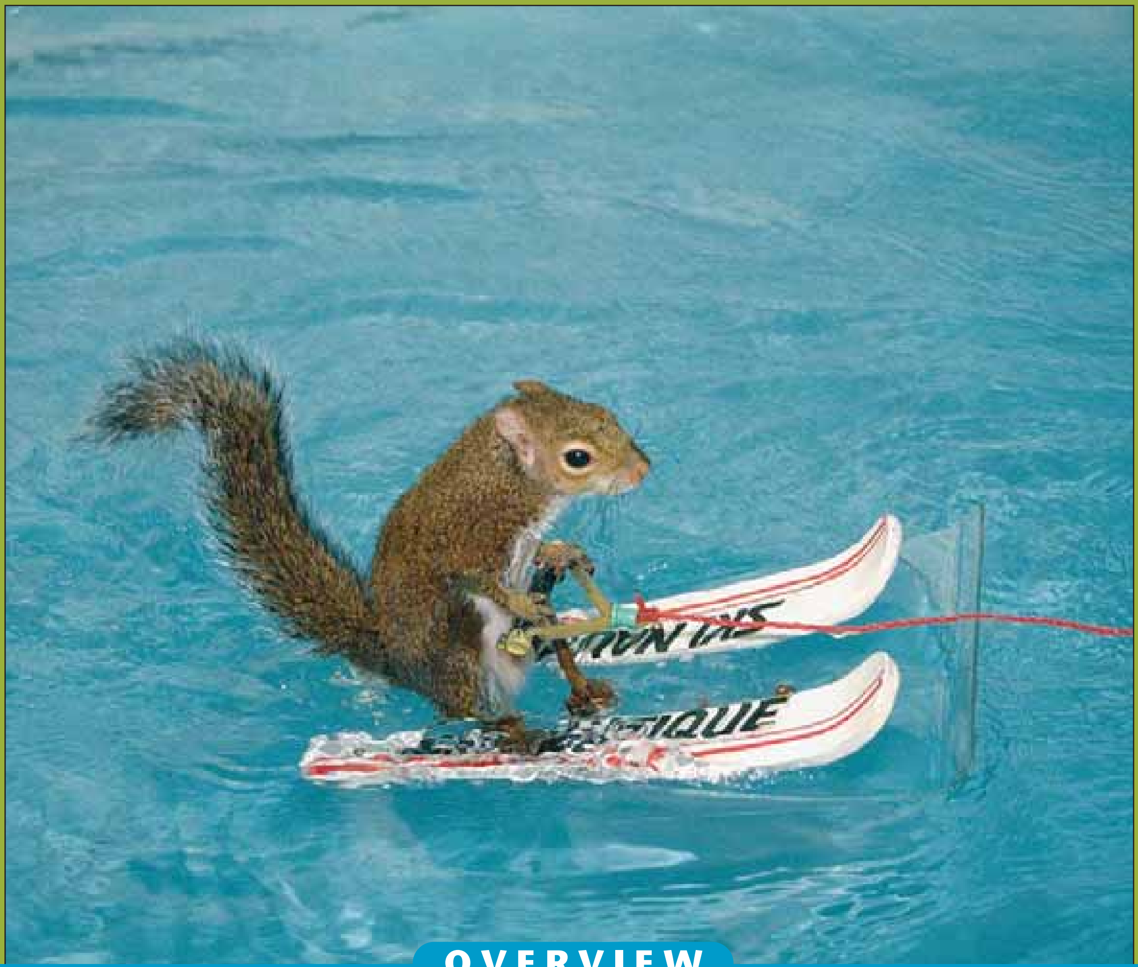
CHAPTER 5

Learning



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What do the following anecdotes have in common?

- In Mozambique, a giant pouched rat the size of a cat scurries across a field, pauses, sniffs the air, turns, sniffs again, and then begins to scratch at the ground with her forepaws. She has discovered yet another land mine buried a few inches underground. After a brief break for a bit of banana and a pat or two from her handler, she scurries off again to find more land mines.
- In the middle of a winter night, Adrian Cole—4 years old and three feet tall—put on his jacket and boots and drove his mother's car to a nearby video store. When he found the store closed, he drove back home. Since he was driving very slowly with the lights off and was also weaving a bit, he understandably attracted the attention of police officers who followed him. When he got home, he collided with two parked cars and then backed into the police cruiser! When the police asked him how he learned to drive, he explained that his mother would put him on her lap while she drove and he just watched what she did.
- "I just can't stand to eat shrimp. I don't like the smell of it, or the sight of it. Once when I young, I had some for dinner while vacationing at the beach and it made me sick for the rest of the week. Now just the thought of it disgusts me."

The common element in all these stories—and the topic of this chapter—is learning. Although most people associate learning with classrooms and studying for tests, psychologists define it more broadly. To them, **learning** occurs whenever experience or practice results in a relatively permanent change in behavior or in potential behavior. This definition includes all the examples previously mentioned, plus a great many more. When you remember how to park a car or where the library water fountain is, you are showing a tiny part of your enormous capacity for learning.

Human life would be impossible without learning; it is involved in virtually everything we do. You could not communicate with other people or recognize yourself as human if you were unable to learn. In this chapter, we explore several kinds of learning. One type is learning to associate one event with another. When pouched rats associate the smell of TNT and receiving food or when a person associates the sight or smell of a food with illness they are engaging in two forms of learning called *operant* and *classical conditioning*. Because psychologists have studied these forms of learning so extensively, much of this chapter is devoted to them. But making associations isn't all there is to human learning. Our learning also involves the formation of concepts, theories, ideas, and other mental abstractions. Psychologists call it *cognitive learning*, and we discuss it at the end of this chapter.

Our tour of learning begins in the laboratory of a Nobel Prize–winning Russian scientist at the turn of the 20th century. His name is Ivan Pavlov, and his work is helping to revolutionize the study of learning. He has discovered classical conditioning.

Enduring Issues in Learning

This chapter addresses how humans and other animals acquire new behaviors as a result of their experiences. Thus, it bears directly on the enduring issue of Stability versus Change (the extent to which organisms change over the course of their lives). The events that shape learning not only vary among different individuals (diversity–universality) but also are influenced by an organism's inborn characteristics (nature–nurture). Finally, some types of learning can affect our physical health by influencing how our body responds to disease (mind–body).

LEARNING OBJECTIVES

- **Define learning.**
- **Describe the elements of classical conditioning, distinguishing between unconditioned stimulus, unconditioned response, conditioned stimulus and conditioned response. Describe the process of establishing a classically conditioned response, including the effect of intermittent pairing.**
- **Provide examples of classical conditioning in humans, including desensitization therapy. Explain the statement that "classical conditioning is selective" and illustrate with examples of conditioned taste aversions.**

CLASSICAL CONDITIONING

How did Pavlov discover classical conditioning?

The Russian physiologist Ivan Pavlov (1849–1936) discovered **classical (or Pavlovian) conditioning**, a form of learning in which a response elicited by a stimulus becomes elicited by a previously neutral stimulus, almost by accident. He was studying digestion, which begins when saliva mixes with food in the mouth. While measuring how much saliva dogs produce when given food, he noticed that they began to salivate even before they tasted the food. The mere sight of food or the sound of his footsteps made them drool. This aroused Pavlov's curiosity. How had the dogs learned to salivate to sights and sounds?

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learning The process by which experience or practice results in a relatively permanent change in behavior or potential behavior.

classical (or Pavlovian) conditioning The type of learning in which a response naturally elicited by one stimulus comes to be elicited by a different, formerly neutral, stimulus.

unconditioned stimulus (US) A stimulus that invariably causes an organism to respond in a specific way.

unconditioned response (UR) A response that takes place in an organism whenever an unconditioned stimulus occurs.

conditioned stimulus (CS) An originally neutral stimulus that is paired with an unconditioned stimulus and eventually produces the desired response in an organism when presented alone.

conditioned response (CR) After conditioning, the response an organism produces when a conditioned stimulus is presented.

To answer this question, Pavlov sounded a bell just before presenting his dogs with food. A ringing bell does not usually make a dog's mouth water, but after hearing the bell many times right before getting fed, Pavlov's dogs began to salivate as soon as the bell rang. It was as if they had learned that the bell signaled the appearance of food; and their mouths watered on cue even if no food followed. The dogs had been *conditioned* to salivate in response to a new stimulus: the bell, which normally would not prompt salivation (Pavlov, 1927). **Figure 5–1** shows one of Pavlov's procedures in which the bell has been replaced by a touch to the dog's leg just before food is given.

Elements of Classical Conditioning

How might you classically condition a pet?

Figure 5–2 diagrams the four basic elements in classical conditioning: the unconditioned stimulus, the unconditioned response, the conditioned stimulus, and the conditioned response. The **unconditioned stimulus (US)** is an event that automatically elicits a certain reflex reaction, which is the **unconditioned response (UR)**. In Pavlov's studies, food in the mouth was the unconditioned stimulus, and salivation to it was the unconditioned response. The third element in classical conditioning, the **conditioned stimulus (CS)**, is an event that is repeatedly paired with the unconditioned stimulus. For a conditioned stimulus, Pavlov often used a bell. At first, the conditioned stimulus does not elicit the desired response. But eventually, after repeatedly being paired with the unconditioned stimulus, the conditioned stimulus alone comes to trigger a reaction similar to the unconditioned response. This learned reaction is the **conditioned response (CR)**.

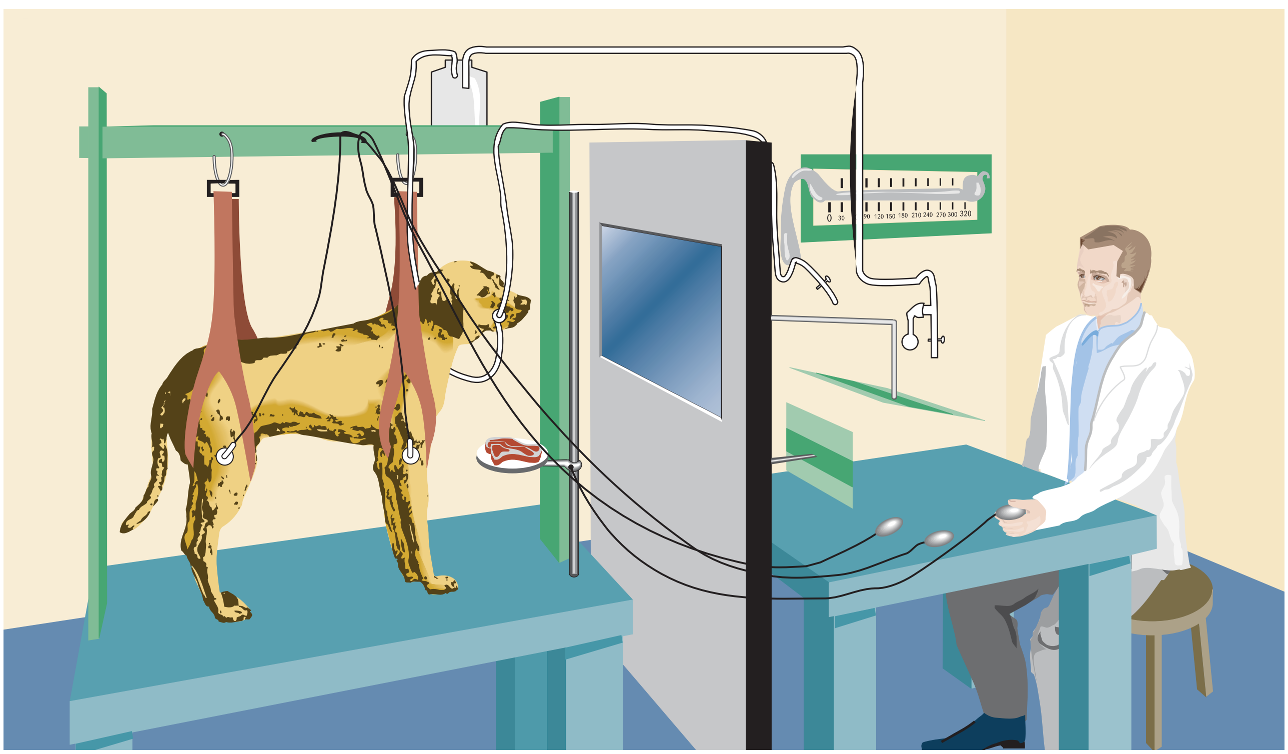

Figure 5–1
Pavlov's apparatus for classically conditioning a dog to salivate.
The experimenter sits behind a one-way mirror and controls the presentation of the conditioned stimulus (touch applied to the leg) and the unconditioned stimulus (food). A tube runs from the dog's salivary glands to a vial, where the drops of saliva are collected as a way of measuring the strength of the dog's response.

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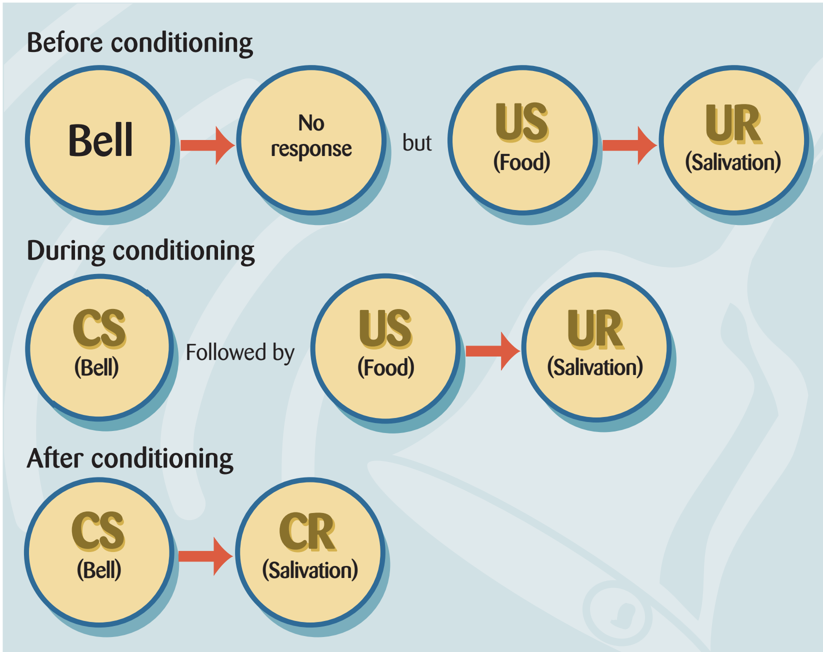


Figure 5–2
A model of the classical conditioning process.

Classical conditioning has been demonstrated in virtually every animal species, even cockroaches, bees, and sheep (Abramson & Aquino, 2002; Johnson, Stanton, Goodlett, & Cudd, 2008; Krasne & Glanzman, 1995; Watanabe, Kobayashi, Sakura, Matsumoto, & Mizunami, 2003; Watanabe & Mizunami, 2006). You yourself may have inadvertently classically conditioned one of your pets. For instance, you may have noticed that your cat begins to purr when it hears the sound of the electric can opener running. For a cat, the taste and smell of food are unconditioned stimuli for a purring response. By repeatedly pairing the can opener whirring with the delivery of food, you have turned this sound into a conditioned stimulus that triggers a conditioned response.

