Unit VI

Learning

Modules

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When a chinook salmon first emerges from its egg in a stream's gravel bed, its genes provide most of the behavioral instructions it needs for life. It knows instinctively how and where to swim, what to eat, and most spectacularly, where to go and when and how to return to its birthplace. Guided by the scent of its home stream, it pursues an upstream odyssey to its ancestral spawning ground and seeks out the best gravel and water flow for breeding. It then mates and, its life mission accomplished, dies.

Unlike salmon, we are not born with a genetic plan for life. Much of what we do we learn from experience. Although we struggle to find the life direction a salmon is born with, our learning gives us more flexibility. We can learn how to build grass huts or snow shelters, submarines or space stations, and thereby adjust to almost any environment. Indeed, nature's most important gift to us may be our adaptability—our capacity to learn new behaviors that help us cope with changing circumstances.

Learning breeds hope. What is learnable we can potentially teach—a fact that encourages parents, teachers, coaches, and animal trainers. What has been learned we can potentially change by new learning—an assumption that underlies counseling, psychotherapy, and rehabilitation programs. No matter how unhappy, unsuccessful, or unloving we are, that need not be the end of our story.

No topic is closer to the heart of psychology than learning. In earlier units we considered how we learn to think critically, and the learning of visual perceptions and of a drug's expected effect. In later units we will see how learning shapes our thoughts and language, our motivations and emotions, our personalities and attitudes. In Unit VII, we will see how the brain stores and retrieves learning.

Module 26

How We Learn and Classical Conditioning

Module Learning Objectives

26-1 Define learning, and identify some basic forms of learning.
26-2 Describe the basic components of classical conditioning, and explain behaviorism's view of learning.
26-3 Summarize the processes of acquisition, extinction, spontaneous recovery, generalization, and discrimination.
26-4 Explain why Pavlov's work remains so important, and describe some applications of his work to human health and well-being.

How Do We Learn?

26-1 What is learning, and what are some basic forms of learning?

Psychologists define learning as the process of acquiring new and relatively enduring information or behaviors. By learning, we humans are able to adapt to our environments. We learn to expect and prepare for significant events such as food or pain (classical conditioning). We typically learn to repeat acts that bring rewards and to avoid acts that bring unwanted results (operant conditioning). We learn new behaviors by observing events and by watching others, and through language we learn things we have neither experienced nor observed (cognitive learning). But how do we learn?

More than 200 years ago, philosophers such as John Locke and David Hume echoed Aristotle's conclusion from 2600 years earlier: We learn by association. Our minds naturally
connect events that occur in sequence. Suppose you see and smell freshly baked bread, eat some, and find it satisfying. The next time you see and smell fresh bread, you will expect that eating it will again be satisfying. So, too, with sounds. If you associate a sound with a frightening consequence, hearing the sound alone may trigger your fear. As one 4-year-old exclaimed after watching a TV character get mugged, "If I had heard that music, I wouldn't have gone around the corner!" (Wellis, 1981).

Learned associations often operate subtly. Give people a red pen (associated with error marking) rather than a black pen, and when correcting essays, they will spot more errors and give lower grades (Rutchick et al., 2010). When voting, people are more likely to support taxes to aid education if their assigned voting place is in a school (Berger et al., 2008).

Learned associations also feed our habitual behaviors (Wood & Neal, 2007). As we repeat behaviors in a given context—sleeping in a certain posture in bed, walking certain routes from class to class, eating popcorn in a movie theater—the behaviors become associated with the contexts. Our next experience of the context then evokes our habitual response. How long does it take to form such habits? To find out, one British research team asked 90 university students to choose some healthy behavior (such as running before dinner or eating fruit with lunch), to do it daily for 84 days, and to record whether the behavior felt automatic (something they did without thinking and would find it hard not to do). On average, behaviors became habitual after about 66 days (Lally et al., 2010). (Is there something you'd like to make a routine part of your life? Just do it every day for two months, or a bit longer for exercise, and you'll likely find yourself with a new habit.)

Other animals also learn by association. Disturbed by a squall of water, the sea slug Aplysia protectsively withdraws its gills. If the squall continues, as happens naturally in choppy water, the withdrawal response diminishes. We say the slug habituates. But if the sea slug repeatedly receives an electric shock just after being squirted, its response to the squid instead grows stronger. The animal has associated the squid with the impending shock.

Complex animals can associate their own behavior with its outcomes. An aquarium seal will repeat behaviors, such as slapping and barking, that prompt people to toss it a herring.

