SECTION 2

Operant Conditioning

Reader's Guide

Main Idea

Operant conditioning occurs when the consequences that follow a behavior increase or decrease the likelihood of that behavior occurring again.

Vocabulary

- operant conditioning
- reinforcement
- primary reinforcer
- secondary reinforcer
- fixed-ratio schedule
- variable-ratio schedule
- fixed-interval schedule
- variable-interval schedule
- shaping
- response chain
- aversive control
- negative reinforcement
- escape conditioning
- avoidance conditioning

Objectives

- Outline the principles of operant conditioning.
- Describe applications of operant conditioning.

EXPLORING PSYCHOLOGY

Saved by a Theory

The therapists noted that the depressed woman did not eat; she was in critical danger of dying of starvation. What should they do? The woman did seem to enjoy visitors at the hospital and the TV set, radio, books and magazines, and flowers in her room. The therapists moved her into a room devoid of all these comforts, and put a light meal in front of her; if she ate anything at all, one of the comforts was temporarily restored. The therapists gradually withheld the rewards unless she continued to eat more. Her eating improved, she gained weight. Within months she was released from the hospital. A follow-up consultation with her 18 months later found her leading a normal life.

—from *The Story of Psychology* by Morton Hunt, 1993

operant conditioning: learning in which a certain action is reinforced or punished, resulting in corresponding increases or decreases in occurrence

Suppose your dog is wandering around the neighborhood, sniffing trees, checking garbage cans, looking for a squirrel to chase. A kind neighbor sees the dog and tosses a bone out the kitchen door to it. The next day, the dog is likely to stop at the same door on its rounds, if not go to it directly. Your neighbor produces another bone, and another the next day. Your dog becomes a regular visitor.

Both stories are examples of **operant conditioning**—that is, learning from the consequences of behavior. The term *operant* is used because the subject (the depressed woman and the wandering dog in our examples) operates on or causes some change in the environment. This produces a result that influences whether the subject will operate or respond in the same way in the future. Depending on the effect of the operant behaviors, the learner will repeat or eliminate these behaviors to get rewards or avoid punishment.

How does operant conditioning differ from classical conditioning? One difference lies in how the experimenter conducts the experiment. In classical conditioning, the experimenter presents the CS and US independent of the participant's behavior. The UR is elicited. Reactions to the CS are then observed. In operant conditioning, the participant must engage in a behavior in order for the programmed outcome to occur. In other words, operant conditioning is the study of how voluntary behavior is affected by its consequences (see Figure 9.5).

REINFORCEMENT

Burrhus Frederic (B.F.) Skinner has been the psychologist most closely associated with operant conditioning. He believed that most behavior is influenced by a person's history of rewards and punishments. Skinner trained (or shaped) rats to respond to lights and sounds in a special enclosure called a Skinner box (see Figure 9.6). To conduct this experiment, a rat is placed inside the box. The rat must learn how to solve the problem of how to get food to appear in the cup. (This can be done by pressing a bar on the cage wall.) The rat first explores the box. When the rat moves toward the bar, the experimenter drops food into the cup. The food is important to the hungry rat. After the rat begins to approach the cup for food consistently, the experimenter begins to drop food into the cup only if the rat presses the bar. Eventually, when the rat is hungry it will press the bar to get food.

Reading Check
How is operant conditioning different from classical conditioning?

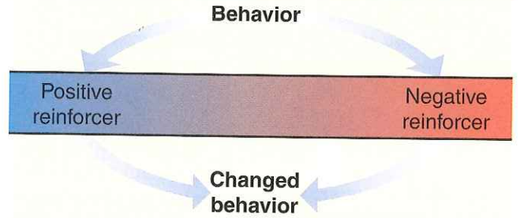
reinforcement: stimulus or event that follows a response and increases the likelihood that the response will be repeated

The food that appears in the cup is a reinforcer in this experiment. **Reinforcement** can be defined as a stimulus or event that increases the likelihood that the preceding behavior will be repeated. Whether or not a particular stimulus is a reinforcement depends on the effect the stimulus has on the learner. Examples of reinforcers that people usually respond to are social approval, money, and extra privileges.

Suppose you want to teach a dog to shake hands. One way would be to give the animal a treat every time it lifts its paw up to you. The treat is called a *positive reinforcer*. In this example, the dog will eventually learn to shake hands to get a reward.

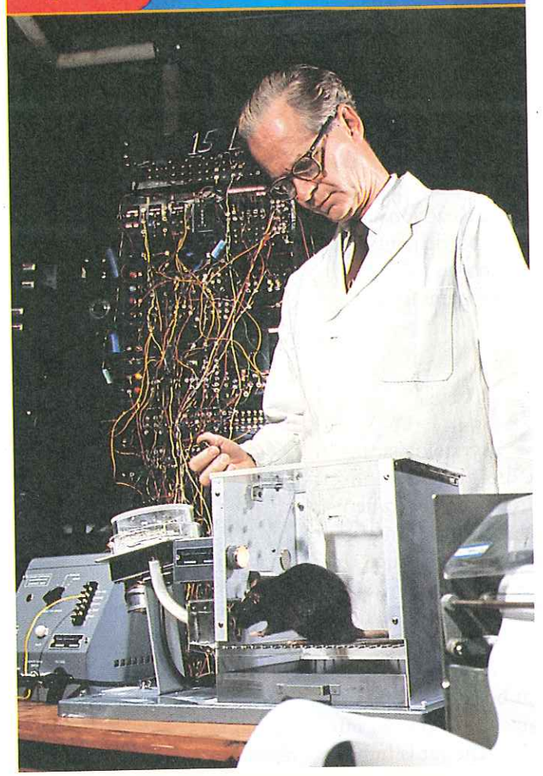
Your dog will stop shaking hands when you forget to reward it for the trick. Extinction will occur because the reinforcement is withheld, but

Figure 9.5 Operant Conditioning



We do not just react to our environment, we behave in ways that seem designed to *produce* certain environmental changes. For example, I flip the light switch to illuminate a room. I say, "Please, pass the salt," to get the salt shaker. ***According to the diagram, what must happen for behavior to change?***

Figure 9.6 A Skinner Box



The Skinner box is a basic apparatus used to test theories of operant conditioning. When the rat presses the bar located on the side of the box, food is delivered to the cup. ***How does the rat display that learning has occurred?***

it will take a period of time. (Remember, in classical conditioning, extinction is the disappearance of a conditioned response when an unconditioned stimulus no longer follows a conditioned stimulus.) In fact, for a while after you stop rewarding the dog, it will probably become impatient, bark, and paw even more insistently than it did before, until it gives up shaking hands. Eventually the dog will try to shake hands again, indicating that spontaneous recovery has occurred.

Whereas positive reinforcement occurs when something the animal wants (a treat for the dog) is *added* after an action, negative reinforcement occurs when something unpleasant is *taken away* if the animal performs an action.

Primary and Secondary Reinforcers

Reinforcers come in many varieties. Some reinforcers are primary and some are secondary. A **primary reinforcer** is one that satisfies a biological need such as hunger, thirst, or sleep. A **secondary reinforcer** is one that has been paired with a primary reinforcer and through classical conditioning has acquired value and the ability to reinforce. With conditioning, almost any stimulus can acquire value and become a secondary reinforcer.