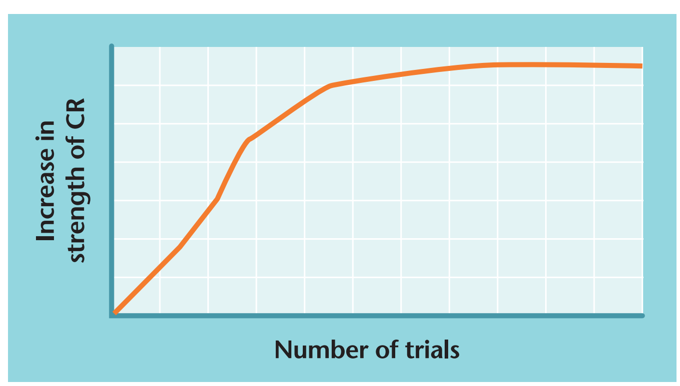
Establishing a Classically Conditioned Response

If you once burned your finger on a match while listening to a certain song, why doesn't that song now make you reflexively jerk your hand away?

As shown in **Figure 5–3**, it generally takes repeated pairings of an unconditioned stimulus and a cue before the unconditioned response eventually becomes a conditioned response. The likelihood or strength of the conditioned response increases each time these two stimuli are paired. This learning, however, eventually reaches a point of diminishing returns. The amount of each increase gradually becomes smaller, until finally no further learning occurs. The conditioned response is now fully established.

It is fortunate that repeated pairings are usually needed for classical conditioning to take place (Barry Schwartz, 1989). There are always a lot of environmental stimuli present whenever an unconditioned stimulus triggers an unconditioned response. If conditioning occurred on the basis of single pairings, all these usually irrelevant stimuli would generate some type of CR. Soon we would be overwhelmed by learned associations. Because a number of pairings are usually needed to produce a conditioned response, only a cue consistently related to the unconditioned stimulus typically becomes a conditioned stimulus.

Figure 5–3
Response acquisition.
At first, each pairing of the US and CS increases the strength of the response. After a number of trials, learning begins to level off; and eventually it reaches a point of diminishing returns.



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intermittent pairing Pairing the conditioned stimulus and the unconditioned stimulus on only a portion of the learning trials.

desensitization therapy A conditioning technique designed to gradually reduce anxiety about a particular object or situation.

The spacing of pairings is also important in establishing a classically conditioned response. If pairings of the CS and US follow each other very rapidly, or if they are very far apart, learning the association is slower. If the spacing of pairings is moderate—neither too far apart nor too close together—learning occurs more quickly. It is also important that the CS and US rarely, if ever, occur alone. Pairing the CS and US only once in a while, called **intermittent pairing**, reduces both the rate of learning and the final strength of the learned response.

Classical Conditioning in Humans

What is an example of classical conditioning in your own life?

Classical conditioning is as common in humans as it is in other animals. For example, some people learn phobias through classical conditioning. *Phobias* are intense, irrational fears of particular things or situations, such as spiders or flying. In Chapter 1, we discussed the study in which John Watson and his assistant, Rosalie Rayner, used classical conditioning to instill a phobia of white rats in a 1-year-old baby named Little Albert (J. B. Watson & Rayner, 1920). They started by pairing a loud noise (an unconditioned stimulus) with the sight of a rat. After a few pairings of the rat and the frightening noise, Albert would cry in fear at the sight of the rat alone.

Several years later, psychologist Mary Cover Jones demonstrated a way that fears can be unlearned by means of classical conditioning (M. C. Jones, 1924). Her subject was a 3-year-old boy named Peter who, like Albert, had a fear of white rats. Jones paired the sight of a rat with an intrinsically pleasant experience—eating candy. While Peter sat alone in a room, a caged white rat was brought in and placed far enough away so that the boy would not be frightened. At this point, Peter was given candy to eat. On each successive day, the cage was moved closer, after which, Peter was given candy. Eventually, he showed no fear of the rat, even without any candy. By being repeatedly paired with a stimulus that evoked a pleasant emotional response, the rat had become a conditioned stimulus for pleasure.

Desensitization therapy is based on the belief that we can overcome fears by learning to remain calm in the face of increasingly fear-arousing situations. Here people being desensitized to a fear of heights are able to swing high above the ground without panicking.

In more recent times, psychiatrist Joseph Wolpe (1915–1997) adapted Jones's method to the treatment of certain kinds of anxiety (Wolpe, 1973, 1990). Wolpe reasoned that because irrational fears are learned (conditioned), they could also be unlearned through conditioning. He noted that it is not possible to be both fearful and relaxed at the same time. Therefore, if people could be taught to relax in fearful or anxious situations, their anxiety should disappear. Wolpe's **desensitization therapy** begins by teaching a system of deep-muscle relaxation. Then the person constructs a list of situations that prompt various degrees of fear or anxiety, from intensely frightening to only mildly so. A person with a fear of heights, for example, might construct a list that begins with standing on the edge of the Grand Canyon and ends with climbing two rungs on a ladder. While deeply relaxed, the person imagines the least distressing situation on the list first. If he or she succeeds in remaining relaxed, the person proceeds to the next item on the list, and so on until no anxiety is felt. In this way, classical conditioning is used to change an undesired reaction: A fear-arousing thought is repeatedly paired with a muscular state that produces calmness until eventually the formerly fearful thought no longer triggers anxiety. Desensitization therapy has been used successfully to treat a variety of disorders such as phobias and post-traumatic stress disorder (Morris, Kratochwill, Schoenfield, & Auster, 2008; S. M. Silver, Rogers, & Russell, 2008). More recently, desensitization therapy has taken on a new form using *virtual reality simulation*. For instance, a person with a fear of flying may learn to relax while in a flight simulator rather than actually aboard an airplane. Therapy using virtual reality desensitization is still in its infancy, but the early results are promising (Parsons & Rizzo, 2008).

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preparedness A biological readiness to learn certain associations because of their survival advantages.

conditioned taste aversion Conditioned avoidance of certain foods even if there is only one pairing of conditioned and unconditioned stimuli.

ENDURING ISSUES

Mind–Body Classical Conditioning and the Immune System

In another example of classical conditioning in humans, researchers have devised a novel way to treat autoimmune disorders, which cause the immune system to attack healthy organs or tissues. Although powerful drugs can be used to suppress the immune system and thus reduce the impact of the autoimmune disorder, these drugs often have dangerous side effects, so they must be administered sparingly. The challenge, then, was to find a treatment that could suppress the immune system without damaging vital organs. Researchers discovered that they could use formerly neutral stimuli either to increase or to suppress the activity of the immune system (Hollis, 1997; Markovic, Dimitrijevic, & Jankovic, 1993). Here's how it works: As US, the researchers use immune-suppressing drugs and pair them with a specific CS, such as a distinctive smell or taste. After only a few pairings of the drug (US) with the smell or taste (CS), the CS alone suppresses the immune system (the CR) without any dangerous side effects! In this case, classical conditioning works on the mind but ultimately affects the body. While the use of classical conditioning to treat autoimmune disorders shows promise, additional research is still necessary to validate its effectiveness and evaluate its potential application as a therapy to treat these disorders (Bovbjerg, 2003; Gregory Miller & Cohen, 2001). ■

Classical Conditioning Is Selective

Why are people more likely to develop a phobia of snakes than of flowers?

If people can develop phobias through classical conditioning, why don't we acquire phobias of virtually everything that is paired with harm? For example, many people get shocks from electric sockets, but almost no one develops a socket phobia. Why should this be the case?

Psychologist Martin Seligman (1971) has offered an answer: The key, he says, lies in the concept of **preparedness**. Some things readily become conditioned stimuli for fear responses because we are biologically prepared to learn those associations. Among the common objects of phobias are heights, snakes, and the dark. In our evolutionary past, fear of these potential dangers probably offered a survival advantage, and so a readiness to form such fears may have become "wired into" our species.

Preparedness also underlies **conditioned taste aversion**, a learned association between the taste of a certain food and a feeling of nausea and revulsion. Conditioned taste aversions are acquired very quickly. It usually takes only one pairing of a distinctive flavor and subsequent illness to develop a learned aversion to the taste of that food. Readily learning connections between distinctive flavors and illness has clear benefits. If we can quickly learn which foods are poisonous and avoid those foods in the future, we greatly increase our chances of survival. Other animals with a well-developed sense of taste, such as rats and mice, also readily develop conditioned taste aversions, just as humans do (Chester, Lumeng, Li, & Grahame, 2003; Guitton, Klin, & Dudai, 2008).

A bird's nervous system is adapted to remember sight–illness combinations, such as the distinctive color of a certain berry and subsequent food poisoning. In mammals, by contrast, taste–illness combinations are quickly and powerfully learned.

ENDURING ISSUES

Nature–Nurture The Evolutionary Basis of Fear

To what extent does our evolutionary heritage condition our fears; and to what extent are fears the result of our experiences? Recent studies suggest that the two work in tandem (Mineka & Oehman, 2002). For example, some stimuli unrelated to human survival through evolution, but which we have learned to associate with danger, can serve as CSs for

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Seligman's theory of preparedness argues that we are biologically prepared to associate certain stimuli, such as heights, the dark, and snakes, with fear responses. In our evolutionary past, fear of these potential dangers probably offered a survival advantage.

fear responses. Pictures of handguns and butcher knives, for example, are as effective as pictures of snakes and spiders in conditioning fear in some people (Lovibond, Siddle, & Bond, 1993). These studies suggest that preparedness may be the result of learning rather than evolution. Other studies have shown that people who do not suffer from phobias can rather quickly unlearn fear responses to spiders and snakes if those stimuli appear repeatedly without painful or threatening USs (Honeybourne, Matchett, & Davey, 1993). Thus, even if humans are prepared to fear these things, that fear can be overcome through conditioning. In other words, our evolutionary history and our personal learning histories interact to increase or decrease the likelihood that certain kinds of conditioning will occur. ■

CHECK YOUR UNDERSTANDING

1. The simplest type of learning is called ____________ ____________. It refers to the establishment of fairly predictable behavior in the presence of well-defined stimuli.
2. Match the following in Pavlov's experiment with dogs:

___ unconditioned stimulus	a. bell
___ unconditioned response	b. food
___ conditioned stimulus	c. salivating to bell
___ conditioned response	d. salivating to food

3. The intense, irrational fears that we call phobias can be learned through classical conditioning. Is this statement true (T) or false (F)?
4. A learned association between the taste of a certain food and a feeling of nausea is called ____________ ____________ ____________.
5. Teaching someone to relax even when he or she encounters a distressing situation is called ____________ ____________.
6. In the experiment with Little Albert, the unconditioned stimulus was __________ __________.

Answers: 1. classical conditioning. 2. unconditioned stimulus—b; unconditioned response—d; conditioned stimulus—a; conditioned response—c. 3. T. 4. conditioned taste aversion. 5. desensitization therapy. 6. loud noises.

APPLY YOUR UNDERSTANDING

1. Which of the following are examples of classical conditioning?
   a. eating when not hungry just because we know it is lunchtime
   b. a specific smell triggering a bad memory
   c. a cat running into the kitchen to the sound of a can opener
   d. All of the above are examples of classical conditioning.
2. You feel nauseated when you read about sea scallops on a restaurant menu, because you once had a bad episode with some scallops that made you sick. For you in this situation, the menu description of the scallops is the
   a. US.
   b. CS.
   c. CR.

Answers: 1. d. 2. b.

LEARNING OBJECTIVES

- **Explain how operant conditioning differs from classical conditioning.**
- **Explain the law of effect (the principle of reinforcement) and the role of reinforcers, punishers, and shaping in establishing an operantly conditioned response. Differentiate between positive reinforcers, negative reinforcers, and punishment. Explain the circumstances under which punishment can be effective and the drawbacks to using punishment.**
- **Explain what is meant by learned helplessness.**
- **Describe how biofeedback and neurofeedback can be used to change behavior.**

OPERANT CONDITIONING

How are operant behaviors different from the responses involved in classical conditioning?

Around the turn of the 20th century, while Pavlov was busy with his dogs, the American psychologist Edward Lee Thorndike (1874–1949) was using a "puzzle box," or simple wooden cage, to study how cats learn (Thorndike, 1898). As illustrated in **Figure 5–4**,

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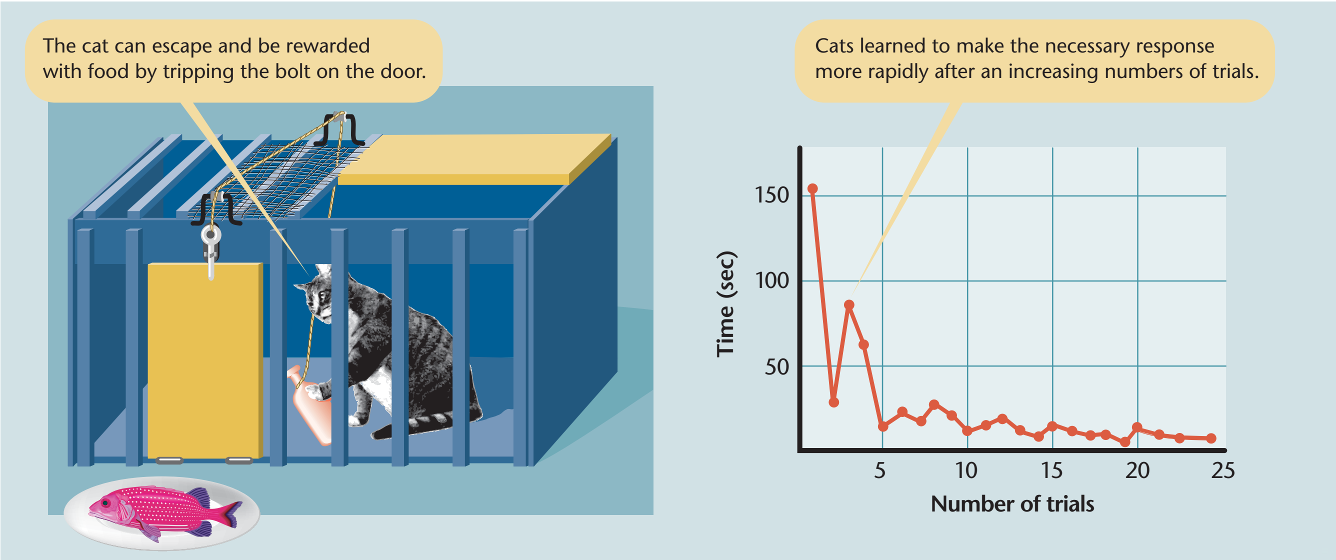

Figure 5–4
A cat in a Thorndike "puzzle box."
The cat can escape and be rewarded with food by tripping the bolt on the door. As the graph shows, Thorndike's cats learned to make the necessary response more rapidly after an increasing number of trials.