By linking two events that occur close together, both animals and herein are exhibiting associative learning. The sea slug associates the squall with an impending shock; the seal associates slapping and barking with a herring treat. Each animal has learned something important to its survival: predicting the immediate future.

This process of learning associations is conditioning, and it takes two main forms:

- In classical conditioning, we learn to associate two stimuli and thus to anticipate events. (A stimulus is any event or situation that evokes a response.) We learn that a flash of lightning signals an impending crack of thunder; when lightning flashes nearby, we start to brace ourselves (FIGURE 26.1).
- In operant conditioning, we learn to associate a response (our behavior) and its consequence. Thus we (and other animals) learn to repeat acts followed by good results (FIGURE 26.2) and avoid acts followed by bad results.

To simplify, we will explore these two types of associative learning separately. Often, though, they occur together, as on one Japanese cattle ranch, where the clever rancher outfitted his herd with electronic pages, which he calls from his cell phone. After a week of training, the animals learn to associate two stimuli—the beep on their pager and the arrival of food (classical conditioning). But they also learn to associate their hasty flight to the food trough with the pleasure of eating (operant conditioning).

Before You Move On

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- Can you remember some example from your childhood of learning through classical conditioning—perhaps salivating at the sound or smell of some delicious food cooking in your family kitchen? Can you remember an example of operant conditioning, when you repeatedly did (or did not repeat) a behavior because you liked (or hated) its consequences? Can you recall watching someone else perform some act and later repeating or avoiding that act?

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As we develop, we learn cues that lead us to expect and prepare for good and bad events. We learn to repeat behaviors that bring rewards. And we watch others act and learn. What do psychologists call these three types of learning?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.
Classical Conditioning

26-2 What are the basic components of classical conditioning, and what was behaviorism's view of learning?

For many people, the name Ivan Pavlov (1849–1936) rings a bell. His early twentieth-century experiments—now psychology’s most famous research—were classics, and the phenomenon he explored is called classical conditioning.

Pavlov’s work laid the foundation for many of psychology’s most-used research methods. As a result, behaviorists today agree with (1) but not with (2).

neutral stimulus (NS) in classical conditioning, a stimulus that elicits no response before conditioning.

Pavlov’s Experiments

Pavlov was driven by a lifelong passion for research. After setting aside his initial plan to follow his father into the Russian Orthodox priesthood, Pavlov received a medical degree at age 33 and spent the next two decades studying the digestive system. This work earned him Russia’s first Nobel Prize in 1904. But his novel experiments on learning, which consumed the last three decades of his life, earned him the esteem of the scientific community.

Pavlov’s new direction came when his creative mind seized on an incidental observation. Without fail, putting food in a dog’s mouth caused the animal to salivate. Moreover, the dog began salivating not only at the taste of the food, but also at the mere sight of the food, or at the foodish dress, or at the very sound of that person’s approach. At first, Pavlov considered these “psychic secretions” an annoyance—until he realized they pointed to a simple but important form of learning.

Pavlov and his assistants tried to imagine what the dog was thinking and feeling as it drooled in anticipation of the food. This only led them into fruitless debates. So, to explore the phenomenon more objectively, they experimented. To eliminate other possible influences, they isolated the dog in a small room, secured it in a harness, and attached a device to divert its saliva to a measuring instrument (FIGURE 26.3). From the next room, they presented food—first by sliding in a food bowl, later by bursting meat powder into the dog’s mouth at a precise moment. They then paired various neutral stimuli (NSs) and measured the dog’s saliva. If a sight or sound signaled the arrival of food, would the dog begin to salivate? If so, would it begin salivating in anticipation of the food?

The answers proved to be yes and yes. Just before placing food in the dog’s mouth, an unconditioned stimulus (US) produced salivation, Pavlov sounded a tone. After several pairings of tone and food, the dog’s just anticipated the meat powder, began salivating to the tone alone. In later experiments, a buzzer, a light, a touch on the leg, even the sight of a circle set off the drooling. (This procedure works with people, too. When hungry young Londoners viewed abstract figures before eating peanut butter or vanilla, their brain soon responded in anticipation to the abstract images alone.)

A dog doesn’t learn to salivate in response to food in its mouth. Food in the mouth automatically, unconditioned, triggers a dog’s salivary reflex (FIGURE 26.4). Thus, Pavlov called the drooling an unconditioned response (UR). And he called the food an unconditioned stimulus (US).