One experimenter (Wolfe, 1936) demonstrated this with chimpanzees. Poker chips have no value for chimps—they are not edible and they are not very much fun to play with. This experimenter, however, used operant and classical conditioning to teach chimps to value poker chips as much as humans value money. He provided the animals with a "Chimp-O-Mat" that dispensed peanuts or bananas, which are primary reinforcers. To obtain food, the chimps had to pull down on a heavily weighted bar to obtain poker chips, then insert the chips in a slot in the machine. With repetition, the poker chips became conditioned reinforcers. Their value was evident from the fact that the chimpanzees would work for them, save them, and sometimes try to steal them from one another.

primary reinforcer: stimulus that is naturally rewarding, such as food or water

secondary reinforcer: stimulus such as money that becomes rewarding through its link with a primary reinforcer

Money is the best example of a secondary reinforcer in human society. You have learned that getting money is associated with buying food or material things. Other examples of secondary reinforcers would include praise, status, and prestige. All of these items are associated with a primary reinforcer and have acquired value, so they reinforce certain types of behavior when they are earned.

SCHEDULES OF REINFORCEMENT

One important factor in operant conditioning is the timing and frequency of reinforcement. Behavior that is reinforced every time it occurs is said to be on a *continuous schedule* of reinforcement. You might suppose that behavior would best be maintained by reinforcing every response. However, when positive reinforcement occurs only intermittently, or on a *partial schedule,* the responses are generally more stable and last longer once they are learned. A person or animal that is continuously reinforced for a behavior tends to maintain that behavior only when the reinforcement is given. If the reinforcement stops, the behavior quickly undergoes extinction. For example, a rat learns to press a bar most rapidly when it receives food each time it does so. When the rat stops receiving food each time it presses the bar, however, it quickly stops its bar-pressing. Behaviors that are acquired on partial schedules of reinforcement are established more slowly but are more persistent. For example, a rat that is only sometimes rewarded with food for pressing a bar will continue to press even though no food appears. Rats and humans that are reinforced on partial schedules of reinforcement cannot always predict when the next reinforcement will occur, so they learn to be persistent.

Skinner discovered the strength of partial reinforcement when his apparatus kept breaking down. Skinner found that the rats kept responding even though they were reinforced randomly. In fact, the rats responded with even greater endurance.

Although intermittent reinforcement may be arranged in a number of ways, four basic methods, or schedules, have been studied in the laboratory (see Figure 9.7). Schedules of partial reinforcement may be based either on the *number* of correct responses that the animal makes between reinforcements (*ratio* schedule) or on the *amount of time* that elapses before reinforcement is given (*interval* schedule). In either case, reinforcement may appear on a *fixed,* or predictable, schedule or on a *variable,* or unpredictable, schedule. The four basic schedules result from the combination of these four possibilities. People and animals respond differently to each type.

- In a **fixed-ratio schedule,** reinforcement depends on a specified quantity of responses, such as rewarding every fourth response. The student who receives a good grade after completing a specified amount of work and the typist who is paid by the number of pages

fixed-ratio schedule: a pattern of reinforcement in which a specific number of correct responses is required before reinforcement can be obtained

Quick Lab

What reinforcement schedules operate in your classroom?

Do you think that students would do schoolwork if there were no grading system? What reinforcements would operate if grades were abolished?

Procedure

1. Identify the types of reinforcers that operate in your classroom.
2. Make a chart that lists the type of reinforcer (primary, secondary, positive, negative) and the classroom behavior it usually elicits.
3. Devise a system for your classroom that could replace the existing reinforcers with new ones (and achieve the same results).

Analysis

1. Describe how the new reinforcers operate.
2. Indicate what responses the new reinforcers are supposed to elicit.

See the Skills Handbook, page 622, for an explanation of designing an experiment.

completed are on fixed-ratio schedules. People tend to work hard on fixed-ratio schedules. Another example would be dentists who get paid $150 for *each* cavity repaired or filled.

variable-ratio schedule: a pattern of reinforcement in which an unpredictable number of responses are required before reinforcement can be obtained

- A **variable-ratio schedule** does not require that a fixed or set number of responses be made for each reinforcement, as in the fixed-ratio schedule. Rather, the number of responses needed for a reinforcement changes from one reinforcer to the next. Slot machines are a good example of a variable-ratio schedule. They are set to pay off after a varying number of attempts at pulling the handle. Generally, animals on variable-ratio schedules of reinforcement tend to work or respond at a steady, high rate. Since the reinforcement is unpredictable, there is typically no pause after a reward because it is possible that a reward will occur on the very next response. Door-to-door salespeople and individuals who do telephone surveys are also operating on variable-ratio schedules since they never know how many doorbells they will have to ring or how many calls they will have to make before they make a sale or find someone who will answer the survey.

fixed-interval schedule: a pattern of reinforcement in which a specific amount of time must elapse before a response will elicit reinforcement

- On a **fixed-interval schedule,** the first correct response after a specified amount of time is reinforced. The time interval is always the same. Once animals gain experience with a fixed-interval reinforcement schedule, they adjust their response rates. Since no reinforcement occurs for a period of time no matter what their behavior, they learn to stop responding immediately after reinforcement is given and then begin to respond again toward the end of the interval. The result is regular, recurring periods of inactivity followed by short bursts of responding, producing a "scalloped" response curve. Tests are often given on a fixed-interval schedule. It is likely that you will study feverishly the day before a test but study much less immediately afterwards.

	Ratio	Interval
Fixed schedules	**Fixed Ratio** (reinforcement after a fixed number of responses) • being paid for every 10 pizzas made • being ejected from a basketball game after five fouls	**Fixed Interval** (reinforcement of first response after a fixed amount of time has passed) • cramming for an exam • picking up your check from your part-time job
Variable schedules	**Variable Ratio** (reinforcement after varying number of responses) • playing a slot machine • sales commissions	**Variable Interval** (reinforcement of first response after varying amounts of time) • surprise (pop) quizzes in class • dialing a friend on the phone and getting a busy signal

Figure 9.7 Partial Schedules of Reinforcement

B.F. Skinner pointed out many examples of how schedules of reinforcement maintain and control different behaviors. The different schedules produce different response rates. ***How does a fixed-ratio schedule differ from a fixed-interval schedule of reinforcement?***

- On a **variable-interval schedule,** the time at which the reinforcement is given changes. If you are trying to call a friend, but the line is busy, what do you do? You keep trying. The reinforcer will be gained the first time you dial after your friend has hung up, but you do not know when that is going to occur. The usual response rate on a variable-interval schedule is slow, but steady—slower than on any other schedule of partial reinforcement. In fact, your eagerness to reach your friend probably will determine roughly how often you try the phone again . . . and again.

In summary, ratio schedules are based on numbers of responses, while interval schedules are based on time. Responses are more resistant to extinction when reinforced on a variable rather than on a fixed schedule. To be most effective, however, the reinforcement must be consistent for the same type of behavior, although it may not occur each time the behavior does. The complexity of our behavior means that most reinforcers in human relationships are on a variable schedule. How people will react cannot always be predicted.