Thorndike confined a hungry cat in the puzzle box, with food just outside where the cat could see and smell it. To get to the food, the cat had to figure out how to open the latch on the box door, a process that Thorndike timed. In the beginning, it took the cat quite a while to discover how to open the door. But on each trial, it took the cat less time, until eventually it could escape from the box in almost no time at all. Thorndike was a pioneer in studying the kind of learning that involves making a certain response due to the consequences it brings. This form of learning has come to be called **operant** or **instrumental conditioning**. The pouched rat described at the opening of this chapter learned to find land mines through operant conditioning.

Elements of Operant Conditioning

What two essential elements are involved in operant conditioning?

One essential element in operant conditioning is *emitted behavior*. This is one way in which operant conditioning is different from classical conditioning. In classical conditioning, a response is automatically triggered by some stimulus, such as a loud noise automatically triggering fear. In this sense, classical conditioning is passive in that the behaviors are elicited by stimuli. However, this process is not true of the behaviors involved in operant conditioning. Thorndike's cats *spontaneously* tried to undo the latch on the door of the box. You *spontaneously* wave your hand to signal a taxi to stop. You *voluntarily* put money into machines to obtain food. These and similar actions are called **operant behaviors** because they involve "operating" on the environment.

A second essential element in operant conditioning is a *consequence* following a behavior. Thorndike's cats gained freedom and a piece of fish for escaping from the puzzle boxes. Consequences like this one, which increase the likelihood that a behavior will be repeated, are called **reinforcers**. In contrast, consequences that *decrease* the chances that a behavior will be repeated are called **punishers**. Imagine how Thorndike's cats might have acted had they been greeted by a large, snarling dog when they escaped from the puzzle boxes. Thorndike summarized the influence of consequences in his **law of effect**: Behavior that brings about a satisfying effect (reinforcement) is likely to be performed again, whereas

operant (or instrumental) conditioning The type of learning in which behaviors are emitted (in the presence of specific stimuli) to earn rewards or avoid punishments.

operant behaviors Behaviors designed to operate on the environment in a way that will gain something desired or avoid something unpleasant.

reinforcers A stimuli that follows a behavior and increases the likelihood that the behavior will be repeated.

punishers Stimuli that follows a behavior and decreases the likelihood that the behavior will be repeated.

law of effect (principle of reinforcement) Thorndike's theory that behavior consistently rewarded will be "stamped in" as learned behavior, and behavior that brings about discomfort will be "stamped out."

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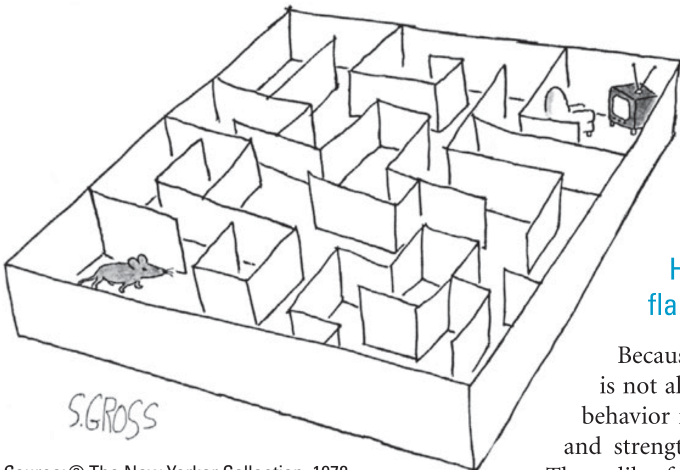

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behavior that brings about a negative effect (punishment) is likely to be suppressed. Contemporary psychologists often refer to the **principle of reinforcement**, rather than the law of effect, but the two terms mean the same thing.

Establishing an Operantly Conditioned Response

How might an animal trainer teach a tiger to jump through a flaming hoop?

Because the behaviors involved in operant conditioning are voluntary ones, it is not always easy to establish an operantly conditioned response. The desired behavior must first be performed spontaneously in order for it to be rewarded and strengthened. Sometimes you can simply wait for this action to happen. Thorndike, for example, waited for his cats to trip the latch that opened the door to his puzzle boxes. Then he rewarded them with fish.

But when there are many opportunities for making irrelevant responses, waiting can be slow and tedious. If you were an animal trainer for a circus, imagine how long you would have to wait for a tiger to decide to jump through a flaming hoop so you could reward it. One way to speed up the process is to increase motivation. Even without food in sight, a hungry animal is more active than a well-fed one and so is more likely, just by chance, to make the response you're looking for. Another strategy is to reduce opportunities for irrelevant responses, as Thorndike did by making his puzzle boxes small and bare. Many researchers do the same thing by using Skinner boxes to train small animals in. A **Skinner box** (named after B. F. Skinner, another pioneer in the study of operant conditioning), is a small cage with solid walls that is relatively empty, except for a food cup and an activating device, such as a bar or a button. (See **Figure 5–5**.) In this simple environment, it doesn't take long for an animal to press the button that releases food into the cup, thereby reinforcing the behavior. **Watch** on **MyPsychLab**

Watch B. F. Skinner Biography at www.mypsychlab.com

Usually, however, the environment cannot be controlled so easily; hence a different approach is called for. Another way to speed up operant conditioning is to reinforce successive approximations of the desired behavior. This approach is called **shaping**. To teach a tiger to jump through a flaming hoop, the trainer might first reinforce the animal simply for jumping up on a pedestal. After that behavior has been learned, the tiger might be reinforced only for leaping from that pedestal to another. Next, the tiger might be required to jump through a hoop between the pedestals to gain a reward. And finally, the hoop is set on fire, and the tiger must leap through it to be rewarded.

Figure 5–5
A rat in a Skinner box.
By pressing the bar, the rat releases food pellets into the box; this procedure reinforces its bar-pressing behavior.

As in classical conditioning, the learning of an operantly conditioned response eventually reaches a point of diminishing returns. If you look back at **Figure 5–4**, you'll see that the first few reinforcements produced quite large improvements in performance, as indicated by the rapid drop in time required to escape from the puzzle box. But each successive reinforcement produced less of an effect until, eventually, continued reinforcement brought no evidence of further learning. After 25 trials, for instance, Thorndike's cats were escaping from the box no more quickly than they had been after 15 trials. The operantly conditioned response had then been fully established. Can operant conditioning

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APPLYING PSYCHOLOGY
Modifying Your Own Behavior

Can you modify your own undesirable behaviors by using operant conditioning techniques? Yes, but first you must observe your own actions, think about their implications, and plan a strategy of intervention.

1. Begin by identifying the behavior you want to acquire: This is called the "target" behavior. You will be more successful if you focus on acquiring a new behavior rather than on eliminating an existing one. For example, instead of setting a target of being less shy, you might define the target behavior as becoming more outgoing or more sociable.
2. The next step is defining the target behavior precisely: What exactly do you mean by "sociable"? Imagine situations in which the target behavior could be performed. Then describe in writing the way in which you now respond to these situations. For example, you might write, "When I am sitting in a lecture hall, waiting for class to begin, I don't talk to the people around me." Next, write down how you would rather act in that situation: "In a lecture hall before class, I want to talk to at least one other person. I might ask the person sitting next to me how he or she likes the class or the professor or simply comment on some aspect of the course."
3. The third step is monitoring your present behavior: You may do so by keeping a daily log of activities related to the target behavior. This will establish your current "base rate" and give you something concrete against which to gauge improvements. At the same time, try to figure out whether your present, undesirable behavior is being reinforced in some way. For example, if you find yourself unable to study, record what you do instead (Get a snack? Watch television?) and determine whether you are inadvertently rewarding your failure to study.
4. The next step—the basic principle of self-modification—is providing yourself with a positive reinforcer that is contingent on specific improvements in the target behavior: You may be able to use the same reinforcer that now maintains your undesirable behavior, or you may want to pick a new reinforcer. For example, if you want to increase the amount of time you spend studying, you might reward yourself with a token for each 30 minutes of study. Then, if your favorite pastime is watching movies, you might charge yourself three tokens for an hour of television, whereas the privilege of going to a movie might cost six.

influence human behavior? See "Applying Psychology: Modifying Your Behavior," above, to learn about how you can use operant conditioning to modify your own behavior.

Remember that the new, more desirable behavior need not be learned all at once. You can use shaping or successive approximations to change your behavior bit by bit. A person who wants to become more sociable might start by giving rewards just for sitting next to another person in a classroom rather than picking an isolated seat. The person could then work up to rewarding increasingly sociable behaviors, such as first saying hello to another person, then striking up a conversation.

A Closer Look at Reinforcement

What is the difference between positive and negative reinforcement? What are some of the unintentional effects that reinforcement can have?

We have been talking about reinforcement as if all reinforcers are alike, but in fact this is not the case. Think about the kinds of consequences that would encourage you to perform some behavior. Certainly these include consequences that give you something positive, like praise, recognition, or money. But the removal of some negative stimulus is also a good reinforcer of behavior. When new parents discover that rocking a baby will stop the infant's persistent crying, they sit down and rock the baby deep into the night; the removal of the infant's crying is a powerful reinforcer.

These examples show that there are two kinds of reinforcers. **Positive reinforcers**, such as praise, add something rewarding to a situation, whereas **negative reinforcers**, such as

Skinner box A box often used in operant conditioning of animals; it limits the available responses and thus increases the likelihood that the desired response will occur.

shaping Reinforcing successive approximations to a desired behavior.

positive reinforcers Events whose presence increases the likelihood that ongoing behavior will recur.

negative reinforcers Events whose reduction or termination increases the likelihood that ongoing behavior will recur.

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punishment Any event whose presence decreases the likelihood that ongoing behavior will recur.

stopping an aversive noise, subtract something unpleasant. Animals will learn to press bars and open doors not only to obtain food and water (positive reinforcement), but also to turn off a loud buzzer or an electric shock (negative reinforcement).

Both positive and negative reinforcement results in the learning of new behaviors or the strengthening of existing ones. Remember, in everyday conversation when we say that we have "reinforced" something, we mean that we have strengthened it. Similarly, in operant conditioning, reinforcement—whether positive or negative—always strengthens or encourages a behavior. A child might practice the piano because she or he receives praise for practicing (positive reinforcement) or because it gives her or him a break from doing tedious homework (negative reinforcement), but in either case the end result is a higher incidence of piano playing.

But what if a particular behavior is just *accidentally* reinforced because it happens by chance to be followed by some rewarding incident? Will the behavior still be more likely to occur again? B. F. Skinner (1948) showed that the answer is yes. He put a pigeon in a Skinner box and at random intervals dropped a few grains of food into the food cup. The pigeon began repeating whatever it had been doing just before the food was given, such as standing on one foot. This action had nothing to do with getting the food, of course. But still the bird repeated it over and over again. Skinner called the bird's behavior *superstitious*, because it was learned in a way that is similar to how some human superstitions are learned (Aeschleman, Rosen, & Williams, 2003). If you happen to be wearing an Albert Einstein T-shirt when you get your first A on an exam, you may come to believe that wearing this shirt was a factor. Even though the connection was pure coincidence, you may keep on wearing your "lucky" shirt to every test thereafter.

In the case of forming superstitions, reinforcement has an illogical effect on behavior, but that effect is generally harmless. Some psychologists believe that reinforcement can also lead inadvertently to negative results. They believe that offering certain kinds of reinforcers (candy, money, play time) for a task that could be intrinsically rewarding (that is, reinforcing in and of itself) can undermine the intrinsic motivation to perform it. People may begin to think that they are working only for the reward and lose enthusiasm for what they are doing. They may no longer see their work as an intrinsically interesting challenge in which to invest creative effort and strive for excellence. Instead, they may see work as a chore that must be done to earn some tangible payoff. This warning can be applied to many situations, such as offering tangible rewards to students for their work in the classroom, or giving employees a "pay for performance" incentive to meet company goals (Kohn, 1993; Rynes, Gerhart, & Parks, 2005).

Other psychologists, however, suggest that this concern about tangible reinforcers may be exaggerated. Although the use of rewards may sometimes produce negative outcomes, this is not always the case (Cameron, Banko, & Pierce, 2001). In fact, one extensive review of more than 100 studies showed that when used appropriately, rewards do not compromise intrinsic motivation, and under some circumstances, they may even help to encourage creativity (Eisenberger & Cameron, 1996; Selarta, Nordström, Kuvaas, & Takemura, 2008). For example, research has shown that rewarding highly creative behavior on one task often enhances subsequent creativity on other tasks (Eisenberger & Rhoades, 2001).

The use of punishment has potential drawbacks. It cannot "unteach" unwanted behavior, only suppress it. Punishment may also stir up negative feelings in the person who is punished or inadvertently provide a model of aggressive behavior.

Punishment

What problems can punishment create?

Although we all hate to be subjected to it, **punishment** is a powerful controller of behavior. After receiving a heavy fine for failing to report extra income to the IRS, we are less likely to make that mistake again. In this case, an unpleasant consequence reduces the likelihood that we will repeat a behavior. This is the definition of punishment.

Punishment is different from negative reinforcement. Reinforcement of whatever kind *strengthens* (reinforces) behavior. Negative reinforcement strengthens behavior by removing something unpleasant from the environment. In contrast, punishment adds something unpleasant to the environment; and as a result, it tends to *weaken* the behavior that caused

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it. If going skiing during the weekend rather than studying for a test results in getting an F, the F is an unpleasant consequence (a punisher) that makes you less likely to skip homework for ski time again.

Is punishment effective? We can all think of instances when it doesn't seem to work. Children often continue to misbehave even after they have been punished repeatedly for that particular misbehavior. Some drivers persist in driving recklessly despite repeated fines. Why are there these seeming exceptions to the law of effect? Why, in these cases, isn't punishment having the result it is supposed to?

For punishment to be effective, it must be imposed properly (Gershoff, 2002). First, punishment should be *swift*. If it is delayed, it doesn't work as well. Sending a misbehaving child immediately to a time-out seat (even when it is not convenient to do so) is much more effective than waiting for a "better" time to punish. Punishment should also be *sufficient* without being cruel. If a parent briefly scolds a child for hitting other children, the effect will probably be less pronounced than if the child is sent to his or her room for the day. At the same time, punishment should be *consistent*. It should be imposed for all infractions of a rule, not just for some.

Punishment is particularly useful in situations in which a behavior is dangerous and must be changed quickly. A child who likes to poke things into electric outlets, or runs out into a busy street must be stopped immediately, so punishment may be the best course of action. But even in situations like these, punishment has drawbacks (Gershoff, 2002; B. F. Skinner, 1953).

THINKING CRITICALLY ABOUT . . .

Corporal Punishment

Some school systems still use some form of corporal punishment, such as paddling, for students who misbehave. The justification is that it is an effective method of changing undesirable behavior, it develops a sense of personal responsibility, it teaches self-discipline, and it helps develop moral character.

Based on what you now know about operant conditioning,

1. under what circumstances (if any) should corporal punishment be used in schools?
2. what factors, besides the student's immediate actions, should adults consider before using corporal punishment?
3. what unintended consequences might arise from the use of corporal punishment?

