Part II

What Teachers Need to Know About Learning

Professor Thomas meets with student teachers on Thursdays from 4 to 6 P.M. Today's topic is learning theory. Dr. Thomas knows he has to create some enthusiasm for an area about which few students get excited—especially after an exhausting day of student teaching.

Julie: I have a hard time seeing the value of learning theory for teachers. My cooperating teacher, Mr. Charles, saw this week's assignments for this class, and he just kind of smirked. He sees this stuff as pretty irrelevant to the classroom—and he received a teaching excellence award last year.

Leon: There were certainly good teachers before there were learning theories. They just knew their content and were excited about teaching it.

Dr. Thomas: So, your point is that you don't have to know about learning theory to be a good teacher?

Howard: I've taught some pretty good lessons so far, and I don't know anything about learning theory. Before every unit, I observe teachers at my school and talk with other teachers to get ideas. So I just don't see that learning theories are necessary.

Maria: Well, teachers may not be able to identify or talk about learning theories, but that doesn't mean they aren't influenced by them. As one of the articles pointed out, many teachers have implicit theories of learning that guide their teaching; they just don't articulate them.

Dr. Thomas: And what else did the article say? Janet?

Janet: The author felt that effective teachers use theories to guide their teaching. They work out a set of rules or principles beforehand that researchers have found valid. Less effective teachers don't have any rules or principles to guide them and probably don't know why they do certain things. So why leave it up to chance? Why not study some of the ways people learn before you begin teaching? That way you can make informed decisions rather than just doing what feels good.

Janet's view about why future teachers should know about learning theory is close to ours: Why leave it up to chance? Although explicit knowledge of learning theory may not be necessary for every lesson you teach, theory will be valuable for decision making and for understanding why some techniques promote learning more than others. As you begin teaching, you will continually ask yourself whether you are lecturing too much, providing enough examples, using too many or too few cues, giving enough feedback, allowing sufficient time for discussion, or providing sufficient opportunities for practice. A knowledge of learning theory can help answer these questions.

Such knowledge also helps teachers explain why their classroom techniques promote learning. By providing a focus or point of observation, learning theories help teachers reflect on what they do and why they do it. Reflection is considered one of the principal ingredients of both student learning and teacher self-renewal (Borich, 1993; Sparks-Langer & Cotton, 1991; Wellington, 1991).

Our purpose in this next sequence of chapters is to help you reflect on why you make certain day-to-day decisions about how you teach. We will answer the basic question: What do teachers need to know about learning? This reflection will serve two goals: it will infuse your lessons with a coherence and consistency of techniques that will make you feel secure and confident, and it will make your learners in turn feel better and more confident about your teaching.

This unit includes those aspects of learning theory and research that are the most pertinent to classroom instruction. Chapter 4 includes what classroom teachers should know about the behavioral science approach to learning. In this chapter we concentrate on how behavioral learning principles can help you teach academic skills. We present an approach to instruction that teaches basic academic skills in a manner that places a premium on clear objectives, guided practice, errorless learning, immediate feedback, and positive consequences.

Chapters 5 and 6 cover the knowledge resulting from cognitive learning theory that is most applicable for teachers. Cognitive learning theory emphasizes what teachers can do to help their learners problem solve, remember, and understand what they read, and also assume greater responsibility for their own learning. In these chapters you will learn instructional strategies for helping your learners take in new information, make connections between this information and what has already been learned, and use this knowledge to solve important problems. In particular, Chapter 6 focuses on techniques for teaching students to solve complex, real-world problems.

Chapter 7 extends our coverage into the area of cognitive approaches to motivating learners. It focuses on how to foster internal motivation in your students. You will learn that motivating learners is a complex endeavor that places as much responsibility on the learner as it does on you.