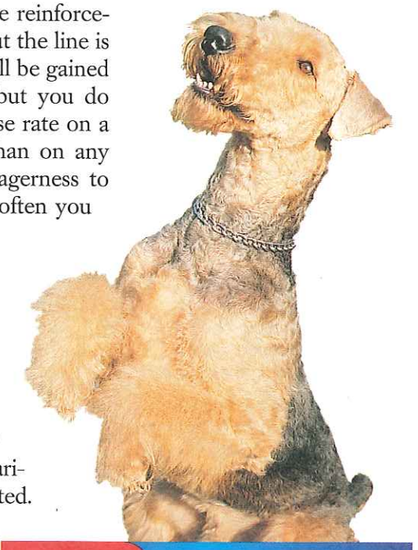


Figure 9.8 Clicker Training

Clicker training is a form of shaping. The trainer waits for the dog to sit on its own. The instant its rear goes down, the trainer hits the clicker (an audio signal) and the dog gets the treat. The clicker acts as an acoustical marker to tell the dog, "That's what I'm reinforcing." ***How might you use shaping to teach a dog to shake?***

SHAPING AND CHAINING

Operant conditioning is not limited to simple behaviors. When you acquire a skill such as knitting, photography, playing basketball, or talking persuasively, you learn more than just a single new stimulus-response relationship. You learn a large number of them, and you learn how to put them together into a large, smooth-flowing unit.

Shaping is a process in which reinforcement is used to sculpt new responses out of old ones. An experimenter can use this method to teach a rat to do something it has never done before and would never do if left to itself. He or she can shape it, for example, to raise a miniature flag. The rat is physically capable of standing on its hind legs and using its mouth to pull a miniature flag-raising cord, but at present it does not do so. The rat probably will not perform this unusual action by accident, so the experimenter begins by rewarding the rat for any action similar to the wanted responses, using reinforcement to produce closer and closer approximations of the desired behavior.

variable-interval schedule: a pattern of reinforcement in which changing amounts of time must elapse before a response will obtain reinforcement

Imagine the rat roaming around on a table with the flag apparatus in the middle. The rat inspects everything and finally sniffs at the flagpole. The experimenter immediately reinforces this response by giving the rat a food pellet. Now the rat frequently sniffs the flagpole, hoping to get another pellet, but the experimenter waits until the rat lifts a paw before he gives it another reward. This process continues with the experimenter reinforcing close responses and then waiting for even closer ones. Eventually, the experimenter has the rat on its hind legs nibbling at the cord. Suddenly the rat seizes the cord in its teeth and yanks it.

shaping: technique in which the desired behavior is "molded" by first rewarding any act similar to that behavior and then requiring ever-closer approximations to the desired behavior before giving the reward

Immediately the rat is rewarded, and it begins pulling rapidly on the cord. A new response has been shaped. Shaping has been used to teach animals tricks. For example, if a television character points her finger to the ground and her dog immediately lies down, we need to remember that shaping was involved in the dog's behavior. If shaping is done properly, almost any animal can learn some unusual tricks.

Combining Responses: Chaining

response chain: learned reactions that follow one another in sequence, each reaction producing the signal for the next

In order to learn a skill, a person must be able to put various new responses together. Responses that follow one another in a sequence are combined into **response chains.** Each response produces the signal for the next one.

In learning, chains of responses are organized into larger *response patterns.* For example, the complex skill of swimming has three major chains that are combined to make up the whole swimming pattern—an arm-stroking chain, a breathing chain, and a leg-kicking chain (see Figure 9.9). After much practice, you no longer have to think about the different steps involved. The behavior takes on a rhythm of its own: the chains of responses flow naturally as soon as you dive into the water.

It is often necessary to learn simple responses before mastering the complex pattern. If you cannot hit a nail with a hammer, you certainly cannot build a house. Therefore, before a person can learn to perform a particular skill, he or she must learn all the lower skills that make the larger skill possible.

AVERSIVE CONTROL

aversive control: process of influencing behavior by means of unpleasant stimuli

negative reinforcement: increasing the strength of a given response by removing or preventing a painful stimulus when the response occurs

Reinforcement refers to anything that increases the frequency of an immediately preceding behavior. Aversive, or unpleasant, consequences influence much of our everyday behavior. **Aversive control** refers to this type of conditioning or learning. There are two ways in which unpleasant events can affect our behavior—as negative reinforcers or as punishers.

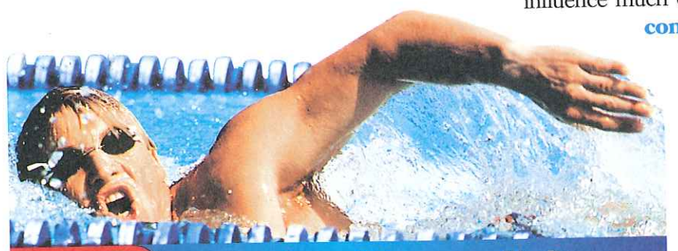


Figure 9.9 Swimming—A Response Chain

To learn to swim, you must first learn the arm stroke, then how to breathe properly, and finally how to kick your legs. ***What similar response chains can you describe that you would have to develop to learn other skills?***

Negative Reinforcement

In **negative reinforcement,** a painful or unpleasant stimulus is removed. The removal of unpleasant consequences increases the frequency of a behavior. It may help you to understand negative reinforcement if you remember that it *follows* and *negates,* or takes away, an aversive stimulus. B.F. Skinner provided this example: If walking with a stone in your shoe causes you to limp, removing the stone (negating it) allows you to walk without pain. Other examples of negative reinforcers are fear and experiencing disapproval of unwelcome behavior.

Two uses of negative reinforcement that psychologists have studied in detail are *escape conditioning* and *avoidance conditioning.* In **escape conditioning,** a person's behavior causes an unpleasant event to stop. Consider the case of a child who hates liver and is served it for dinner. She whines about the food and gags while eating it. At this point, her father removes the liver. The whining and gagging behavior has been thus negatively reinforced, and the child is likely to whine and gag in the future when given an unpleasant meal. This kind of learning is called escape conditioning because the behavior of the child allowed her to escape the liver meal.

escape conditioning: training of an organism to remove or terminate an unpleasant stimulus

In **avoidance conditioning,** the person's behavior has the effect of preventing an unpleasant situation from happening. In our example, if the child starts whining and gagging when the father removes the liver from the refrigerator to cook it, we would identify the situation as avoidance conditioning; the child avoided the unpleasant consequences by whining early enough. The reinforcer here is the reduction of the child's disgust—not having to eat liver.

avoidance conditioning: training of an organism to respond so as to prevent the occurrence of an unpleasant stimulus

Punishment

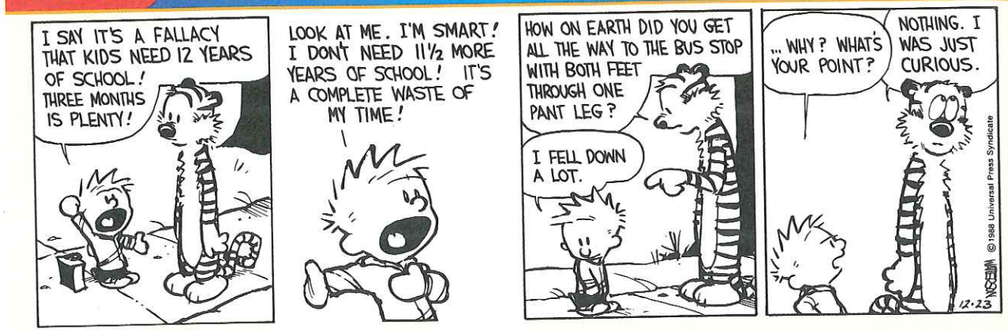
The most obvious form of aversive control is punishment. In punishment, an unpleasant consequence occurs and decreases the frequency of the behavior that produced it. Negative reinforcement and punishment operate in opposite ways. In negative reinforcement, escape or avoidance behavior is *repeated* and increases in frequency. In punishment, behavior that is punished decreases or is *not repeated.* If you want to stop a dog from pawing at you when it wants attention, you should loudly say, "NO!" and reprimand it when it paws at you. Such actions are called *punishers* (see Figure 9.10).