1. The “buzzer” (English translation) was perhaps Pavlov’s supposed bell—a small electric bell (Fest, 1977).

unconditioned response (UR) in classical conditioning an unlearned, naturally occurring response (such as salivation) to an unconditioned stimulus (US) (such as food in the mouth).

unconditioned stimulus (US) in classical conditioning, a stimulus that unconditionally—naturally and automatically—triggers a response (UR).

Figure 26.3 Pavlov’s device for recording saliva. A tube in the dog’s cheek collects saliva, which is measured in a cylinder outside the chamber.
Salivation in response to the tone, however, is learned. Because it is conditional upon the dog's associating the tone and the food, we call this response the **conditioned response** (CR). The stimulus that used to be neutral (the tone) and is now a conditioned stimulus (CS), is a previously meaningless tone that now triggers the salivation. This is the **conditioned stimulus** (CS). Distinguishing these two kinds of stimuli and responses is easy: Conditioned = learned; unconditioned = unlearned.

Let's check your understanding with a second example. An experimenter sounds a tone just before delivering an air puff to your blinking eye. After several repetitions, you blink to the tone alone. What is the NS? The US? The US'?' The CS? The CR?

If Pavlov's demonstration of associative learning was so simple, what did he do for the next three decades? What discoveries did his research factory publish in his 532 pages on salivary conditioning (Windholz, 1997)? He and his associates explored five major conditioning processes: acquisition, extinction, spontaneous recovery, generalization, and discrimination.

**ACQUISITION**

In classical conditioning, what are the processes of acquisition, extinction, spontaneous recovery, generalization, and discrimination?

To understand the **acquisition**, or initial learning, of the stimulus-response relationship, Pavlov and his associates had to confront the question of timing. How much time should elapsed between presenting the NS (the tone, the light, the touch) and the US (the food)? In most cases, not much—half a second usually works well.

What do you suppose would happen if the food (US) appeared before the tone (NS) rather than after? Would conditioning occur? Not likely. With just a few exceptions, conditioning doesn't happen when the NS follows the US. Remember, classical conditioning is biologically adaptive because it helps humans and other animals prepare for good or bad events. To Pavlov's dogs, the originally neutral tone became a CS after signaling an important biological event—the arrival of food (US). To deet in the forest, the snapping of a twig (CS) may signal a predator's approach (US). If the good or bad event has already occurred, the tone or the sound won't help the animal prepare.

More recent research on male Japanese quail shows how a CS can signal another important biological event (Dornjan, 1992, 1994, 2005). Just before presenting an approachable female quail, the researchers turned on a red light. Over time, as the red light continued to herald the female's arrival, the light caused the male quail to become excited. They developed a preference for their cage's red-light district, and when a female appeared, they mated with her more quickly and released more semen and sperm (Matthews et al., 2007). All in all, the quail's capacity for classical conditioning gives it a reproductive edge.

In humans, too, objects, smells, and sights associated with sexual pleasure can become conditioned stimuli for sexual arousal (Byrne, 1982). Onion breath does not usually produce sexual arousal. But when repeatedly paired with a passionate kiss, it can become a CS and do just that. The larger lesson: Conditioning helps an animal survive and reproduce—by responding to cues that help it gain food, avoid dangers, locate mates, and produce offspring (Follis, 1997).

**CONDITIONED RESPONSE**

A new NS becomes a new CS. All that's required is for it to become associated with a previously conditioned stimulus. If a tone regularly signals food and produces salivation, then a light that becomes associated with

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**Exam Tip**

Spontaneous recovery is, in fact, spontaneous. Notice that the extinguished conditioned response returns without any additional pairing with the unconditioned stimulus. It is not a form of acquisition.

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2 NS = tone before procedure; US = air puff; UR = blink to air puff; CS = tone after procedure; CR = blink to tone
Generalization in classical conditioning, the learned ability to distinguish between a conditioned stimulus and stimulus that do not signal an unconditioned stimulus.

DISCRIMINATION
Pavlov's Legacy

Why does Pavlov's work remain so important, and what have been some applications of his work to human health and well-being?

What remains today of Pavlov's ideas? A great deal. Most psychologists now agree that classical conditioning is a basic form of learning. Judged by today's knowledge of the interplay of our biology, psychology, and social-cultural environment, Pavlov's ideas were incomplete. But if we see further than Pavlov did, it is because we stand on his shoulders.

Why does Pavlov's work remain so important? If he had merely taught us that old dogs can learn new tricks, his experiments would long ago have been forgotten. Why should we care that dogs can be conditioned to salivate at the sound of a tone? The importance lies first in this finding: Many other responses to many other stimuli can be classically conditioned in many other organisms—in fact, in every species tested, from earthworms to fish to dogs to monkeys to people (Schwartz, 1984). Thus, classical conditioning is one way that virtually all organisms learn to adapt to their environment.