Punishment Cannot Unteach Unwanted Behaviors First, it only *suppresses* the undesired behavior; it doesn't prompt someone to "unlearn" the behavior, and it doesn't teach a more desirable one. If the threat of punishment is removed, the negative behavior is likely to recur. This result is apparent on the highway. Speeders slow down when they see a police car (the threat of punishment), but speed up again as soon as the threat is passed. Punishment, then, rarely works when long-term changes in behavior are wanted (Pogarsky & Piquero, 2003).

Punishment Can Backfire Second, punishment often stirs up negative feelings (frustration, resentment, self-doubt), which can impede the learning of new, more desirable behaviors. For example, when a child who is learning to read is scolded for every mispronounced word, the child may become very frustrated and hesitant. This frustration and doubt about ability can prompt more mispronunciations, which lead to more scolding. In time, the negative feelings that punishment has caused can become so unpleasant that the child may avoid reading altogether. In addition, some studies have shown that children who frequently experience corporal punishment have a higher incidence of depression, antisocial behavior, decreased self-control, and increased difficulty relating to their peers (C. E. Leary, Kelley, Morrow, & Mikulka, 2008; Slessareva & Muraven, 2004).

Punishment Can Teach Aggression. A third drawback of punishment, when it is harsh, is the unintended lesson that it teaches: Harsh punishment may encourage the learner to copy that same harsh and aggressive behavior toward other people (Gershoff, 2002). In laboratory studies, monkeys that are harshly punished tend to attack other monkeys (Barry Schwartz, 1989). In addition, punishment often makes people angry, aggressive, and hostile (Lansford et al., 2005; Mathurin, Gielen, & Lancaster, 2006).

Because of these drawbacks, punishment should be used carefully, and always together with reinforcement of desirable behavior. Once a more desirable response is established, punishment should be removed to reinforce negatively that new behavior. Positive rein-

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forcement (praise, rewards) should also be used to strengthen the desired behavior because it teaches an alternative behavior to replace the punished one. Positive reinforcement also makes the learning environment less threatening.

Sometimes, after punishment has been administered a few times, it needn't be continued, because the mere threat of punishment is enough to induce the desired behavior. Psychologists call it **avoidance training**, because the person is learning to avoid the possibility of a punishing consequence. Avoidance training is responsible for many everyday behaviors. It has taught you to keep your hand away from a hot iron to avoid the punishment of a burn. Avoidance training, however, doesn't always work in our favor. For instance, a child who has been repeatedly criticized for poor performance in math may learn to shun difficult math problems in order to avoid further punishment. Unfortunately, the child fails to develop math skills and therefore fails to improve any innate capabilities, and so a vicious cycle has set in. The avoidance must be unlearned through some positive experiences with math in order for this cycle to be broken.

ENDURING ISSUES

Diversity–Universality What Is Punishment?

We do not know whether something is reinforcing or punishing until we see whether it increases or decreases the occurrence of a response. We might also assume that having to work alone, rather than in a group of peers, would be punishing, but some children prefer to work alone. Teachers must understand the children in their classes as individuals before they decide how to reward or punish them. Similarly, what is reinforcing for people in one culture might not have the same effect for people in other cultures.

In addition, an event or object might not be consistently rewarding or punishing over time. So even if candy is initially reinforcing for some children, if they eat large amounts of it, it can become neutral or even punishing. We must therefore be very careful in labeling items or events as "reinforcers" or "punishers." ■

Learned Helplessness

In what ways do some college students exhibit learned helplessness?

Have you ever met someone who has decided he will never be good at science? We have said that through avoidance training, people learn to prevent themselves from being punished, but what happens when such avoidance of punishment isn't possible? The answer is often a "giving-up" response that can generalize to other situations. This response is known as **learned helplessness.** Explore on MyPsychLab

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Martin Seligman and his colleagues first studied learned helplessness in experiments with dogs (Seligman & Maier, 1967). They placed two groups of dogs in chambers that delivered a series of electric shocks to the dogs' feet at random intervals. The dogs in the control group could turn off (escape) the shock by pushing a panel with their nose. The dogs in the experimental group could not turn off the shock—they were, in effect, helpless. Next, both the experimental and the control animals were placed in a different situation, one in which they could escape shock by jumping over a hurdle. A warning light always came on 10 seconds before each 50-second shock was given. The dogs in the control group quickly learned to jump the hurdle as soon as the warning light flashed, but the dogs in the experimental group didn't. These dogs, which had previously experienced unavoidable shocks, didn't even jump the hurdle *after* the shock started. They just lay there and accepted the shocks. Also, many of these dogs were generally listless, suffered loss of appetite, and displayed other symptoms associated with depression.

Many subsequent studies have shown that learned helplessness can occur both in animals and in humans (G. W. Evans & Stecker, 2004; C. Peterson, Maier, & Seligman, 1993b;

avoidance training Learning a desirable behavior to prevent the occurrence of something unpleasant, such as punishment.

learned helplessness Failure to take steps to avoid or escape from an unpleasant or aversive stimulus that occurs as a result of previous exposure to unavoidable painful stimuli.

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Overmier, 2002). Once established, the condition generalizes to new situations and can be very persistent, even given evidence that an unpleasant circumstance can now be avoided (C. Peterson, Maier, & Seligman, 1993a). For example, when faced with a series of unsolvable problems, a college student may eventually give up trying and make only halfhearted efforts to solve new problems, even when the new problems are solvable. Moreover, success in solving new problems has little effect on the person's behavior. He or she continues to make only halfhearted tries, as if never expecting *any* success at all. Similarly, children raised in an abusive family, where punishment is unrelated to behavior, often develop a feeling of helplessness (C. Peterson & Bossio, 1989). Even in relatively normal settings outside their home, they often appear listless, passive, and indifferent. They make little attempt either to seek rewards or to avoid discomfort.

biofeedback A technique that uses monitoring devices to provide precise information about internal physiological processes, such as heart rate or blood pressure, to teach people to gain voluntary control over these functions.

neurofeedback A biofeedback technique that monitors brain waves with the use of an EEG to teach people to gain voluntary control over their brain wave activity.

Shaping Behavioral Change Through Biofeedback

How can operant conditioning be used to control biological functions?

Patrick, an 8-year-old third grader, was diagnosed with *attention-deficit disorder (ADD)*. He was unable to attend to what was going on around him, was restless, and was unable to concentrate. An EEG showed increased numbers of slow brain waves. After a course of 40 training sessions using special computer equipment that allowed Patrick to *monitor* his brain-wave activities, he learned how to produce more of the fast waves that are associated with being calm and alert. As a result, Patrick became much more "clued in" to what was going on around him and much less likely to become frustrated when things didn't go his way (Fitzgerald, 1999; Fuchs, Birbaumer, Lutzenberger, Gruzelier, & Kaiser, 2003; Monastra, 2008).

When operant conditioning is used to control certain biological functions, such as blood pressure, skin temperature or heart rate, it is referred to as **biofeedback**. Instruments are used to measure particular biological responses—muscle contractions, blood pressure, heart rate. Variations in the strength of the response are reflected in signals, such as light or tones. By using these signals, the person can learn to control the response through shaping. For example, Patrick learned to control his brain waves by controlling the movement of a Superman icon on a computer screen. When biofeedback is used to monitor and control brain waves, as in Patrick's case, it is referred to as **neurofeedback** (Butnik, 2005).

Biofeedback and neurofeedback have become well-established treatments for a number of medical problems, including migraine headaches (Kropp, Siniatchkin, & Gerber, 2005), hypertension (Rau, Buehrer, & Weitkunat, 2003; Reineke, 2008), and panic attacks (Meuret, Wilhelm, & Roth, 2004). Biofeedback has also been used by athletes, musicians, and other performers to control the anxiety that can interfere with their performance.

Biofeedback treatment does have some drawbacks. Learning the technique takes considerable time, effort, patience, and discipline. And it does not work for everyone. But it gives many patients control of their treatment, a major advantage over other treatment options, and it has achieved impressive results in alleviating certain medical problems (Olton & Noonberg, 1980).

THINKING CRITICALLY ABOUT . . .

Biofeedback and Neurofeedback

Assume for the moment that you are skeptical about the benefits of biofeedback and neurofeedback. What questions would you ask about research studies that claim to show they are beneficial? To get started, refer back to Chapter 1 and the section on "Critical Thinking."

1. What kind of evidence would you look for to support your skeptical position? What kind of evidence would cause you to rethink your position? Are you swayed by reports of single cases (such as Patrick) or would you be more influenced by studies of large numbers of people? Would you be interested in short-term effects, or would you want to see results over a much longer period of time?
2. What assumptions would you need to watch out for? How would you know whether biofeedback or neurofeedback really worked? (Remember that you should be skeptical of self-reports.)
3. Might there be alternative explanations for the results of the research you find? In other words, is it possible that something quite apart from biofeedback or neurofeedback could explain the results?
4. Once you have formulated your position on the benefits of biofeedback or neurofeedback, how would you avoid oversimplifying your conclusions?

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CHECK YOUR UNDERSTANDING

1. An event whose reduction or termination increases the likelihood that ongoing behavior will recur is called ____________ reinforcement, whereas any event whose presence increases the likelihood that ongoing behavior will recur is called ____________ reinforcement.
2. A type of learning that involves reinforcing the desired response is known as ____________ ____________.
3. When a threat of punishment induces a change to more desirable behavior, it is called ____________ ____________.
4. Superstitious behavior can result when a behavior is rewarded by pure ____________.
5. Any stimulus that follows a behavior and decreases the likelihood that the behavior will be repeated is called a ____________.
6. Which of the following problems may result from avoidance training?
   a. A person may continue to avoid something that no longer needs to be avoided.
   b. The effects of avoidance training tend to last for only a short time.
   c. Avoidance training may produce latent learning.
   d. Avoidance training tends to take effect when it is too late to make a difference in avoiding the problem situation.

Answers: 1. negative; positive. 2. operant conditioning. 3. avoidance training. 4. coincidence. 5. punishment. 6. a.

APPLY YOUR UNDERSTANDING

1. Imagine that you want to teach a child to make his or her bed. What kind of reinforcement could you use to do that?
   a. punishment
   b. positive reinforcement
   c. negative reinforcement
   d. both (b) and (c) would work
2. You are hired to make a commercial for a company that manufactures dog food. They want you to get a dog to run from a hallway closet, under a coffee table, around a sofa, leap over a wagon, rush to the kitchen, and devour a bowl of dog food. The most effective way to accomplish this task would be to
   a. wait for this chain of events to happen and then use a reinforcer to increase the likelihood that the behavior will occur again on demand.
   b. use shaping.
   c. teach the dog to discriminate between the various landmarks on its way to the food.
   d. hire a smart dog.

Answers: 1. d. 2. b.

LEARNING OBJECTIVES

- **Describe the importance of contingencies in both operant and classical conditioning.**
- **Differentiate between the four schedules of reinforcement in operant conditioning and their effect on learned behavior.**
- **Describe the processes of extinction, spontaneous recovery, generalization, and discrimination in classical and operant conditioning.**
- **Explain what is meant by higher order conditioning and differentiate between primary and secondary reinforcers.**

FACTORS SHARED BY CLASSICAL AND OPERANT CONDITIONING

Can you think of any similarities between classical and operant conditioning?

Despite the differences between classical and operant conditioning, these two forms of learning have many things in common. First, they both involve the learning of associations. In classical conditioning, it is a learned association between one stimulus and another, whereas in operant conditioning, it is a learned association between some action and a consequence. Second, the responses in both classical and operant conditioning are under the control of stimuli in the environment. A classically conditioned fear might be triggered by the sight of a white rat; an operantly conditioned jump might be cued by the flash of a red light. In both cases, moreover, the learned responses to a cue can generalize to similar stimuli. Third, neither classically nor operantly conditioned responses will last forever if

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they aren't periodically renewed. This doesn't necessarily mean that they are totally forgotten, however. Even after you think that these responses have long vanished, either one can suddenly reappear in the right situation. And fourth, in both kinds of learning—classical *and* operant conditioning—new behaviors can build on previously established ones.

The Importance of Contingencies

How can changes in the timing of a conditioned stimulus lead to unexpected learning? Why does intermittent reinforcement result in such persistent behavior?

Because classical and operant conditioning are both forms of associative learning, they both involve perceived contingencies. A **contingency** is a relationship in which one event *depends* on another. Graduating from college is *contingent* on passing a certain number of courses. In both classical and operant conditioning, perceived contingencies are very important.

Contingencies in Classical Conditioning In classical conditioning, a contingency is perceived between the CS and the US. The CS comes to be viewed as a signal that the US is about to happen. This is why, in classical conditioning, the CS not only must occur in close proximity to the US, but also should precede the US and provide predictive information about it (Rescorla, 1966, 1967, 1988).

Scientists once believed that no conditioning would occur if the CS *followed* the US; this belief, however, turns out not to be entirely true. The explanation again lies in contingency learning. Imagine a situation in which a tone (the CS) always follows a shock (the US). This process is called *backward conditioning*. After a while, when the tone is sounded alone, the learner will not show a conditioned fear response to it. After all, the tone has never predicted that a shock is about to be given. But what the learner *does* show is a conditioned *relaxation* response to the sound of the tone, because the tone has served as a signal that the shock is over and will not occur again for some time. Again, we see the importance of contingency learning: The learner responds to the tone on the basis of the information that it gives about what will happen next.

Other studies similarly show that predictive information is crucial in establishing a classically conditioned response. In one experiment with rats, for instance, a noise was repeatedly paired with a brief electric shock until the noise soon became a conditioned stimulus for a conditioned fear response (Kamin, 1969). Then a second stimulus—a light—was added right before the noise. You might expect that the rat came to show a fear of the light as well, because it, too, preceded the shock. But this is not what happened. Apparently, the noise–shock contingency that the rat had already learned had a **blocking** effect on learning that the light also predicted shock. Once the rat had learned that the noise signaled the onset of shock, adding yet another cue (a light) provided no new predictive information about the shock's arrival, and so the rat learned to ignore the light (Kruschke, 2003). Classical conditioning, then, occurs only when a stimulus tells the learner something *new* or *additional* about the likelihood that a US will occur.

Contingencies in Operant Conditioning Contingencies also figure prominently in operant conditioning. The learner must come to perceive a connection between performing a certain voluntary action and receiving a certain reward or punishment. If no contingency is perceived, there is no reason to increase or decrease the behavior.

But once a contingency is perceived, does it matter how often a consequence is actually delivered? When it comes to rewards, the answer is yes. Fewer rewards are often better than more. In the language of operant conditioning, *partial* or *intermittent reinforcement* results in behavior that will persist longer than behavior learned by *continuous reinforcement.* Why would this be the case? The answer has to do with expectations. When people receive only

contingency A reliable "if–then" relationship between two events, such as a CS and a US.

blocking A process whereby prior conditioning prevents conditioning to a second stimulus even when the two stimuli are presented simultaneously.