As with reinforcers, the events or actions that serve as punishers depend on their effect on the learner. For example, if a young child in a large family seeks extra attention from her parents, that child may misbehave. In response the parents punish the child by reprimanding her. The reprimands are meant to be punishers. The reprimands, however, may actually serve as reinforcers for a child who wants attention. Perhaps sending her to her room every time she misbehaved would have been an appropriate punisher; this unpleasant stimulus would have discouraged her from repeating the behavior.

Disadvantages of Punishment

Psychologists have found several disadvantages in using aversive stimuli (punishment) to change behavior. For one thing, aversive stimuli can produce unwanted side effects such as rage, aggression, and fear. Then, instead of having to change only one problem behavior, there may be two

Figure 9.10 Aversive Stimuli



Punishment occurs when an unpleasant consequence following a behavior decreases the chances that the behavior will recur. ***How might Calvin's tumbles act as punishers?***

or more. For example, children whose parents rely on spanking to control disobedience may also have to deal with the problem of their children's increased aggressiveness toward other children.

A second problem with punishment is that people learn to avoid the person delivering the aversive consequences. Children learn to stay away from parents or teachers who often punish them. One consequence of this is that such parents and teachers have less opportunity to correct the children's inappropriate behavior. Also, punishment is likely to merely suppress, but not eliminate, such behavior. The punished behavior is likely to occur at some other time or in some other place.

Punishment alone does not teach appropriate and acceptable behavior. Without positive coaching and modeling, the child may never learn the correct behavior or understand what the parents think is the acceptable behavior in a given situation.

SECTION 2 Assessment

1. **Review the Vocabulary** Explain how the four schedules of partial reinforcement work.
2. **Visualize the Main Idea** In a chart similar to the one below, list four types of reinforcers and give an example of each.

Types of Reinforcers	Example

3. **Recall Information** What is the difference between escape conditioning and avoidance conditioning?
4. **Think Critically** How do positive and negative reinforcement affect a teenager's choice and purchase of clothes? Provide examples in your answer.
5. **Application Activity** Using principles of operant conditioning, design a plan to teach a puppy a new trick.

SECTION 3 Social Learning

Reader's Guide

Main Idea

Social learning, consisting of cognitive learning and modeling, involves how people make decisions and act upon the information available to them.

Vocabulary

- social learning
- cognitive learning
- cognitive map
- latent learning
- learned helplessness
- modeling
- behavior modification
- token economy

Objectives

- Cite the principles involved in cognitive learning and modeling.
- Identify the principles of learning used in behavior modification.

EXPLORING PSYCHOLOGY

Would You Treat Bobo This Way?

Children were told to play while in another part of the room an adult "model" aggressively "played" with a 5-foot inflated Bobo doll. The model laid the Bobo doll on its side, sat on it, and punched it repeatedly in the nose. The model then raised the Bobo doll, picked up a mallet and struck the doll on the head, then kicked the doll around the room. Following this experience, the youngsters were brought to a room that contained many attractive toys and the Bobo doll. The children exhibited a good deal of aggressive behavior toward the Bobo doll—behavior resembling that of the adult model.

—adapted from "Transmission of Aggression Through Imitation of Aggressive Models" by Albert Bandura, Dorothea Ross, and Sheila A. Ross, published in *Journal of Abnormal and Social Psychology*, 1961

Why did the children display such aggressive behavior? Albert Bandura performed the study above in 1961 to demonstrate that the children learned aggressive behaviors simply by watching a model perform these behaviors. The study illustrated the third type of learning, called **social learning.** Social learning theorists view learning as purposeful—going beyond mechanical responses to stimuli or reinforcement. The two types of social learning are cognitive learning and modeling.

social learning: process of altering behavior by observing and imitating the behavior of others

Figure 9.11 Mazes and Maps

This cartoonist exaggerates the cognitive learning capabilities of rats. ***In what ways do humans use information obtained from latent learning in daily life?***

COGNITIVE LEARNING

Cognitive learning focuses on how information is obtained, processed, and organized. Such learning is concerned with the *mental* processes involved in learning. Latent learning and learned helplessness are examples of cognitive learning.

Latent Learning and Cognitive Maps

In the 1930s, Edward Tolman argued that learning involved more than mechanical responses to stimuli; it involved mental processes. Tolman would place a rat in a maze and allow it to explore the maze without giving the rat any reinforcement, such as food. Then he would place food at the end of the maze and record which path the rat took to reach the food. The rat quickly learned to take the shortest route to the food. Next, Tolman blocked the shortest path to the food. The rat then followed the next shortest path to the food. Tolman believed that the rat had developed a **cognitive map** of the maze. A cognitive map is a mental picture of a place, such as the maze. The rats had developed a cognitive map of the maze when allowed to explore the maze on their own.

cognitive learning: form of altering behavior that involves mental processes and may result from observation or imitation

cognitive map: a mental picture of spatial relationships or relationships between events

latent learning: alteration of a behavioral tendency that is not demonstrated by an immediate, observable change in behavior

Tolman called the type of learning demonstrated by the rat **latent learning.** Latent learning is not demonstrated by an immediately observable change in behavior at the time of the learning. Although the learning typically occurs in the absence of a reinforcer, it may not be demonstrated until a reinforcer appears. For example, have you ever had to locate a building or street in a section of your city or town that you were unfamiliar with? You may have been through that section of town before and remembered details such as an unusual sign or large parking lot. Remembering these details may have helped you find the building or street you were looking for. You had learned some details without intending to do so.

Learned Helplessness

Psychologists have shown that general learning strategies can affect a person's relationship to the environment. For example, if a person has numerous experiences in which his or her actions have no effect, he or she may learn a general strategy of helplessness or laziness.

In the first stage of one study (Hiroto, 1974), one group of college students were able to turn off an unpleasant loud noise, while another group had no control over the noise. Later, all were placed in a situation in which they merely had to move a lever to stop a similar noise. Only the ones who had control over the noise in the first place learned to turn it off. The others did not even try!

It is not hard to see how these results can apply to everyday situations. In order to be able to try hard and to be full of energy, people must learn that their actions *do* make a difference. If rewards come without effort, a person never learns to work (learned laziness). If pain comes no matter how hard one tries, a person gives up. This occurrence is called **learned helplessness.**

learned helplessness: condition in which repeated attempts to control a situation fail, resulting in the belief that the situation is uncontrollable

Martin Seligman believes that learned helplessness is one major cause of depression. He reasons that when people are unable to control events in their lives, they generally respond in one of the following ways: (1) they may be less motivated to act and thus stop trying; (2) they may experience a lowered sense of self-esteem and think negatively about themselves; or (3) they may feel depressed (see Figure 9.12).

