conditioning

We look at classical conditioning in detail when we discuss Pavlov's views on learning in Chapter 7, but for now we can summarize classical conditioning as follows:

1. A stimulus, such as food, is presented to an organism and will cause a natural and automatic reaction, such as salivating. The stimulus causing this natural reaction is called the unconditioned stimulus (US). In this case, the food was the US. The natural, automatic reaction to the US is called the unconditioned response (UR). In this case, salivation was the UR.
2. A neutral stimulus (one that does not cause a UR), such as a tone or light, is presented to the organism just prior to the presentation of the US. This neutral stimulus is called the conditioned stimulus (CS).
3. After the CS and US are paired a number of times, with the CS always preceding the US, the CS alone can be presented, and the organism will salivate. This salivating response, similar to the organism's response to the US, now occurs in response to the CS, the tone or the light. We now say that a conditioned response (CR) has been demonstrated. In classical conditioning, the US is called reinforcement because the entire conditioning procedure depends on it. Note, however, that in classical conditioning, the organism has no control over reinforcement: It occurs when the experimenter wants it to occur. In other words, in classical conditioning, reinforcement is not contingent on any overt response made by the organism.

Instrumental Conditioning

The relationship between reinforcement and the organism's behavior is distinctively different in instrumental conditioning. With instrumental conditioning, the organism must act in a certain way *before* it is reinforced; that is, reinforcement is contingent on the organism's behavior. If the animal does not emit the desired

behavior, it is not reinforced. Thus in instrumental conditioning, the animal's behavior is "instrumental" in getting it something it wants, that is, a reinforcer.

A small experimental test chamber called the **Skinner box** is often used to demonstrate instrumental conditioning (or a closely allied form of conditioning called operant conditioning). Such a box is a Plexiglas cage with a grid floor that can be electrified and a lever that, when pressed, activates a feeder mechanism that delivers food pellets to the animal inside. The experimenter introduces a hungry rat (for example) into the Skinner box. As the rat explores the enclosure, it will eventually activate the lever and receive a pellet of food. Soon the rat will associate lever pressing with the appearance of food, and its rate of lever pressing will increase. In this case, the rat must engage in lever pressing in order to get food. The lever pressing is the conditioned behavior; the food is the reinforcement. If the Skinner box is programmed so that when a hungry animal presses the lever it is given a pellet of food, the rate at which it presses the lever will increase.

Escape and avoidance conditioning are special kinds of instrumental conditioning. In **escape conditioning,** a rat is placed in the Skinner box and the electrified grid is activated. The animal must perform some response, such as jumping a small hurdle or climbing onto a small platform, to terminate the shock. The rat will associate the response with the termination of the shock. In this case the response is the conditioned behavior, and the termination of shock is the reinforcement.

To demonstrate **avoidance conditioning,** let the Skinner box grid be activated at intervals, with a signal, such as a light, set up to precede the onset of shock by, say, five seconds. The rat will soon learn to associate the light with the onset of shock, and it will perform its response in order to avoid the shock whenever it sees the light go on. In avoidance conditioning, the lab animal learns to respond quickly so that it no longer experiences the actual shock.

Learning theorists have become increasingly aware that confining themselves to research involved with just classical and instrumental conditioning leaves out vast areas of human experience. For example, Gagné (1970) feels it is more realistic to assume that there are eight kinds of learning. Gagné believes that the eight kinds of learning are arranged in a hierarchy, with one sort being a prerequisite for the next. Thus, for Gagné, simple conditioning simply provides the basis for the more advanced kinds of learning. As we see in Chapter 12, Tolman took a similar position much earlier. Although many theorists believe that complex behavior ultimately can be understood in terms of classical or instrumental conditioning, other influential theorists oppose that contention.

LEARNING AND SURVIVAL

Throughout our long evolutionary past, our bodies have developed the capacity to respond automatically to certain needs. For example, we breathe automatically, and if our body temperature becomes too high or too low, mechanisms are triggered that cause sweating, which cools the body, or shivering, which raises body temperature. Likewise, if blood sugar is too low, the liver secretes sugar into the blood until the concentration of blood sugar is restored to a normal level. These