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occasional reinforcement, they learn not to expect reinforcement with every response, so they continue responding in the hopes that eventually they will gain the desired reward. Vending machines and slot machines illustrate these different effects of continuous versus partial reinforcement. A vending machine offers continuous reinforcement. Each time you put in the right amount of money, you get something desired in return (reinforcement). If a vending machine is broken and you receive nothing for your coins, you are unlikely to put more money in it. In contrast, a casino slot machine pays off intermittently; only occasionally do you get something back for your investment. This intermittent payoff has a compelling effect on behavior. You might continue putting coins into a slot machine for a very long time even though you are getting nothing in return.

Psychologists refer to a pattern of reward payoffs as a **schedule of reinforcement**. Partial or intermittent reinforcement schedules are either fixed or variable, and they may be based on either the number of correct responses or the time elapsed between correct responses. **Table 5–1** gives some everyday examples of different reinforcement schedules.

On a **fixed-interval schedule**, learners are reinforced for the first response after a certain amount of time has passed since that response was previously rewarded. That is, they have to wait for a set period before they will be reinforced again. With a fixed-interval schedule, performance tends to fall off immediately after each reinforcement and then tends to pick up again as the time for the next reinforcement draws near. For example, when exams are given at fixed intervals—like midterms and finals—students tend to decrease their studying right after one test is over and then increase studying as the next test approaches. (See **Figure 5–6**.)

Table 5–1 EXAMPLES OF REINFORCEMENT IN EVERYDAY LIFE

Continuous reinforcement (reinforcement every time the response is made)	Putting money in a parking meter to avoid getting a ticket. Putting coins in a vending machine to get candy or soda.
Fixed-ratio schedule (reinforcement after a fixed number of responses)	Being paid on a piecework basis. In the garment industry, for example, workers may be paid a fee per 100 dresses sewn.
Variable-ratio schedule (reinforcement after a varying number of responses)	Playing a slot machine. The machine is programmed to pay off after a certain number of responses have been made, but that number keeps changing. This type of schedule creates a steady rate of responding, because players know that if they play long enough, they will win. Sales commissions. You have to talk to many customers before you make a sale, and you never know whether the next one will buy. The number of sales calls you make, not how much time passes, will determine when you are reinforced by a sale, and the number of sales calls will vary.
Fixed-interval schedule (reinforcement of first response after a fixed amount of time has passed)	You have an exam coming up, and as time goes by and you haven't studied, you have to make up for it all by a certain time, and that means cramming. Picking up a salary check, which you receive every week or every 2 weeks.
Variable-interval response (reinforcement of first response after varying amounts of time)	Surprise quizzes in a course cause a steady rate of studying because you never know when they'll occur; you have to be prepared all the time. Watching a football game; waiting for a touchdown. It could happen anytime. If you leave the room, you may miss it, so you have to keep watching continuously.

Source: From Landy, 1987, p. 212. Adapted by permission.

schedule of reinforcement In operant conditioning, the rule for determining when and how often reinforcers will be delivered.

fixed-interval schedule A reinforcement schedule in which the correct response is reinforced after a fixed length of time since the last reinforcement.

variable-interval schedule A reinforcement schedule in which the correct response is reinforced after varying lengths of time following the last reinforcement.

fixed-ratio schedule A reinforcement schedule in which the correct response is reinforced after a fixed number of correct responses.

variable-ratio schedule A reinforcement schedule in which a varying number of correct responses must occur before reinforcement is presented.

extinction A decrease in the strength or frequency, or stopping, of a learned response because of failure to continue pairing the US and CS (classical conditioning) or withholding of reinforcement (operant conditioning).

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A **variable-interval schedule** reinforces correct responses after varying lengths of time following the last reinforcement. One reinforcement might be given after 6 minutes and the next after 4 minutes. The learner typically gives a slow, steady pattern of responses, being careful not to be so slow as to miss all the rewards. For example, if exams are given during a semester at unpredictable intervals, students have to keep studying at a steady rate, because on any given day there might be a test.

On a **fixed-ratio schedule**, a certain number of correct responses must occur before reinforcement is provided, resulting in a high response rate, since making many responses in a short time yields more rewards. Being paid on a piecework basis is an example of a fixed-ratio schedule. Under a fixed-ratio schedule, a brief pause after reinforcement is followed by a rapid and steady response rate until the next reinforcement. (See **Figure 5–6**.)

On a **variable-ratio schedule**, the number of correct responses needed to gain reinforcement is not constant. The casino slot machine is a good example of a variable-ratio schedule. It will eventually pay off, but you have no idea when. Because there is always a chance of hitting the jackpot, the temptation to keep playing is great. Learners on a variable-ratio schedule tend not to pause after reinforcement and have a high rate of response over a long period of time. Because they never know when reinforcement may come, they keep on testing for a reward.

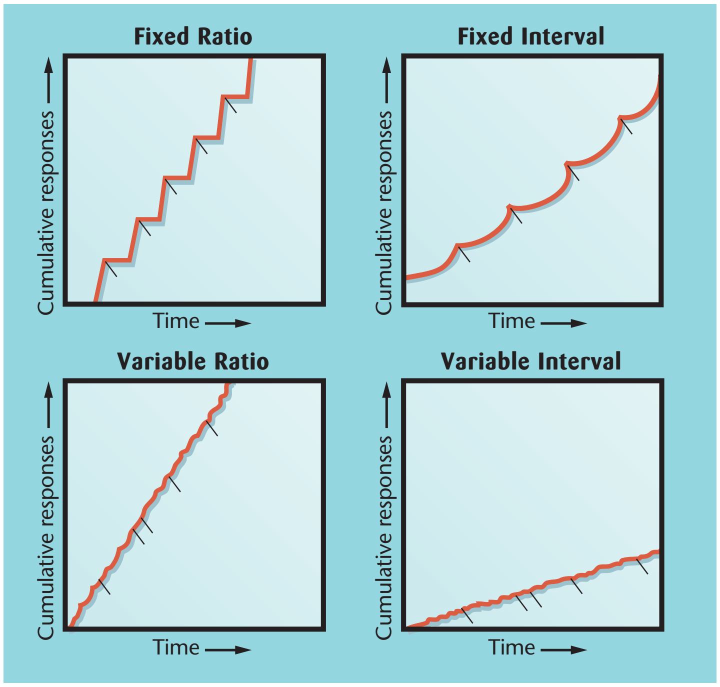

Figure 5–6
Response patterns to schedules of reinforcement.
On a fixed-interval schedule, as the time for reinforcement approaches, the number of responses increases, and the slope becomes steeper. On a variable-interval schedule, the response rate is moderate and relatively constant. Notice that each tick mark on the graph represents one reinforcement. The fixed-ratio schedule is characterized by a high rate of response and a pause after each reinforcement. A variable-ratio schedule produces a high rate of response with little or no pause after each reinforcement.

Extinction and Spontaneous Recovery

Can you ever get rid of a conditioned response? Under what circumstances might old learned associations suddenly reappear?

Another factor shared by classical and operant conditioning is that learned responses sometimes weaken and may even disappear. If a CS and a US are never paired again or if a consequence always stops following a certain behavior, the learned association will begin to fade until eventually the effects of prior learning are no longer seen. This outcome is called **extinction** of a conditioned response.

The slot machine is a classic example of a variable-ratio schedule of reinforcement. The machine eventually pays off, but always after a variable number of plays. Because people keep hoping that the next play will be rewarded, they maintain a high rate of response over a long period of time.

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THINKING CRITICALLY ABOUT . . .

Reinforcement Schedules

Think about how you could apply the principles of behavioral learning to

1. design the ideal slot machine–one that would keep people playing over and over again, even though they won very little money.
2. design a reward system for a fifth-grade class that would result in both effort at schoolwork and in good behavior.
3. design an ideal lottery or mail-in contest.
4. design an ideal payment system for salespeople (you may include both salary and commission).

For each type of reward system, think about what the reinforcers should be, what contingencies are operating, and what behaviors you want to elicit. Also think about how you would demonstrate to a skeptic that your procedures have actually resulted in a change in the desired direction.

Extinction and Spontaneous Recovery in Classical Conditioning For an example of extinction in classical conditioning, let's go back to Pavlov's dogs, which had learned to salivate upon hearing a bell. What would you predict happened over time when the dogs heard the bell (the CS), but food (the US) was no longer given? The conditioned response to the bell—salivation—gradually decreased until eventually it stopped altogether. The dogs no longer salivated when they heard the bell. Extinction had taken place.

Once such a response has been extinguished, is the learning gone forever? Pavlov trained his dogs to salivate when they heard a bell, then extinguished this conditioned response. A few days later, the dogs were exposed to the bell again in the laboratory setting. As soon as they heard it, their mouths began to water. The response that had been learned and then extinguished reappeared on its own with no retraining. This phenomenon is known as **spontaneous recovery**. The dogs' response was now only about half as strong as it had been before extinction, and it was very easy to extinguish a second time. Nevertheless, the fact that the response occurred at all indicated that the original learning was not completely forgotten (see **Figure 5–7**).

How can extinguished behavior disappear and then reappear later? According to Mark Bouton (1993, 1994, 2002), the explanation is that extinction does not erase learning. Rather, extinction occurs because new learning interferes with a previously learned response. New stimuli in other settings come to be paired with the conditioned stimulus; and these new stimuli may elicit responses different from (and sometimes incompatible with) the original conditioned response. For example, if you take a break from watching the latest horror movies in theaters and instead watch reruns of classic horror films on television, these classic films may seem so amateurish that they make you laugh rather than scare you. Here you are learning to associate the scary music in such films with laughter, which in effect opposes your original fear response. The result is interference and extinction. Spontaneous recovery consists of overcoming this interference. For instance, if you return to the theater to see the latest Stephen King movie, the conditioned response of fear to the scary music may suddenly reappear. It is as if the unconditioned stimulus of watching

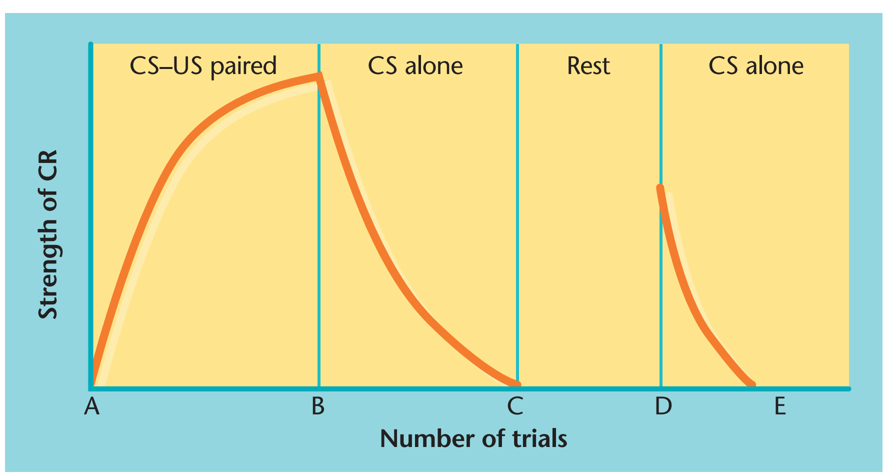

Figure 5–7
Response acquisition and extinction in classical conditioning.
From point A to point B, the conditioned stimulus and the unconditioned stimulus were paired; and learning increased steadily. From B to C, however, the conditioned stimulus was presented alone. By point C, the response had been extinguished. After a rest period from C to D, spontaneous recovery occurred—the learned response reappeared at about half the strength that it had at point B. When the conditioned stimulus was again presented alone, the response extinguished rapidly (point E).

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"up-to-date" horror acts as a reminder of your earlier learning and renews your previous classically conditioned response. Such "reminder" stimuli work particularly well when presented in the original conditioning setting.

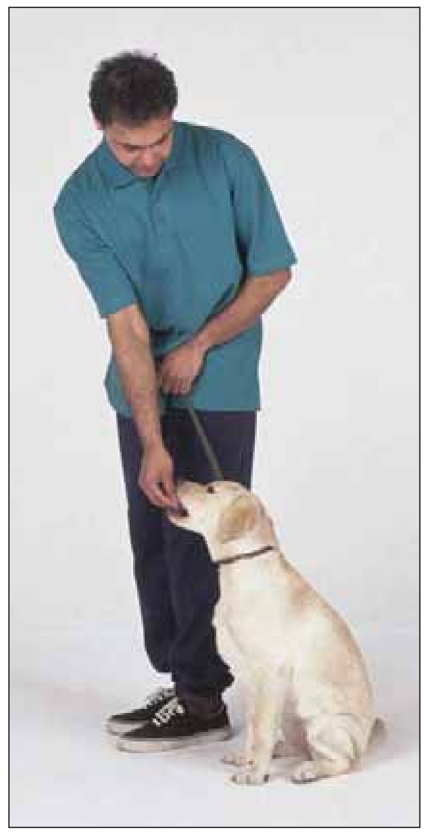
spontaneous recovery The reappearance of an extinguished response after the passage of time, without training.

Extinction and Spontaneous Recovery in Operant Conditioning Extinction and spontaneous recovery also occur in operant conditioning. In operant conditioning, extinction happens as a result of withholding reinforcement. The effect usually isn't immediate. In fact, when reinforcement is first discontinued, there is often a brief *increase* in the strength or frequency of responding before a decline sets in. For instance, if you put coins in a vending machine and it fails to deliver the goods, you may pull the lever more forcefully and in rapid succession before you finally give up.

Just as in classical conditioning, extinction in operant conditioning doesn't completely erase what has been learned. Even though much time has passed since a behavior was last rewarded and the behavior seems extinguished, it may suddenly reappear. This spontaneous recovery may again be understood in terms of interference from new behaviors. If a rat is no longer reinforced for pressing a lever, it will start to engage in other behaviors—turning away from the lever, attempting to escape, and so on. These new behaviors will interfere with the operant response of lever pressing, causing it to extinguish. Spontaneous recovery is a brief victory of the original learning over interfering responses. The rat decides to give the previous "reward" lever one more try, as if testing again for a reward.

The difficulty of extinguishing an operantly conditioned response depends on a number of factors:

- **Strength of the original learning.** The stronger the original learning, the longer it takes the response to extinguish. If you spend many hours training a puppy to sit on command, you will not need to reinforce this behavior very often once the dog grows up.
- **Pattern of reinforcement.** As you learned earlier, responses that were reinforced only occasionally when acquired are usually more resistant to extinction than responses that were reinforced every time they occurred.
- **Variety of settings in which the original learning took place.** The greater the variety of settings, the harder it is to extinguish the response. Rats trained to run several different types of alleys in order to reach a food reward will keep running longer after food is withdrawn than will rats trained in a single alley.
- **Complexity of the behavior.** Complex behavior is much more difficult to extinguish than simple behavior is. Complex behavior consists of many actions put together, and each of those actions must be extinguished in order for the whole to be extinguished.
- **Learning through punishment versus reinforcement.** Behaviors learned through punishment rather than reinforcement are especially hard to extinguish. If you avoid jogging down a particular street because a vicious dog there attacked you, you may never venture down that street again, so your avoidance of the street may never extinguish.