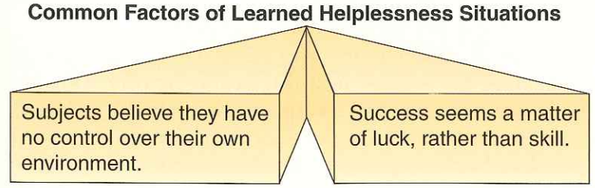
Seligman identified three important elements of learned helplessness: *stability, globality,* and *internality.* Stability refers to the person's belief that the state of helplessness results from a permanent characteristic. For example, a student who fails a math test can decide that the problem is either temporary ("I did poorly on this math test because I was sick") or *stable* ("I never have done well on math tests and never will"). Similarly, the person can decide that the problem is either specific ("I'm no good at math tests") or *global* ("I'm just dumb"). Both stability and globality focus on the student—on *internal* reasons for failure. The student could have decided that the problem was external ("This was a bad math test") instead of internal. People who attribute an undesirable outcome to their own inadequacies will probably experience depression along with guilt and self-blame.

Figure 9.12 Learned Helplessness

Examples of How Learned Helplessness Develops

- Parents punish children constantly for any and all offenses.
- You are overly critical of all your friend's actions.
- A student is placed in an advanced math course without proper preparation (taking and passing the basic math course first).

Common Factors of Learned Helplessness Situations



What happens when it is impossible for a learner to have an effect on the environment? What happens when a learner is punished and cannot escape the punishment? The learner may give up trying to learn. ***How can learned helplessness cause depression?***

More About...

TV and Violence

Before you turn 18 years old, you probably will have witnessed 200,000 violent acts on TV. What effect does this have on you? Since the 1960s more than 3,000 studies have investigated the link between television violence and real violence.

A study released in 1998 (National Television Violence Study found that by watching violence on television, viewers risk the following results: (1) They learn to behave violently. (2) They become desensitized to violence. (3) They become more fearful of being attacked.

The study also found the following:

- 45 percent of the "bad" characters in violent TV programs go unpunished.
- 51 percent of the violent interactions on TV show no pain; 34 percent show unrealistically low levels of harm.
- 26 percent of violent scenes involve the use of guns.
- Only 3 percent of violent programs emphasize a nonviolent theme.
- Only 14 percent of violent scenes show blood and gore.
- 42 percent of violent scenes on TV involve humor.

MODELING

The second type of social learning is **modeling.** When you go to a concert for the first time, you may be very hesitant about where to go, when to enter (especially if you are late), when to clap, how to get a better seat after the first intermission, and so on. So you observe others, follow them, and soon you are an "old hand." This illustrates a third type of learning—observation and imitation.

The general term for this kind of learning is *modeling.* It includes three different types of effects. In the simplest case—the first type of modeling—the behavior of others simply increases the chances that we will do the same thing. We clap when others do, look up at a building if everyone else is looking there, and copy the styles and verbal expressions of our peers. No learning occurs in this case, in the sense of acquiring new responses. We simply perform old responses that we otherwise might not be using at the time.

The second type of modeling is usually called *observational learning,* or imitation. In this sort of learning an observer watches someone perform a behavior and is later able to reproduce it closely, though the observer was unable to do this before observing the model. An example is watching someone else do an unfamiliar dance step and afterward being able to do the dance step yourself.

Have you ever noticed that some children seem to behave in a manner similar to their parents? Albert Bandura suggested that we watch models perform and then imitate the models' behavior. Bandura and his colleagues demonstrated observational learning by using a Bobo doll (see Exploring Psychology on page 259). The experimenters found that children were more likely to act aggressively after they had observed aggressive behavior.

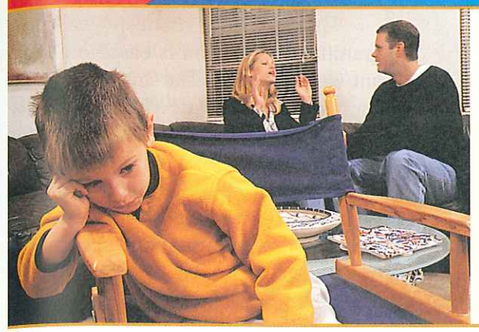
modeling: learning by imitating others; copying behavior

Individual differences in personality may help to explain why people act differently when shown the same movie containing violent material. The American Psychological Association (APA) Commission on Violence and Youth (1993) reported that personal qualities do play a role. One child may learn that violence is right and another child may view violence as pitiful. Others have found that more aggressive children seek out violent television and are also more affected by it.

Reading Check
How does observational learning differ from disinhibition? Give classroom examples.

A third type of modeling involves *disinhibition.* When an observer watches someone else engage in a threatening activity without being punished, the observer may find it easier to engage in that behavior later. For example, someone with a snake phobia may watch another person handling snakes. Such observation may help alleviate the phobia. This procedure is used in clinical work as we will see in the chapter on therapies (Chapter 17).

Figure 9.13 The Imitation of Others



Social learning theorists argue that much learning results from observing the behavior of others and from imagining the consequences of our own behavior. ***What behaviors might this child be learning?***

Inflated doll similar to Bobo doll

BEHAVIOR MODIFICATION

The term *behavior modification* often appears in magazine articles describing research on changing people's behavior through drugs, "mind control," or even brain surgery. In fact, it is none of these things. **Behavior modification** refers to the systematic application of learning principles (classical conditioning, operant conditioning, and social learning) to change people's actions and feelings. When you give your little brother a quarter to leave you alone, that is very much like behavior modification. Behavior modification involves a series of well-defined steps to change behavior. The success of each step is carefully evaluated to find the best solution for a given situation.

behavior modification: systematic application of learning principles to change people's actions and feelings

The behavior modifier usually begins by defining a problem in concrete terms. For example, Johnnie's mother might complain that her son is messy. If she used behavior modification to reform the child, she would first have to define "messy" in objective terms. For example, he does not make his bed in the morning, he drops his coat on the couch when he comes inside, and so on. She would not worry about where his bad habits come from. Rather, she would work out a system of rewards and punishments aimed at getting Johnnie to make his bed, hang up his coat, and do other straightening-up tasks.

Modeling, operant conditioning, and classical conditioning principles have been used in behavior modification. Classical conditioning principles are particularly useful in helping people to overcome fears, and we shall discuss them when we consider the problem of treating psychological disorders (Chapter 17). Modeling is often used to teach desired behaviors. In addition, as you will see in the following examples, operant conditioning principles have also been applied to everyday problems.

Computer-Assisted Instruction

Some instructors teach their students by a conversational method very similar to what computer-assisted instruction (CAI) is using today. CAI is a refinement of the concept of programmed instruction that was

PSYCHOLOGY and You — How You Form Bad Habits

Do you procrastinate? For example, have you ever found yourself cramming for an important test the night before? Operant conditioning probably played a role in your bad habit of procrastination. You selected immediate positive reinforcement and delayed punishment. That is, you opted to spend your time doing something else, such as watching TV, instead of studying.

Procrastination provided the *immediate* reinforcement of giving you more leisure time. The punishment, lower grades or lack of sleep the day before the test, was *delayed*. Many bad habits are formed when people follow this pattern of immediate reinforcement and delayed punishment.

introduced by S.L. Pressey (1933) and refined by B.F. Skinner in the 1950s.

The essential concept of programmed instruction is based on operant conditioning. The material to be learned is broken down into simpler units called frames. Each time the student shows that she or he has learned the information in a frame, the student is given positive reinforcement in the form of new information, choices, or point rewards similar to those used in video games. Each question, or prompt, builds on information already mastered. The computer retains (as does the student) exactly what the learner understands on the basis of the student's answers to questions.