Chapter 4

The Behavioral Science Approach to Learning

This chapter will help you answer the following questions about your learners:

- How can I help my learners develop a positive attitude toward what I teach?
- How can I help my learners become more persistent in their efforts to learn?
- How will I know when my learners have attained the prerequisite skills required for new learning?
- How can I encourage errorless learning?
- What types of practice and feedback are required for new learning to occur?
- How will I know whether my lessons provide appropriate rewards and reinforcement?
- How do I make my learners less dependent on external rewards and more motivated to learn for learning's sake?
- What are some cautions I should be aware of when considering the use of negative consequences in my classroom?

In this chapter you will also learn the meanings of these terms:

ABC model of learning

active responding

classical conditioning

conditioned response

conditioned stimulus

continuous reinforcement schedule

discrimination training

extinction

intermittent reinforcement schedule

interval schedule

intrinsic reinforcement

least-to-most prompting

natural reinforcers

negative reinforcement

operant conditioning

passive responding

positive reinforcement

prompts

punisher

punishment

ratio schedule

reinforcement

schedule of reinforcement

stimulus control

task analysis

unconditioned response

unconditioned stimulus

Although educational psychologists disagree about the effectiveness of instructional methods based on behavioral science, the behavioral science approach to classroom learning has considerable significance for teaching. Its major contributions to your teaching lie in what it says about the learning of basic academic skills. We will explore the essential principles and methods of this knowledge base in this chapter.

First we will present a historical overview of the behavioral science approach to learning. From this overview, you will learn about the principles that underlie classical and operant conditioning. Then we will describe how these principles of learning can be applied to the classroom to help learners acquire important academic skills.

Overview of the Behavioral Science Approach

What should teachers know about learning in order to deliver effective instruction to their students? Behavioral scientists have clear recommendations on this matter. Before examining these ideas and their historical antecedents, let's look at how a behavioral scientist describes the ideal classroom. Here is Ogden Lindsley's vision of the twenty-first century:

> The only adult in the classroom seems to be loitering....She is moving about the classroom from student to student, answering a question with a whisper here, offering a quiet suggestion there, helping with a chart decision here, and giving a pat and a smile of appreciation there. Now and then, she calls for a class one-minute practice session.
>
> The students are busy at their desks, in teams of two, timing each other's practice, jumping up to take a chart down from the wall, or to post new

> data. The students are noisy, shouting correct answers as fast as they can at 200 words per minute, several shouting at once at neighboring desks....It is not the orderly class that student teachers were taught to manage....
>
> The precision teacher performs like a coach, an advisor, and an on-line instructional designer. She arranges materials and methods for the students to teach themselves, including self-counting, timing, charting, and one-on-one direction and support. (Lindsley, 1992b, p. 51)

According to behavioral scientists like Lindsley, who advocates an approach called *precision teaching*, this classroom contains most of the basic conditions required for learning. These conditions are:

- An environment scientifically designed to elicit correct and rapid performance.
- A focus on observable behavior or performance.
- Opportunities for feedback and reinforcement following performance.

These three essential elements make up the **ABC model of learning,** which is illustrated in Figure 4.1. The ABC model of learning refers to antecedents in the environment (A) that elicit desired behavior (B), which then becomes strengthened when followed by appropriate consequences (C). This simple model includes all the essential elements of the behavioral science approach. Think of it as an overview of the behavioral model of learning as a whole and keep its main components—antecedents, behaviors, and consequences—in mind as we examine the historical roots of behaviorism and its three major components.

Classical Conditioning

Have you ever had the experience of taking a shower when suddenly someone in the apartment above you, or in a nearby bathroom, flushes the toilet? The shower's relaxing warmth turns to scalding heat! You flinch, tense up, maybe even scream in pain. But soon the water returns to its former temperature, and you relax once again—but this time your ears are alert to the sound. When you hear the flush again, you anticipate the burning water and jump back even before the temperature changes. Your body reacts reflexively.

Your body has learned an important lesson—that there is a predictable relationship or association between two events, a sound and a change in water temperature. It has learned this association through a process called **classical conditioning.**

Pavlov's Experiment

Ivan Pavlov, a Russian physiologist, discovered the phenomenon of classical conditioning nearly a century ago. He did this by demonstrating that dogs could "learn" to salivate at the sound of a bell that was rung before they were fed, even before they could see or smell the food. The components of the classical conditioning process are shown in Figure 4.2.