When reinforcement has been frequent, a learned behavior tends to be retained even after reinforcement is reduced. A dog "shaking hands" is an excellent example. Many previous rewards for this response tend to keep the dog offering people its paw even when no reward follows.

One way to speed up the extinction of an operantly conditioned response is to put the learner in a situation that is different from the one in which the response was originally learned. The response is likely to be weaker in the new situation, and therefore it will extinguish more quickly. Of course, when the learner is returned to the original learning setting after extinction has occurred elsewhere, the response may undergo spontaneous recovery, just as in classical conditioning. But now the response is likely to be weaker than it was initially, and it should be relatively easy to extinguish once and for all. You may have experienced this phenomenon yourself when you returned home for the holidays after your first semester in college. A habit that you thought you had outgrown at school may have suddenly reappeared. The home setting worked as a "reminder" stimulus, encouraging the response, just as we mentioned when discussing classical conditioning. Because you have already extinguished the habit in another setting, however, extinguishing it at home shouldn't be difficult.

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The skills a person learns in playing tennis may also be utilized in such sports as Ping-Pong, squash, and badminton. This is an example of stimulus generalization in operant conditioning.

Stimulus Control, Generalization, and Discrimination

How can anxiety about math in grade school affect a college student? Why do people often slap the wrong card when playing a game of slapjack?

The home setting acting as a "reminder" stimulus is just one example of how conditioned responses are influenced by surrounding cues in the environment. This outcome is called **stimulus control**, and it occurs in both classical and operant conditioning. In classical conditioning, the conditioned response (CR) is under the control of the conditioned stimulus (CS) that triggers it. Salivation, for example, might be controlled by the sound of a bell. In operant conditioning, the learned response is under the control of whatever stimuli come to be associated with delivery of reward or punishment. A leap to avoid electric shock might come under the control of a flashing light, for instance. In both classical and operant conditioning, moreover, the learner may respond to cues that are merely similar (but not identical) to the ones that prevailed during the original learning. This tendency to respond to similar cues is known as **stimulus generalization**.

Generalization and Discrimination in Classical Conditioning There are many examples of stimulus generalization in classical conditioning. One example is the case of Little Albert, who was conditioned to fear white rats. When the experimenters later showed him a white rabbit, he cried and tried to crawl away, even though he had not been taught to fear rabbits. He also showed fear of other white, furry objects like cotton balls, a fur coat, even a bearded Santa Claus mask. Little Albert had generalized his learned reactions from rats to similar stimuli. In much the same way, a person who learned to feel anxious over math tests in grade school might come to feel anxious about any task involving numbers, even balancing a checkbook.

Stimulus generalization is not inevitable, however. Through a process called **stimulus discrimination**, learners can be trained not to generalize, but rather to make a conditioned response only to a single specific stimulus. This process involves presenting several similar stimuli, only one of which is followed by the unconditioned stimulus. For instance, Albert might have been shown a rat and other white, furry objects, but only the rat would be followed by a loud noise (the US). Given this procedure, Albert would have learned to discriminate the white rat from the other objects, and the fear response would not have generalized as it did.

Learning to discriminate is essential in everyday life. We prefer for children to learn not to fear *every* loud noise and *every* insect, but only those that are potentially harmful. Through stimulus discrimination, behavior becomes more finely tuned to the demands of our environment.

Generalization and Discrimination in Operant Conditioning Stimulus generalization also occurs in operant conditioning. A baby who is hugged and kissed for saying "Mama" when he sees his mother may begin to call everyone "Mama." Although the person whom the baby sees—the stimulus—changes, he responds with the same word.

In operant conditioning, responses, too, can be generalized, not just stimuli. For example, the baby who calls everyone "Mama" may also call people "Nana." His learning has generalized to other sounds that are similar to the correct response, "Mama." This is called **response generalization**. Response generalization doesn't occur in classical conditioning. If a dog is taught to salivate when it hears a high-pitched tone, it will salivate less when it hears a low-pitched tone, but the response is still salivation.

Just as discrimination is useful in classical conditioning, it is also useful in operant conditioning. Learning *what* to do has little value if you do not know *when* to do it. Learning that a response is triggered is pointless if you do not know which response is right. Discrimination training in operant conditioning consists of reinforcing *only* a specific, desired response and *only* in the presence of a specific stimulus. With this procedure, pigeons have been trained to peck at a red disk, but not at a green one. First they are taught to peck at a

stimulus control Control of conditioned responses by cues or stimuli in the environment.

stimulus generalization The transfer of a learned response to different but similar stimuli.

stimulus discrimination Learning to respond to only one stimulus and to inhibit the response to all other stimuli.

response generalization Giving a response that is somewhat different from the response originally learned to that stimulus.

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disk. Then they are presented with two disks, one red and one green. They get food when they peck at the red one, but not when they peck at the green. Eventually they learn to discriminate between the two colors, pecking only at the red.

New Learning Based on Original Learning

How might you build on a conditioned response to make an even more complex form of learning? Why is money such a good reinforcer for most people?

There are other ways, besides stimulus generalization and discrimination, that original learning can serve as the basis for new learning. In classical conditioning, an existing conditioned stimulus can be paired with a new stimulus to produce a new conditioned response. This is called **higher order conditioning**. In operant conditioning, objects that have no intrinsic value can nevertheless become reinforcers because of their association with other, more basic reinforcers. These learned reinforcers are called *secondary reinforcers*.

Higher Order Conditioning Pavlov demonstrated higher order conditioning with his dogs. After the dogs had learned to salivate when they heard a bell, Pavlov used the bell (*without* food) to teach the dogs to salivate at the sight of a black square. Instead of showing them the square and following it with food, he showed them the square and followed it with the bell until the dogs learned to salivate when they saw the square alone. In effect, the bell served as a substitute unconditioned stimulus, and the black square became a new conditioned stimulus. This procedure is known as *higher order conditioning* not because it is more complex than other types of conditioning or because it incorporates any new principles, but simply because it is conditioning based on previous learning.

Higher order conditioning is difficult to achieve because it is battling against extinction of the original conditioned response. The unconditioned stimulus no longer follows the original conditioned stimulus and that is precisely the way to extinguish a classically conditioned response. During higher order conditioning, Pavlov's dogs were exposed to the square followed by the bell, but no food was given. Thus, the square became a signal that the bell would not precede food, and soon all salivation stopped. For higher order conditioning to succeed, the unconditioned stimulus must be occasionally reintroduced. Food must be given once in a while after the bell sounds so that the dogs will continue to salivate when they hear the bell. Explore on MyPsychLab

Explore Higher-Order Conditioning at www.mypsychlab.com

Secondary Reinforcers Some reinforcers, such as food, water, and sex, are intrinsically rewarding in and of themselves. These are called **primary reinforcers**. No prior learning is required to make them reinforcing. Other reinforcers have no intrinsic value. They have acquired value only through association with primary reinforcers. These are the **secondary reinforcers** we mentioned earlier. They are called secondary not because they are less important, but because prior learning is needed before they will function as reinforcers. Suppose a rat learns to get food by pressing a bar; then a buzzer is sounded every time food drops into the dish. Even if the rat stops getting the food, it will continue to press the bar for a while just to hear the buzzer. Although the buzzer by itself has no intrinsic value to the rat, it has become a secondary reinforcer through association with food, a primary reinforcer.

Note how, in creating a secondary reinforcer, classical conditioning is involved. Because it has been paired with an intrinsically pleasurable stimulus, a formerly neutral stimulus comes to elicit pleasure, too. This stimulus can then serve as a reinforcer to establish an operantly conditioned response.

For humans, money is one of the best examples of a secondary reinforcer. Although money is just paper or metal, through its exchange value for primary reinforcers, it becomes a powerful reinforcer. Children come to value money only after they learn that it will buy such things as candy (a primary reinforcer). Then the money becomes a secondary

higher order conditioning Conditioning based on previous learning; the conditioned stimulus serves as an unconditioned stimulus for further training.

primary reinforcers Reinforcers that are rewarding in themselves, such as food, water, or sex.

secondary reinforcers Reinforcers whose value is acquired through association with other primary or secondary reinforcers.

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reinforcer. And through the principles of higher order conditioning, stimuli paired with a secondary reinforcer can acquire reinforcing properties. Checks and credit cards, for example, are one step removed from money, but they can also be highly reinforcing.

Summing Up

Does operant conditioning ever look like classical conditioning?

Classical and operant conditioning both entail forming associations between stimuli and responses, and perceiving contingencies between one event and another. Both are subject to extinction and spontaneous recovery, as well as to stimulus control, generalization, and discrimination. The main difference between the two is that in classical conditioning, the learner is passive and the behavior involved is usually involuntary, whereas in operant conditioning, the learner is active and the behavior involved is usually voluntary.

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CHECK YOUR UNDERSTANDING

1. After extinction and a period of rest, a conditioned response may suddenly reappear. This phenomenon is called ____________ ____________.
2. The process by which a learned response to a specific stimulus comes to be associated with different, but similar stimuli is known as ____________ ____________.
3. Classify the following as primary (P) or secondary (S) reinforcers.
   a. food ____________
   b. money ____________
   c. college diploma ____________
   d. sex ____________

Answers: 1. spontaneous recovery. 2. stimulus generalization. 3. a. (P); b. (S); c. (S); d. (P).

APPLY YOUR UNDERSTANDING

1. On the first day of class, your instructor tells you that there will be unscheduled quizzes *on average* about every 2 weeks throughout the term, but not exactly every 2 weeks. This is an example of a ____________ reinforcement schedule.
   a. continuous
   b. fixed-interval
   c. fixed-ratio
   d. variable-interval
2. In the situation in question 1, what study pattern is the instructor most likely trying to encourage?
   a. slow, steady rates of studying
   b. cramming the night before quizzes
   c. studying a lot right before quizzes, then stopping for a while right after them

Answers: 1. d. 2. a.

LEARNING OBJECTIVES

- **Define cognitive learning and how it can be inferred from evidence of latent learning and cognitive maps.**
- **Explain what is meant by insight and its relation to learning sets.**
- **Explain the process of observational (vicarious) learning and the conditions under which it is most likely to be reflected in behavior.**
- **Give examples of cognitive learning in nonhumans.**

COGNITIVE LEARNING

How would you study the kind of learning that occurs when you memorize the layout of a building?

Some psychologists insist that because classical and operant conditioning can be *observed* and *measured*, they are the only legitimate kinds of learning to study scientifically. But others contend that mental activities are crucial to learning and so can't be ignored. How do you grasp the layout of a building from someone else's description of it? How do you enter

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into memory abstract concepts like *conditioning* and *reinforcement*? You do all these things and many others through **cognitive learning**—the mental processes that go on inside us when we learn. Cognitive learning is impossible to observe and measure directly, but it can be *inferred* from behavior, and so it is also a legitimate topic for scientific study.

cognitive learning Learning that depends on mental processes that are not directly observable.

latent learning Learning that is not immediately reflected in a behavior change.

cognitive map A learned mental image of a spatial environment that may be called on to solve problems when stimuli in the environment change.

Latent Learning and Cognitive Maps

Did you learn your way around campus solely through operant conditioning (rewards for correct turns, punishments for wrong ones), or was something more involved?

Interest in cognitive learning began shortly after the earliest work in classical and operant conditioning (Eichenbaum & Cohen, 2001). In the 1930s, Edward Chace Tolman, one of the pioneers in the study of cognitive learning, argued that we do not need to show our learning in order for learning to have occurred. Tolman called learning that isn't apparent because it is not yet demonstrated **latent learning**. Simulate on MyPsychLab

Simulation on Latent Learning at www.mypsychlab.com

Tolman studied latent learning in a famous experiment (Tolman & Honzik, 1930). Two groups of hungry rats were placed in a maze and allowed to find their way from a start box to an end box. The first group found food pellets (a reward) in the end box; the second group found nothing there. According to the principles of operant conditioning, the first group would learn the maze better than the second group—which is, indeed, what happened. But when Tolman took some of the rats from the second, unreinforced group and started to give them food at the goal box, almost immediately they ran the maze as well as the rats in the first group. (See **Figure 5–8**.) Tolman argued that the unrewarded rats had actually learned a great deal about the maze as they wandered around inside it. In fact, they may have even learned *more* about it than the rats that had been trained with food rewards, but their learning was *latent*—stored internally, but not yet reflected in their behavior. It was not until they were given a motivation to run the maze that they put their latent learning to use.

Since Tolman's time, much work has been done on the nature of latent learning regarding spatial layouts and relationships. From studies of how animals or humans find their way around a maze, a building, or a neighborhood with many available routes, psychologists have proposed that this kind of learning is stored in the form of a mental image, or **cognitive map**. When the proper time comes, the learner can call up the stored image and put it to use.

In response to Tolman's theory of latent learning, Thorndike proposed an experiment to test whether a rat could learn to run a maze and store a cognitive image of the maze without experiencing the maze firsthand. He envisioned researchers carrying each rat through the maze in a small wire-mesh container and then rewarding the rat at the end of each trial as if it had run the maze itself. He predicted that the rat would show little or no evidence of learning as compared with rats that had learned the same maze on their own through trial and error. Neither he nor Tolman ever conducted the experiment.

Two decades later, however, researchers at the University of Kansas did carry out Thorndike's idea (McNamara, Long, & Wike, 1956). But instead of taking the passive rats through the "correct" path, they carried them over the same path that a free-running rat had taken in that maze. Contrary to Thorndike's prediction, the passenger rats learned the maze just as well as the free-running rats. They did, however, need visual cues to learn the maze's layout. If carried through the maze only in the dark, they later showed little latent learning.

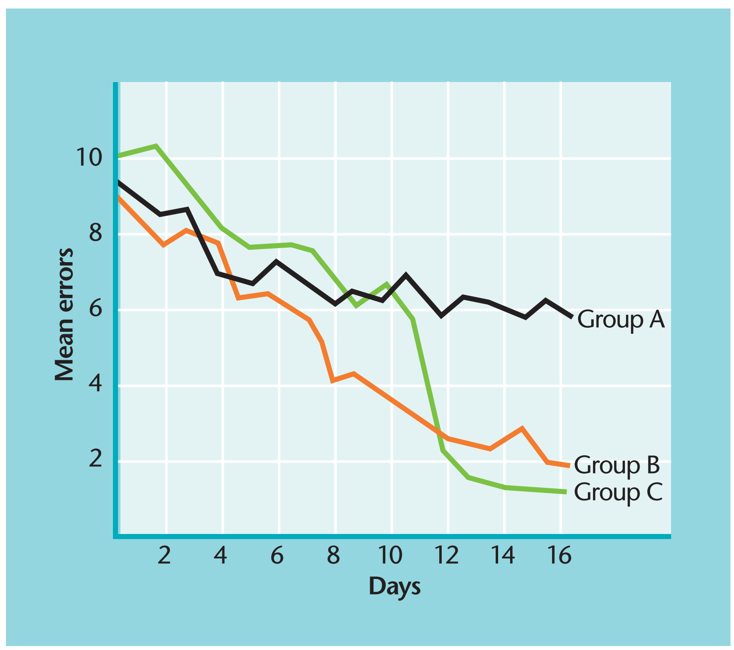

Figure 5–8
Graph showing the results of the Tolman and Honzik study.
The results of the classic Tolman and Honzik study are revealed in the graph. Group A never received a food reward. Group B was rewarded each day. Group C was not rewarded until the 11th day, but note the significant change in the rats' behavior on Day 12. The results suggest that Group C had been learning all along, although this learning was not reflected in their performance until they were rewarded with food for demonstrating the desired behaviors.
Source: Tolman & Honzik, 1930.