Several principles of learning are being applied in CAI. The student is learning complex material through a response chain. She or he is reinforced constantly. Knowledge is being shaped in a systematic and predictable way. The student is able to have a dialogue with the instructor on every point, which is often impossible for a class of students in a conventional setting.

token economy: conditioning in which desirable behavior is reinforced with valueless objects, which can be accumulated and exchanged for valued rewards

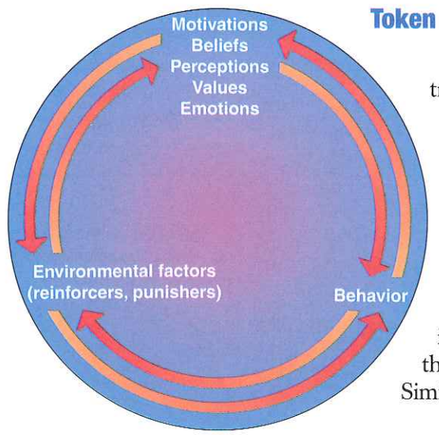


Figure 9.14 How Social Learning Works

Social learning theorists argue that much learning results from observing the behavior of others and from imagining the consequences of our own behavior. ***What role does the environment play in social learning?***

Token Economies

Psychologists tried an experiment with a group of troubled boys in Washington, D.C. In fact, the boys had been labeled "uneducable" and placed in the National Training School. The experimenters used what is known as a **token economy** to motivate the boys. The youngsters received points—or secondary reinforcers—for good grades on tests. They could cash in these points for such rewards as snacks or lounge privileges. A majority of the students showed a significant increase in IQ scores. The boys continued to improve in the months that followed, showing that they were, indeed, educable (Cohen & Filipczak, 1971). Similarly, behavioral programs to reduce prison violence reduce post-prison violence in the community (French et al., 2003).

In token economies, people are systematically paid to act appropriately. In the real world, behaviorists argue, the rewards are just as real; they are simply less systematic. In overcrowded mental hospitals, for example, the only way some patients can get attention is by acting out. Overworked staff members simply do not have time to bother with people who are not causing trouble. Since attention from the staff is reinforcing for these patients, people are rewarded for undesirable behavior. By systematically rewarding only desirable behavior, token economies have improved conditions in prisons, mental hospitals, halfway houses, and classrooms.

Self-Control

One of the most important features in behavior modification is an emphasis on asking people to set up personal systems of rewards and punishments to shape their own thoughts and actions—this is a self-control program. As in any application of behavior modification, the first step in self-control is to define the problem. People who smoke too much would be encouraged to actually count how many cigarettes they smoked every hour of the day and note what kinds of situations led them to smoke. (After a meal? When talking to friends? Driving to work?) Similarly, people who have a very poor opinion of themselves would have to define the problem more concretely. They might begin by counting the number of self-deprecating remarks they make and thoughts they have. Researchers have found that just keeping track of behavior in this way often leads a person to start changing it.

The next step may be to set up a behavioral contract. A behavioral contract simply involves choosing a reinforcer (buying a new shirt, watching a favorite TV program) and making it depend on some less desirable but necessary act such as getting to work on time or washing the kitchen floor. One soda lover who had trouble studying decided

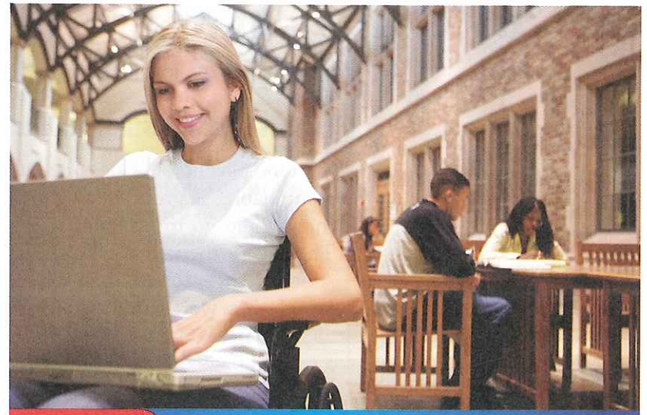


Figure 9.15 Improving Study Habits

Studying effectively is an active process. By using successive approximations (reading one more page each time you sit down to study) and positive reinforcements (rewarding yourself for productive studying), you can improve your study habits. The SQ4R and PQ4R methods are active methods of studying. ***How can you improve your own study habits?***

SQ4R Method	PQ4R Method
Survey the chapter. Read the headings. Read any summaries. Your goal is to get a general understanding of the chapter.	**Preview** the chapter by surveying general topics to be studied.
Question the material. Formulate questions about the material as if you were the instructor writing the test.	**Question** yourself by transforming heads into questions.
Read carefully and try to answer the questions you formulated. If you become distracted or tired, stop reading. Pick it up later.	**Read** the section or chapter carefully while trying to answer the questions you created.
Write down the answers to your questions. Sum up the information in your own words.	**Reflect** on the text as you are reading to try and understand it, think of examples, and relate to information about the topic that you already know.
Recite to yourself what you have read. Recall main headings and ideas. Be sure to put the material into your own words. Answer questions aloud.	**Recite** the information by answering your own questions aloud.
Review the material. Summarize the main points in the chapter. Answer the questions you have formulated.	**Review** the material by recalling and summarizing main points.

that she would allow herself a soda only after she studied for half an hour. Her soda addiction remained strong, but her study time increased dramatically under this system.

Improving Your Study Habits

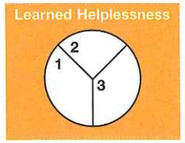
One psychologist designed a program to help students improve their study habits. A group of student volunteers were told to set a time when they would go to a small room in the library they had not used before. They were then to work only as long as they remained interested. As soon as they found themselves fidgeting, daydreaming, or becoming bored, they were to read one more page before they left.

The next day they were asked to repeat the same procedure, adding a second page to the amount they read between the time they decided to leave and the time they actually left the library. The third day they added a third page, and so on. Students who followed this procedure found that in time they were able to study more efficiently and for longer periods.

Why did this procedure work? Requiring students to leave as soon as they felt distracted helped to reduce the negative emotions associated with studying. Studying in a new place removed the conditioned aversive stimulus. Thus, aversive responses were not conditioned to the subject matter or the room, as they are when students force themselves to work. The procedure also made use of successive approximations. The students began by reading just one more page after they became bored and only gradually increased the assignment. In conclusion, it is important to note that classical and operant conditioning and social learning do not operate independently in our lives. All three forms of learning interact in a complex way to determine what and how we learn.

SECTION 3 Assessment

1. **Review the Vocabulary** How is a token economy an example of behavior modification?
2. **Visualize the Main Idea** In a diagram similar to the one below, identify three important elements of learned helplessness.



3. **Recall Information** How can you improve your study habits through conditioning?
4. **Think Critically** What principles of modeling should parents consider when rewarding and punishing their children? Provide reasons for your answer.

5. Application Activity Devise a plan of behavior modification (such as teaching your dog not to bark indoors or stopping your friend from knuckle cracking) by applying learning principles.

CHAPTER 9

Summary and Vocabulary

Learning is a relatively permanent change in a behavioral tendency that results from experience. Not all behaviors are acquired in the same way. Psychologists have studied three basic types of learning: classical conditioning, operant conditioning, and social learning.