Second, Pavlov showed us a process such as learning can be studied objectively. He was proud that his methods involved virtually no subjective judgments or guesses about what went on in a dog's mind. The salivary response is a behavior measurable in cubic centimeters of saliva. Pavlov's success therefore suggested a scientific model for how the young discipline of psychology might proceed—by isolating the basic building blocks of complex behaviors and studying them with objective laboratory procedures.

APPLICATIONS OF CLASSICAL CONDITIONING

Other units in this text—on consciousness, motivation, emotion, health, psychological disorders, and therapy—show how Pavlov's principles can influence human health and well-being. Two examples:

- Former drug users often feel a craving when they are again in the drug-using context—such as places and people associated with previously high drug use. This drug cues induce craving and increase use. When drug cues act as true unconditioned stimuli, they can become conditioned that are active, and the drug use can become conditioned. Drugs act as true unconditioned stimuli, and they can become conditioned that are active, and the drug use can become conditioned. Drugs can promote and maintain drug use through this process.

- When a particular taste accompanies a drug that influences immune responses, the taste by itself may come to produce an immune response (Ader & Cohen, 1985).

Pavlov's work also provided a basis for Watson's (1913) idea that human emotions and behaviors, though biologically influenced, are mainly a bundle of conditioned responses. Watson argued that people are conditioned to respond to stimuli in the environment. For example, if a baby is presented with a red stripe, the baby will learn to associate the red stripe with positive or negative experiences, and this association will become a conditioned response.

Before You Move On

★ ASK YOURSELF
How have your emotions or behaviors been classically conditioned?
★ TEST YOURSELF
In other movies, sexually arousing images of women are sometimes paired with violence against women. Based on classical conditioning principles, what might be the effect of this pairing?

Answers to the "Test Yourself" questions can be found in Appendix E at the end of the book.
Module 26 Review

26-1 What is learning, and what are some basic forms of learning?
- Learning is the process of acquiring new and relatively enduring information or behaviors.
- In associative learning, we learn that certain events occur together.
- In classical conditioning, we learn to associate two or more stimuli (a stimulus is any event or situation that evokes a response).
- In operant conditioning, we learn to associate a response and its consequences.
- Through cognitive learning, we acquire mental information that guides our behavior. For example, in observational learning, we learn new behaviors by observing events and watching others.

26-2 What are the basic components of classical conditioning, and what was behaviorism's view of learning?
- Classical conditioning is a type of learning in which an organism comes to associate stimuli.
- In classical conditioning, an NS is a stimulus that elicits no response before conditioning.
- A UR is an event that occurs naturally (such as salivation), in response to some stimulus.
- A US is something that naturally and automatically (without learning) triggers the unlearned response (as food in the mouth triggers salivation).
- A CS is a previously neutral stimulus (such as a tone) that, after association with a US (such as food) comes to trigger a CR.
- A CR is the learned response (salivating) to the originally neutral (but now conditioned) stimulus.
- Ivan Pavlov's work on classical conditioning laid the foundation for behaviorism, the view that psychology should be an objective science that studies behavior without reference to mental processes.
- The behaviorists believed that the basic laws of learning are the same for all species, including humans.

26-3 In classical conditioning, what are the processes of acquisition, extinction, spontaneous recovery, generalization, and discrimination?
- In classical conditioning, acquisition is associating an NS with the US so that the NS begins triggering the CR.
- Acquisition occurs most readily when the NS is presented just before (ideally, about a half-second before) a US, preparing the organism for the upcoming event. This finding supports the view that classical conditioning is biologically adaptive. Through higher-order conditioning, a new NS can become a new CS.
- Extinction is diminished responding when the CS no longer signals an impending US.
- Spontaneous recovery is the appearance of a formerly extinguished response, following a rest period.
- Generalization is the tendency to respond to stimuli that are similar to a CS.
- Discrimination is the learned ability to distinguish between a CS and other irrelevant stimuli.

26-4 Why does Pavlov's work remain so important, and what have been some applications of his work to human health and well-being?
- Pavlov taught us that significant psychological phenomena can be studied objectively, and that classical conditioning is a basic form of learning that applies to all species.
- Classical conditioning techniques are used to improve human health and well-being in many areas, including therapy for those recovering from drug addiction and those overcome fears. The body's immune system may also respond to classical conditioning.