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insight Learning that occurs rapidly as a result of understanding all the elements of a problem.

More recent research confirms this picture of cognitive spatial learning. Animals show a great deal more flexibility in solving problems than can be explained by simple conditioning (Collett & Graham, 2004). In experiments using rats in a radial maze, rats are able to recall which arms of the maze contain food, even when scent cues are removed (Grandchamp & Schenk, 2006). Moreover, when the configuration of the maze is repeatedly changed, the rats not only quickly adapt but also remember previous maze configurations (J. Tremblay & Cohen, 2005). Studies such as these suggest that the rats develop a cognitive map of the maze's layout (Save & Poucet, 2005). Even in rats, learning involves more than just a new behavior "stamped in" through reinforcement. It also involves the formation of new mental images and constructs that may be reflected in future behavior.

Insight and Learning Sets

Do you have a learning set for writing a term paper?

During World War I, the German Gestalt psychologist Wolfgang Köhler conducted a classic series of studies into another aspect of cognitive learning: sudden **insight** into a problem's solution. Outside a chimpanzee's cage, Köhler placed a banana on the ground, not quite within the animal's reach. When the chimp realized that it couldn't reach the banana, it reacted with frustration. But then it started looking at what was in the cage, including a stick left there by Köhler. Sometimes quite suddenly the chimp would grab the stick, poke it through the bars of the cage, and drag the banana within reach. The same kind of sudden insight occurred when the banana was hung from the roof of the cage, too high for the chimp to grasp. This time the cage contained some boxes, which the chimp quickly learned to stack up under the banana so that it could climb up to pull the fruit down. Subsequent studies have shown that even pigeons under certain conditions can display insight (R. Epstein, Kirshnit, Lanza, & Rubin, 1984; Aust & Huber, 2006).

Köhler's experiments with chimpanzees illustrate learning through insight. In this photo, one of the chimps has arranged a stack of boxes to reach bananas hanging from the ceiling. Insights gained in this problem-solving situation may transfer to similar ones.

ENDURING ISSUES

Stability–Change Human Insight

Insightful learning is particularly important in humans, who must learn not only where to obtain food and how to escape from predators but also such complex ethical and cultural ideas as the value of hard work, helping others, or overcoming addictions. In Chapter 7, "Cognition and Mental Abilities," we will explore the role of insight in creative problem solving. As we will see, there are times when all other problem-solving techniques fail to produce a solution; in such cases, it is not unusual for the solution to suddenly "pop up" in a moment of insight (Novick & Sherman, 2003). Moreover, to the extent that people gain insight into their own behavior, they should be capable of changing significantly over the course of their lives (Bornstein & Masling, 1998). ■

Previous learning can often be used to help solve problems through insight. This was demonstrated by Harry Harlow in a series of studies with rhesus monkeys (Harlow, 1949). Harlow presented each monkey with two boxes—say, a round green box on the left side of a tray and a square red box on the right side. A morsel of food was put under one of the boxes. The monkey was permitted to lift just one box; if it chose the correct box, it got the food. On the next trial, the food was put under the same box (which had been moved to a new position), and the monkey again got to choose just one box. Each monkey had six trials to figure out that the same box covered the food no matter where that box was located. Then the monkeys were given a new set of choices—say, between a blue triangular box and an orange oval one—and another six trials, and so on with other shapes and colors of boxes. The solution was always the same: The food was invariably under only one of the boxes. Initially the monkeys chose boxes randomly, sometimes finding the food, sometimes not. After a while, however, their behavior changed: In just one or two trials, they would

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find the correct box, which they chose consistently thereafter until the experimenter changed the boxes. They seemed to have learned the underlying principle—that the food would always be under the same box—and they used that learning to solve almost instantly each new set of choices given.

Harlow concluded that the monkeys "learned how to learn," that is, they had established a **learning set** regarding this problem: Within the limited range of choices available to them, they had discovered how to tell which box would give the reward. Similarly, Köhler's chimps could be said to have established a learning set regarding how to get food that was just out of reach. When presented with a new version of the problem, they simply called upon past learning in a slightly different situation (reaching a banana on the ground versus reaching one hanging from the ceiling). In both Harlow's and Köhler's studies, the animals seemed to have learned more than just specific behaviors: They had apparently learned *how* to learn. More recent studies confirm learning sets can be formed by other species of primates such as capuchin and rhesus monkeys (Beran, 2008), and even by rats (Bailey, 2006). Moreover, research with humans has shown that the prefrontal cortex (**Figure 2–8**), which plays a pivotal role in human insight (van der Plasse, & Feenstra, 2008; Yokoyama, Tsukada, Watanabe, & Onoe, 2005), is also involved in learning set formation in monkeys (Browning, Easton, & Gaffan, 2007). Whether this means that nonhuman animals can think is an issue still being debated.

learning set The ability to become increasingly more effective in solving problems as more problems are solved.

observational (or vicarious) learning Learning by observing other people's behavior.

social learning theorists Psychologists whose view of learning emphasizes the ability to learn by observing a model or receiving instructions, without firsthand experience by the learner.

Learning by Observing

Why would it be harder to learn to drive a car if you had never been in one before? Why is it hard for deaf children to learn spoken language when they can easily be reinforced for correct speech sounds?

The first time you drove a car, you successfully turned the key in the ignition, put the car in gear, and pressed the gas pedal without having ever done any of those things before. How were you able to do that without step-by-step shaping of the correct behaviors? The answer is that like Adrian Cole, the 4-year-old driver described at the start of the chapter, you had often watched other people driving, a practice that made all the difference. There are countless things we learn by watching other people and listening to what they say. This process is called **observational** or **vicarious learning**, because although we are learning, we don't have to do the learned behaviors firsthand; we merely view or hear the modeled behavior. Observational learning is a form of "social learning," in that it involves interaction with other people. Psychologists who study it are known as **social learning theorists**.

Observational learning is very common. In fact, recent evidence shows that young children often "over imitate"—slavishly following what they are shown to do, even when that is not the most effective way to behave (Horner & Whiten, 2005; Zimmer, 2005). By watching other people who model new behavior we can learn such things as how to start a lawn mower and how to saw wood. Research has shown that we can even learn bad habits, such as smoking, by watching actors smoke in a movie (Dal Cin, Gibson, Zanna, Shumate, & Fong, 2007). When the Federal Communications Commission (FCC) banned cigarette commercials on television, it was acting on the belief that providing models of smokers would prompt people to imitate smoking.

Of course, we do not imitate *everything* that other people do. Why are we selective in our imitation? There are several reasons (Bandura, 1977, 1986; Whiten, Horner, & Marshall-Pescini, 2005). First, we can't pay attention to everything going on around us. The behaviors we are most likely to imitate are those that are modeled by someone who commands our attention (as does a famous or attractive person, or an expert). Second, we must remember what a model does in order to imitate it. If a behavior isn't memorable, it won't be learned. Third, we must make an effort to convert what we see into action. If we have no motivation to perform an observed behavior, we probably won't show

In observational or vicarious learning, we learn by watching a model perform a particular action and then trying to imitate that action correctly. Some actions would be very difficult to master without observational learning.

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vicarious reinforcement (or punishment) Reinforcement or punishment experienced by models that affects the willingness of others to perform the behaviors they learned by observing those models.

what we've learned. This is a distinction between *learning* and *performance*, which is crucial to social learning theorists: We can learn without any change in overt behavior that demonstrates our learning. Whether or not we act depends on our motivation.

One important motivation for acting is the kind of consequences associated with an observed behavior—that is, the rewards or punishments it appears to bring. These consequences do not necessarily have to happen to the observer. They may happen simply to the other people whom the observer is watching. This is called **vicarious reinforcement** or **vicarious punishment**, because the consequences aren't experienced firsthand by the learner: They are experienced *through* other people. If a young teenager sees adults drinking and they seem to be having a great deal of fun, the teenager is experiencing vicarious reinforcement of drinking and is much more likely to imitate it.

The foremost proponent of social learning theory is Albert Bandura, who refers to his perspective as a *social cognitive theory* (Bandura, 1986, 2004). In a classic experiment, Bandura (1965) showed that people can learn a behavior without being reinforced directly for it and that learning a behavior and performing it are not the same thing. Three groups of nursery schoolchildren watched a film in which an adult model walked up to an adult-size plastic inflated doll and ordered it to move out of the way. When the doll failed to obey, the model became aggressive, pushing the doll on its side, punching it in the nose, hitting it with a rubber mallet, kicking it around the room, and throwing rubber balls at it. However, each group of children saw a film with a different ending. Those in the *model-rewarded condition* saw the model showered with candies, soft drinks, and praise by a second adult (vicarious reinforcement). Those in the *model-punished condition* saw the second adult shaking a finger at the model, scolding, and spanking him (vicarious punishment). And those in the *no-consequences condition* saw nothing happen to the model as a result of his aggressive behavior.

Immediately after seeing the film, the children were individually escorted into another room where they found the same large inflated doll, rubber balls, and mallet, as well as many other toys. Each child played alone for 10 minutes, while observers behind a one-way mirror recorded the number of imitated aggressive behaviors that the child spontaneously

After watching an adult behave aggressively toward an inflated doll, the children in Bandura's study imitated many of the aggressive acts of the adult model.

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performed in the absence of any direct reinforcement for those actions. After 10 minutes, an experimenter entered the room and offered the child treats in return for imitating things the model had done. This was a measure of how much the child had previously learned from watching the model, but perhaps hadn't yet displayed.

The green bars in **Figure 5–9** show that *all* the children had learned aggressive actions from watching the model, even though they were not overtly reinforced for that learning. When later offered treats to copy the model's actions, they all did so quite accurately. In addition, the yellow bars in the figure show that the children tended to suppress their inclination spontaneously to imitate an aggressive model when they had seen that model punished for aggression. This result was especially true of girls. Apparently, vicarious punishment provided the children with information about what might happen to them if they copied the "bad" behavior. Vicarious reinforcement similarly provides information about likely consequences, but in this study, its effects were not large. For children of this age (at least those not worried about punishment), imitating aggressive behavior toward a doll seems to have been considered "fun" in its own right, even without being associated with praise and candy. This outcome was especially true for boys.

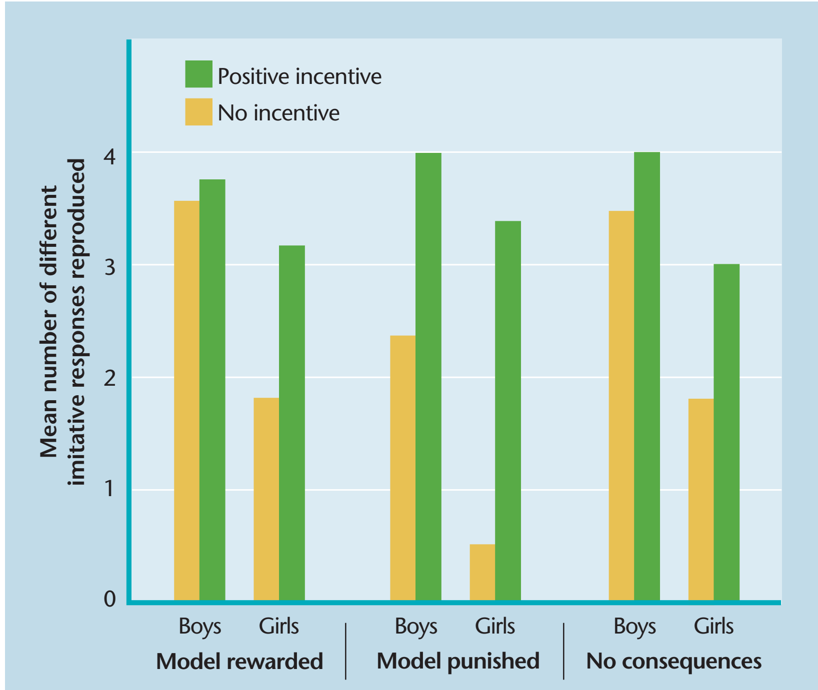

Figure 5–9
Results of Bandura's study.
As the graph shows, even though all the children in Bandura's study of imitative aggression learned the model's behavior, they performed differently depending on whether the model whom they saw was rewarded or punished.

Source: Results of Bandura's study. From "Influence of models' reinforcement contingencies on the acquisition of imitative responses" by A. Bandura, *Journal of Personality and Social Psychology*, 1, 592, 1965. Reprinted by permission of the American Psychological Association and the author.

This study has important implications regarding how not to teach aggression unintentionally to children. Suppose that you want to get a child to stop hitting other children. You might think that slapping the child as punishment would change the behavior, and it probably would suppress it to some extent. But slapping the child also demonstrates that hitting is an effective means of getting one's way. So slapping not only provides a model of aggression; it also provides a model associated with vicarious reinforcement. Perhaps this is why children who experience corporal punishment are more likely to imitate the violent behavior of their parents when they become adults (Barry, 2007). You and the child would both be better off if the punishment given for hitting was not a similar form of aggression and if the child could also be rewarded for showing appropriate interactions with others (Bandura, 1973, 1977; Gershoff & Bitensky, 2007).

Social learning theory's emphasis on expectations, insights, and information broadens our understanding of how people learn. According to social learning theory, humans use their powers of observation and thought to interpret their own experiences and those of others when deciding how to act (Bandura, 1962). Moreover, Bandura and more recently others (Duncan & McKeachie, 2005; Schunk, 2005) stress that human beings are capable of setting performance standards for themselves and then rewarding (or punishing) themselves for achieving or failing to achieve those standards as a way to regulate their own behavior. This important perspective can be applied to the learning of many different things, from skills and behavioral tendencies to attitudes, values, and ideas.

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Cognitive Learning in Nonhumans

Are nonhuman animals capable of cognitive learning?

We have seen that contemporary approaches to conditioning emphasize that conditioned stimuli, reinforcers, and punishers provide information about the environment. Classical and operant conditioning are not viewed as purely mechanical processes that can proceed without at least some cognitive activity. Moreover, animals are capable of latent learning, learning cognitive maps, and insight, all of which involve cognitive processes. Thus,

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Use of sponges as tools among some dolphins. Dolphins have been observed using sponges to protect their snouts as they probe the sea floor searching for fish. Researchers believe mother dolphins teach this sponge-tool technique to their young. See http://animal.discovery.com/news/briefs/20050606/dolphin.html

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because all animals can be conditioned, we might reasonably conclude that all animals are capable of at least minimal cognitive processing of information. Do nonhuman animals also exhibit other evidence of cognitive learning? The answer seems to be a qualified yes.