Section 1 Classical Conditioning

Main Idea: People acquire certain behaviors through classical conditioning, a learning procedure in which associations are made between a neutral stimulus and a conditioned response.

- Ivan Pavlov discovered the principles of classical conditioning.
- The four elements involved in classical conditioning are US, UR, CS, and CR.
- Generalization and discrimination are complementary processes in which the participant responds to similar stimuli in the same manner or responds differently to dissimilar stimuli.
- A CR will sometimes reappear spontaneously after extinction in a process called spontaneous recovery.
- Classical conditioning may be used to affect human behavior, such as taste aversions and fears.

Section 2 Operant Conditioning

Main Idea: Operant conditioning occurs when the consequences that follow a behavior increase or decrease the likelihood of that behavior occurring again.

- Operant conditioning, as explained by B.F. Skinner, means that human behavior is influenced by one's history of rewards and punishments.
- Reinforcers (positive and negative, and primary and secondary) are stimuli that increase the likelihood that certain behaviors will be repeated.
- Behavior is reinforced according to continuous or partial reinforcement schedules that are based on numbers of responses or times of responses.
- Reinforcing responses that are increasingly similar to the desired behavior is a process called shaping.
- Punishments are stimuli that decrease the likelihood that certain behaviors will be repeated.

Section 3 Social Learning

Main Idea: Social learning, consisting of cognitive learning and modeling, involves how people make decisions and act upon the information available to them.

- Latent learning is not demonstrated by an immediately observable change in behavior at the time of learning.
- If people have numerous experiences in which their actions have no effect, they may learn a general strategy of learned helplessness.
- Modeling is a type of learning that occurs as the result of observation and imitation.
- Behavior modification uses learning principles to change people's actions or feelings.

Chapter Vocabulary

classical conditioning (p. 241)
neutral stimulus (p. 242)
unconditioned stimulus (US) (p. 242)
unconditioned response (UR) (p. 242)
conditioned stimulus (CS) (p. 242)
conditioned response (CR) (p. 242)
generalization (p. 244)
discrimination (p. 244)
extinction (p. 245)
operant conditioning (p. 250)
reinforcement (p. 251)
primary reinforcer (p. 252)
secondary reinforcer (p. 252)
fixed-ratio schedule (p. 253)
variable-ratio schedule (p. 254)
fixed-interval schedule (p. 254)
variable-interval schedule (p. 255)
shaping (p. 255)
response chain (p. 256)
aversive control (p. 256)
negative reinforcement (p. 256)
escape conditioning (p. 257)
avoidance conditioning (p. 257)
social learning (p. 259)
cognitive learning (p. 260)
cognitive map (p. 260)
latent learning (p. 260)
learned helplessness (p. 261)
modeling (p. 262)
behavior modification (p. 263)
token economy (p. 264)

CHAPTER 9 Assessment

PSYCHOLOGY Online

Self-Check Quiz
Visit the *Understanding Psychology* Web site at glencoe.com and click on **Chapter 9—Self-Check Quizzes** to prepare for the Chapter Test.

Reviewing Vocabulary

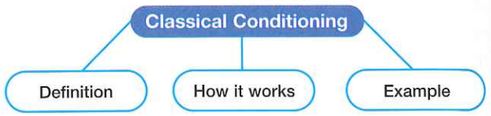
Choose the letter of the correct term or concept below to complete the sentence.

a. extinction	**f.** secondary
b. behavior modification	**g.** token economy
c. unconditioned stimulus	**h.** modeling
d. generalization	**i.** operant conditioning
e. schedules	**j.** escape conditioning

1. A stimulus that elicits a predictable response without training is called a(n) _____.
2. Money is an example of a(n) _____ reinforcer.
3. _____ is a type of learning based on the consequences of actions.
4. In conditioning, _____ results from the repeated performance of a response without reinforcement.
5. _____ is the process of removing an aversive stimulus after it has started.
6. In a(n) _____, people are rewarded for behaving in an appropriate manner with valueless objects.
7. _____ refers to the systematic application of learning principles to change people's actions and feelings.
8. When children imitate the behavior of their parents, they are practicing a form of learning called _____.
9. The tendency for a stimulus similar to the original conditioned stimulus to elicit a response similar to the conditioned response is called _____.
10. The various ways that reinforcers occur after a behavior has been elicited are referred to as _____.

Recalling Facts

1. What are the differences between classical and operant conditioning?
2. How do taste aversions develop?
3. What are the four partial schedules of reinforcement, and how do they differ?
4. Create three diagrams like the one below on your paper—one each for classical conditioning, operant conditioning, and social learning. Fill in each with the definition, how it works, and an example of that type of learning.



5. Name and describe the three different types of modeling.

Critical Thinking

1. **Identifying Alternatives** Which of the schedules of reinforcement do your instructors generally use in conducting their classes? How would your classes be different if they used the other schedules?
2. **Applying Concepts** Businesses often make use of conditioning techniques in their commercials. Think of specific examples of such advertising. Describe how the principles of conditioning are used in those advertisements.
3. **Synthesizing Information** How might a therapist help cigarette smokers quit smoking using classical conditioning techniques? Using operant conditioning techniques? Using social learning techniques?
4. **Evaluating Information** Is punishment an effective tool of learning? Describe the advantages or disadvantages of using punishment to teach a child a behavior.
5. **Predicting Consequences** How has technology made parenting more challenging? Provide examples to support your answer.

CHAPTER 9 Assessment

Psychology Projects

1. **Classical Conditioning** Select some particular task that you find difficult or unpleasant. Whenever you begin to work at this task, play one of your favorite tapes or CDs. Do this for two weeks and then analyze your reactions. Have your feelings toward the music become associated with the task? Do you find it easier to work and complete the task? Write a report that explains your findings in light of what you know about conditioning techniques.
2. **Operant Conditioning** Go to a public place where you can watch parents and children interacting. Watch a parent-child interaction long enough to identify an aversive stimulus the parent or child may be using to control behavior. What particular behavior of the child is the parent attempting to change? What particular behavior of the parent is the child attempting to change? Are they successful? Collect your observations and conclusions in a report.

Technology Activity

Use the Internet to locate the Web site of a self-help or support group at which self-control and other self-improvement techniques are taught. You should look for the following stages/techniques: definition of the problem, establishment of behavioral contracts, and application of reinforcers in a program of successive approximations. Evaluate the site and summarize your findings in a brief report.

Psychology Journal

Reread the journal entry in which you described your attempts to teach a skill or task. Did you use classical conditioning, operant conditioning, or social learning techniques? Make a new entry, describing and identifying your learning techniques. Explain why your teaching strategy was successful or unsuccessful.

Building Skills

Interpreting a Chart Review the chart of O. Hobart Mowrer's experiment to stop bed-wetting below. Then answer the questions that follow.

Practice and **assess** key social studies skills with **Glencoe Skillbuilder Interactive Workbook CD-ROM, Level 2.**

Mowrer's Experiment	*Stimulus*	*Response*
Before Conditioning	Full Bladder (neutral stimulus) Alarm (US)	No awakening Awakening (UR)
During Conditioning	Full Bladder (CS) paired with Alarm (US)	Awakening (UR)
After Conditioning	Full Bladder (CS)	Awakening (CR)

1. What happened in the above experiment? What things were paired to lead to awakening?
2. Explain how the CS, US, CR, and UR relate to the end result (awakening).
3. Which type of learning is displayed in this chart?

See the Skills Handbook, page 628, for an explanation of interpreting charts.

TIME REPORTS

Fertile Minds

From birth, a baby's brain cells proliferate wildly, making connections that may shape a lifetime of experience. The first three years are critical

By J. MADELEINE NASH

RAT-A-TAT-TAT. RAT-A-TAT-TAT. If scientists could eavesdrop on the brain of a human embryo 10, maybe 12 weeks after conception, they would hear an astonishing racket. Inside the womb, long before the earliest dreamy images flicker through the cortex, nerve cells in the developing brain crackle with purposeful activity. Like teenagers with telephones, cells in one neighborhood of the brain are calling friends in another, and these cells are calling their friends, and they keep calling one another over and over again, "almost," says neurobiologist Carla Shatz of the University of California, Berkeley, "as if they were autodialing."

But these neurons—as the long, wiry cells that carry electrical messages through the nervous system and the brain are called—are not transmitting signals in scattershot fashion. That would produce a featureless static, the sort of noise picked up by a radio tuned between stations. On the contrary, evidence is growing that the staccato bursts of electricity that form those distinctive rat-a-tat-tats arise from coordinated waves of neural activity, and that those pulsing waves, like currents shifting sand on the ocean floor, actually change the shape of the brain, carving mental circuits into patterns that over time will enable the newborn infant to perceive a father's voice, a mother's touch, a shiny mobile twirling over the crib.

Wiring Vision

WHAT'S GOING ON Babies can see at birth, but not in fine-grained detail. They have not yet acquired the knack of focusing both eyes on a single object or developed more sophisticated visual skills like depth perception. They also lack hand-eye coordination.
WINDOW OF LEARNING Unless it is exercised early on, the visual system will not develop.

The finding that the electrical activity of brain cells changes the physical structure of the brain is breathtaking. For the rhythmic firing of neurons is no longer assumed to be a by-product of building the brain but essential to the process, and it begins well before birth. The brain begins working long before it is finished. And the same processes that wire the brain before birth also drive the explosion of learning that occurs immediately afterward.

At birth, a baby's brain contains 100 billion neurons. Also in place are a trillion glial cells which form a kind of honeycomb that protects and nourishes the neurons. But while the brain contains virtually all the nerve cells it will ever have, the pattern of wiring between them has yet to stabilize. Up to this point, says Shatz, "what the brain has done is lay out circuits that are its best guess about what's required for vision, for language, for whatever." And now it is up to neural activity—no longer spontaneous, but driven by sensory experiences—to take this rough blueprint and refine it.

During the first years of life, the brain undergoes a series of extraordinary changes. Starting shortly after birth, a baby's brain produces trillions more connections between neurons than it can possibly use. Then the brain eliminates connections, or synapses, that are seldom or never used. The excess synapses in a child's brain undergo a pruning, starting around the age of 10 or earlier, leaving behind a mind whose patterns of emotion and thought are unique.

Wiring Feelings

WHAT'S GOING ON Among the first circuits the brain constructs are those that govern emotions. Around two months of age, the distress and contentment experienced by newborns start to evolve into more complex feelings: joy and sadness, pride and shame.
WINDOW OF LEARNING Emotions develop in increasingly complex layers.

FROM LEFT TO RIGHT: PENNY GENTIEU, JADE ALBERT, JADE ALBERT, PENNY GENTIEU

Deprived of a stimulating environment, a child's brain suffers. Researchers at Baylor College of Medicine, for example, have found that children who don't play much or are rarely touched develop brains 20% to 30% smaller than normal for their age. Lab animals provide another parallel. Not only do young rats reared in toy-strewn cages exhibit more complex behavior than rats confined to sterile, uninteresting boxes, researchers at the University of Illinois have found, but the brains of these rats contain as many as 25% more synapses per neuron. Rich experiences, in other words, really do produce rich brains.

The new insights into brain development have profound implications for parents and policymakers. In an age when mothers and fathers are increasingly pressed for time, the results coming out of the labs are likely to increase concerns about leaving very young children in the care of others. For the data underscore the importance of hands-on parenting, of finding the time to cuddle a baby, talk with a toddler and provide infants with stimulating experiences.

Wiring Language

WHAT'S GOING ON Even before birth, an infant tunes into the melody of its mother's voice. Over the next six years, its brain will set up the circuitry to decipher and reproduce the lyrics. A six-month-old can recognize the vowel sounds that are building blocks of speech.
WINDOW OF LEARNING Language skills, sharpest early on, grow throughout life.

The new insights have infused new passion into the political debate over early education and day care. There is an urgent need, say child-development experts, for preschool programs designed to boost the brain power of kids born into impoverished households. Without such programs, they warn, the current drive to curtail welfare costs by pushing mothers with infants and toddlers into the work force may backfire. "There is a time scale to brain development, and the most important year is the first," notes Frank Newman, president of the Education Commission of the States. By three, a neglected child bears marks that are very difficult to erase.

But the new research offers hope as well. Scientists have found that the brain during the first years of life is so malleable that very young children who suffer strokes or injuries that wipe out an entire hemisphere can still mature into highly functional adults. Moreover, it is becoming clear that well-designed preschool programs can help many children overcome glaring deficits in their home environment. With appropriate therapy, say researchers, even serious disorders like dyslexia may be treatable. While inherited problems may place certain children at greater risk than others, says Dr. Harry Chugani, a neurologist at Wayne State University in Detroit, that is no excuse for ignoring the environment's power to remodel the brain. "We may not do much to change what happens before birth, but we can change what happens after a baby is born," he observes.

Wiring Movement

WHAT'S GOING ON At birth babies can move their limbs, but in a jerky, uncontrolled fashion. Over the next four years, the brain progressively refines the circuits for reaching, grabbing, sitting, crawling, walking and running.
WINDOW OF LEARNING Motor-skill development moves from gross to increasingly fine.

Strong evidence that activity changes the brain began accumulating in the 1970s. But only recently have researchers had tools powerful enough to reveal the precise mechanisms by which those changes are brought about. Neural activity triggers a biochemical cascade that reaches all the way to the nucleus of cells and the coils of DNA that encode specific genes. In fact, two of the genes affected by neural activity in embryonic fruit flies, neurobiologist Corey Goodman and his colleagues at Berkeley reported, are identical to those that other studies have linked to learning and memory. How thrilling, exclaims Goodman, that the snippets of DNA that embryos use to build their brains are the same ones that will later allow adult organisms to process and store new information.

As researchers explore the once hidden links between brain activity and brain structure, they are beginning to construct a sturdy bridge over the chasm that previously separated genes from the environment. Experts now agree that a baby does not come into the world as a genetically preprogrammed automaton or a blank slate, but arrives as something much more interesting. For this reason the debate that engaged countless generations of philosophers—whether nature or nurture calls the shots—no longer interests most scientists. They are much too busy chronicling the ways in which genes and the environment interact. "It's not a competition," says Dr. Stanley Greenspan, a psychiatrist at George Washington University. "It's a dance." ■

—For the complete text of this article and related articles from TIME, please visit www.time.com/teach

Analyzing the Article

1. What "discovery" does this article detail?
2. **CRITICAL THINKING** Do you agree that your "uniqueness" was developed in the first three years of your life? Why or why not?