For example, in the wild, chimpanzees learn to use long sticks to fish for termites by watching their mothers (Lonsdorf, 2005). Capuchin monkeys show they can benefit from the *mistakes* of other monkeys they watched make unsuccessful attempts at opening a container (Kuroshima, Kuwahata, & Fujita, 2008). Some female dolphins in Australia cover their sensitive beaks with sponges when foraging for food on the sea floor, a skill they apparently learn by imitating their mothers (Krützen et al., 2005). Meerkats have been observed teaching their young how to hunt and handle difficult prey (A. Thornton, 2008). And even rats that watch other rats try a novel or unfamiliar food without negative consequences show an increased tendency to eat the new food (Galef & Whiskin, 2004; Galef, Dudley, & Whiskin, 2008). These surprising results, along with reports that animals as diverse as chickens and octopi, whales and bumblebees learn by watching others, further support the notion that nonhuman animals do indeed learn in ways that reflect the cognitive theory of learning.

CHECK YOUR UNDERSTANDING

Match the following terms with the appropriate definition.

1. ___ latent learning
2. ___ insight
3. ___ observational learning

a. new, suddenly occurring idea to solve a problem
b. learning by watching a model
c. learning that has not yet been demonstrated in behavior

Are the following statements true (T) or false (F)?

4. ____________ "Social learning theory broadens our understanding of how people learn skills and gain abilities by emphasizing expectations, insight, information, self-satisfaction, and self-criticism."
5. ____________ "Social learning theory supports spanking as an effective way to teach children not to hit."

Answers: 1. (c). 2. (a). 3. (b). 4. (T). 5. (F).

APPLY YOUR UNDERSTANDING

1. An ape examines a problem and the tools available for solving it. Suddenly the animal leaps up and quickly executes a successful solution. This is an example of
   a. insight.
   b. operant conditioning.
   c. trial-and-error learning.
2. Before Junior got his driver's license, he rode along whenever his older sister had driving lessons, watching and listening carefully, especially when she had trouble learning to parallel park and another driver yelled at her for denting his fender. When Junior's turn to drive came, he was especially careful never to bump other cars when parallel parking. Junior learned to avoid parallel parking collisions as a result of
   a. insight.
   b. vicarious punishment.
   c. trial-and-error learning.
   d. higher order conditioning.

Answers: 1. a. 2. b.

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CHAPTER REVIEW

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CLASSICAL CONDITIONING

How did Pavlov discover classical conditioning? **Learning** is the process by which experience or practice produces a relatively permanent change in behavior or potential behavior. One basic form of learning involves learning to associate one event with another. **Classical conditioning** is a type of associative learning that Pavlov discovered while studying digestion. Pavlov trained a dog to salivate at the sound of a bell when he rang the bell just before food was given. The dog learned to associate the bell with food and began to salivate at the sound of the bell alone.

How might you classically condition a pet? Suppose you wanted to classically condition salivation in your own dog. You know that food is an **unconditioned stimulus (US)** that automatically evokes the **unconditioned response (UR)** of salivation. By repeatedly pairing food with a second, initially neutral stimulus (such as a bell), the second stimulus would eventually become a **conditioned stimulus (CS)** eliciting a **conditioned response (CR)** of salivation.

If you once burned your finger on a match while listening to a certain song, why doesn't that song now make you reflexively jerk your hand away? Establishing a classically conditioned response usually is easier if the US and CS are paired with each other repeatedly, rather than a single time or even once in a while (**intermittent pairing**). That is why a single burn to your finger is not usually enough to produce a classically conditioned response. It is also important that the spacing of pairings be neither too far apart nor too close together.

What is an example of classical conditioning in your own life? In the case of Little Albert, Watson conditioned a child to fear white rats by always pairing a loud, frightening noise with a rat. Perhaps you have acquired a classically conditioned fear or anxiety (to the sound of a dentist's drill, for instance) in much the same way; or perhaps you have also unlearned a conditioned fear by repeatedly pairing the feared object with something pleasant. Mary Cover Jones paired the sight of a feared rat (at gradually decreasing distances) with a child's pleasant experience of eating candy. This procedure was the precursor to **desensitization therapy**.

Why are people more likely to develop a phobia of snakes than of flowers? The concept of **preparedness** accounts for the fact that certain conditioned responses are acquired very easily. The ease with which we develop **conditioned taste aversions** illustrates preparedness. Because animals are biologically prepared to learn them, conditioned taste aversions can occur with only one pairing of the taste of a tainted food and later illness, even when there is a lengthy interval between eating the food and becoming ill. A fear of snakes may also be something that humans are prepared to learn.

OPERANT CONDITIONING

How are operant behaviors different from the responses involved in classical conditioning? **Operant** or **instrumental conditioning** is learning to make or withhold a certain response because of its consequences. **Operant behaviors** are different from the responses involved in classical conditioning because they are voluntarily emitted, whereas those involved in classical conditioning are elicited by stimuli.

What two essential elements are involved in operant conditioning? One essential element in operant conditioning is an operant behavior, or a behavior performed by one's own volition while "operating" on the environment. The second essential

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element is a consequence associated with that operant behavior. When a consequence increases the likelihood of an operant behavior's being emitted, it is called a **reinforcer**. When a consequence decreases the likelihood of an operant behavior, it is called a **punisher**. These relationships are the basis of the **law of effect**, or **principle of reinforcement**: Consistently rewarded behaviors are likely to be repeated, whereas consistently punished behaviors are likely to be suppressed.

How might a speech therapist teach the sound of "s" to a child with a lisp? To speed up establishing an operantly conditioned response in the laboratory, the number of potential responses may be reduced by restricting the environment, as in a **Skinner box**. For behaviors outside the laboratory, which cannot be controlled so conveniently, the process of **shaping** is often useful. In shaping, reinforcement is given for successive approximations to the desired response. A speech therapist might use shaping to teach a child to pronounce a certain sound correctly.

What is the difference between positive and negative reinforcement? What are some of the unintentional effects that reinforcement can have? Several kinds of reinforcers strengthen or increase the likelihood of behavior. **Positive reinforcers** (such as food) add something rewarding to a situation. **Negative reinforcers** (for example, stopping an electric shock) subtracts something unpleasant. When an action is followed closely by a reinforcer, we tend to repeat the action, even if it did not actually produce the reinforcement. Such behaviors are called *superstitious*.

What problems can punishment create? **Punishment** is any unpleasant consequence that decreases the likelihood that the preceding behavior will recur. Whereas negative reinforcement strengthens behavior, punishment weakens it. Although punishment can be effective, it also can stir up negative feelings and serve to model aggressive behavior. Also, rather than teaching a more desirable response, it only suppresses an undesirable one. After punishment has occurred a few times, further repetitions sometimes are unnecessary because the threat of punishment is enough. With this process, called **avoidance training,** people learn to avoid the possibility of a punishing consequence.

In what ways do some college students exhibit learned helplessness? When people or other animals are unable to escape from a punishing situation, they may acquire a "giving-up" response, called **learned helplessness**. Learned helplessness can generalize to new situations, causing resignation in the face of unpleasant outcomes, even when the outcomes can be avoided. A college student who gives up trying to do well in school after a few poor grades on tests is exhibiting learned helplessness.

How can operant conditioning be used to control biological functioning? When operant conditioning is used to control biological functions, such as blood pressure or heart rate, it is referred to as **biofeedback.** When it is used to control brain waves it is called **neurofeedback.** Biofeedback and neurofeedback have been successfully applied to a variety of medical problems, including migraine headaches, hypertension, and asthma. Biofeedback has also been used by athletes and musicians to improve performance and control anxiety.

FACTORS SHARED BY CLASSICAL AND OPERANT CONDITIONING

Can you think of any similarities between classical and operant conditioning? Despite the differences between classical and operant conditioning, these two forms of learning have many things in common. (1) Both cases involve learned associations; (2) in both cases, responses come under control of stimuli in the environment; (3) in both cases, the responses will gradually disappear if they are not periodically renewed; and (4) in both cases, new behaviors can build upon previously established ones.

How can changes in the timing of a conditioned stimulus lead to unexpected learning? Why does intermittent reinforcement result in such persistent behavior? In both classical and operant conditioning, an "if–then" relationship, or **contingency**, exists either between two stimuli or between a stimulus and a response. In both these kinds of learning, perceived contingencies are very important.

In classical conditioning, the contingency is between the CS and the US. The CS comes to be viewed as a signal that the US is about to happen. For that reason, the CS must not only occur in close proximity to the US, but must also precede the US and provide predictive information about it. If the CS occurs *after* the US, it will come to serve as a signal that the US is over, not that the US is imminent.

In operant conditioning, contingencies exist between responses and consequences. Contingencies between responses and rewards are called **schedules of reinforcement**. *Partial reinforcement*, in which rewards are given only for some correct responses, generates behavior that persists longer than that learned by *continuous reinforcement*. A **fixed-interval schedule**, by which reinforcement is given for the first correct response after a fixed time period, tends to result in a flurry of responding right before a reward is due. A **variable-interval schedule**, which reinforces the first correct response after an unpredictable period of time, tends to result in a slow, but steady pattern of responding. In a **fixed-ratio schedule**, behavior is rewarded after a fixed number of correct responses, so the result is usually a high rate of responding. Finally, a **variable-ratio schedule** provides reinforcement after a varying number of correct responses. It encourages a high rate of response that is especially persistent.

Can you ever get rid of a conditioned response? Under what circumstances might old learned associations suddenly reappear? Learned responses sometimes weaken and may even disappear, a phenomenon called **extinction**. The learning is not necessarily completely forgotten, however. Sometimes a **spontaneous recovery** occurs, in which the learned response suddenly reappears on its own, with no retraining.

Extinction is produced in classical conditioning by failure to continue pairing the CS and the US. The CS no longer serves as a signal that the US is about to happen, and so the conditioned response dies out. An important contributing factor is often new, learned associations that interfere with the old one. In situations in which you are reminded of the old association, spontaneous recovery may occur.

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Extinction occurs in operant conditioning when reinforcement is withheld until the learned response is no longer emitted. The ease with which an operantly conditioned behavior is extinguished varies according to several factors: the strength of the original learning, the variety of settings in which learning took place, and the schedule of reinforcement used during conditioning.

How can anxiety about math in grade school affect a college student? Why do people often slap the wrong card when playing a game of slapjack? When conditioned responses are influenced by surrounding cues in the environment, **stimulus control** occurs. The tendency to respond to cues that are similar, but not identical, to those that prevailed during the original learning is known as **stimulus generalization**. An example of stimulus generalization in classical conditioning is a student's feeling anxious about studying math in college because he or she had a bad experience learning math in grade school. **Stimulus discrimination** enables learners to perceive differences among cues so as not to respond to all of them.

In operant conditioning, the learned response is under the control of whatever cues come to be associated with delivery of reward or punishment. Learners often generalize about these cues, responding to others that are broadly similar to the ones that prevailed during the original learning. An example is slapping any face card in a game of slapjack. Learners may also generalize their responses by performing behaviors that are similar to the ones that were originally reinforced. This result is called **response generalization**. Discrimination in operant conditioning is taught by reinforcing only a certain response and only in the presence of a certain stimulus.

How might you build on a conditioned response to make an even more complex form of learning? Why is money such a good reinforcer for most people? In both classical and operant conditioning, original learning serves as a building block for new learning. In classical conditioning, an earlier CS can be used as an US for further training. For example, Pavlov used the bell to condition his dogs to salivate at the sight of a black square. This effect, which is called **higher order conditioning**, is difficult to achieve because of extinction. Unless the original unconditioned stimulus is presented occasionally, the initial conditioned response will die out.

In operant conditioning, initially neutral stimuli can become reinforcers by being associated with other reinforcers. A **primary reinforcer** is one that, like food and water, is rewarding in and of itself. A **secondary reinforcer** is one whose value is learned through its association with primary reinforcers or with other secondary reinforcers. Money is such a good secondary reinforcer because it can be exchanged for so many different primary and secondary rewards.

Does operant conditioning ever look like classical conditioning? Despite their differences, classical and operant conditioning share many similarities: Both involve associations between stimuli and responses; both are subject to extinction and spontaneous recovery as well as generalization and discrimination; in both, new learning can be based on original learning. Operant conditioning can even be used, in **biofeedback** and **neurofeedback** training, to learn to control physiological responses that are usually learned through classical conditioning. Many psychologists now wonder whether classical and operant conditioning aren't just two ways of bringing about the same kind of learning.

COGNITIVE LEARNING

How would you study the kind of learning that occurs when you memorize the layout of a chessboard? **Cognitive learning** refers to the mental processes that go on inside us when we learn. Some kinds of learning, such as memorizing the layout of a chessboard, seem to be purely cognitive, because the learner does not appear to be "behaving" while the learning takes place. Cognitive learning, however, can always affect future behavior, such as reproducing the layout of a memorized chessboard after it is cleared away. It is from such observable behavior that cognitive learning is inferred.

Did you learn your way around campus solely through operant conditioning (rewards for correct turns, punishments for wrong ones) or was something more involved? **Latent learning** is any learning that has not yet been demonstrated in behavior. Your knowledge of psychology is latent if you have not yet displayed it in what you say, write, and do. One kind of latent learning is knowledge of spatial layouts and relationships, which is usually stored in the form of a **cognitive map.** Rewards or punishments aren't essential for latent learning to take place. You did not need rewards and punishments to learn the layout of your campus, for example. You acquired this cognitive map simply by storing your visual perceptions.

Do you have a learning set for writing a term paper? A **learning set** is a concept or procedure that provides a key to solving a problem even when its demands are slightly different from those of problems you have solved in the past. As a student, you probably have a learning set for writing a term paper that allows you successfully to develop papers on many different topics. A learning set can sometimes encourage **insight** or the sudden perception of a solution even to a problem that at first seems totally new. In this case, you are perceiving similarities between old and new problems that weren't initially apparent.

Why would it be harder to learn to drive a car if you had never been in one before? Why is it hard for deaf children to learn spoken language when they can easily be reinforced for correct speech sounds? **Social learning theorists** argue that we learn much by observing other people who model a behavior or by simply hearing about something. This process is called **observational** (or **vicarious**) **learning**. It would be harder to learn to drive a car without ever having been in one because you would lack a model of "driving behavior." It is hard for deaf children to learn spoken language because they have no auditory model of correct speech.

The extent to which we imitate behaviors learned through observation depends on our motivation to do so. One important motivation is any reward or punishment that we have seen the behavior bring. When a consequence isn't experienced firsthand, but only occurs to other people, it is called **vicarious reinforcement** or **vicarious punishment**.

Are nonhuman animals capable of cognitive learning? Research has shown that many animals, including chimpanzees, dolphins, whales, rats, octopi, and even bumblebees are capable of various forms of cognitive learning.

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