Before a dog undergoes the conditioning process, the bell is a *neutral stimulus* (NS). In other words, a bell does not automatically elicit a physiological response from a dog. Food, on the other hand, automatically causes a dog to salivate. The food, therefore, is an **unconditioned stimulus** (UCS), meaning "naturally conditioned" or "conditioned by nature." Salivation is an **unconditioned response** (UCR), a reaction that automatically follows an unconditioned stimulus.

During the conditioning process, the bell is rung, and food is placed in the dog's mouth just seconds later. The food causes the dog to salivate. If these events are repeated, eventually the dog will salivate at the sound of the bell alone, without tasting, seeing, or smelling the food. When this occurs, the bell is no longer a neutral stimulus. Instead, it becomes a **conditioned stimulus** (CS). When a response, such as salivation, occurs following a conditioned stimulus, it is called a **conditioned response** (CR). The bell, which prior to conditioning had no effect on salivation, has become a conditioned stimulus that elicits a physiological response. While nature created the connection between food (UCS) and salivation (UCR), conditioning created the connection between salivation (CR) and the sound of a bell (CS).

Many learning theorists use the classical conditioning paradigm to explain how we learn relationships between environmental stimuli and behavioral, cognitive, and emotional responses. For example, how do we account for the following phenomena?

The smell of a certain perfume reminds you of a close friend or loved one.

You recoil at the sight of a snake when you've never encountered one before except in pictures or stories.

As a first-grader you became anxious at the sound of the school bell.

Your professor utters the word "exam" and you get a funny feeling in your stomach.

A familiar song on the radio creates mental images that change your mood.

What these events have in common is that a neutral stimulus (an odor, the sight of an animal, a sound, a spoken word, a song) has developed the power to evoke an emotional (affective), physiological (a muscle contraction), behavioral (running away), psychological (a shiver), or cognitive (an image) response. Thus, classical

conditioning theorists propose that many of our behavioral, emotional, and cognitive responses to people, places, and things have been acquired through a process of classical conditioning.

For example, how might a learner develop a fear of math? Math, in and of itself, is a neutral stimulus. There is no natural connection between it and the emotional responses associated with fear (increased adrenalin flow, constriction of blood vessels, increased blood pressure, rapid breathing). However, there is a natural (unconditioned) association between being reprimanded (UCS) by a teacher or parent and the fear (UCR) that might immediately follow answering a question incorrectly or receiving a failing test grade. Such events, repeated over time, can condition a learner to respond with intense fear at the sight of a math test—or even the announcement that one is forthcoming.

Relevance for Teachers

As a teacher, you will want your learners to acquire positive attitudes toward you and your subject. Initially, you and your learning activities will be neutral stimuli, but over time you and how you teach can become conditioned stimuli that elicit emotions (or conditioned responses) of interest and joy, evoke approach behaviors such as studying and asking questions, and even arouse physiological responses of comfort and naturalness.

Learning theorists remind us that classical conditioning processes go on in classrooms all the time. Your role is to be aware of the classical conditioning paradigm and use it to build positive associations between your teaching activities and learning. In Chapter 7 we will offer some specific recommendations to help you achieve this goal.

While the classical conditioning paradigm can explain how children learn certain emotional, behavioral, and cognitive responses to neutral stimuli, it is not

as successful in explaining how children learn to be successful in Lindsley's ideal classroom: to read and solve problems, follow directions, and work productively with others. Let's look at a second learning paradigm, which can explain how learners develop these skills in their learners.

Operant Conditioning

B. F. Skinner, a Harvard psychologist, has been one of the most influential psychologists of the twentieth century. His theories and research have been applied to education, business, health care, mental health, prison reform, and military training. Skinner was thoroughly familiar with the writings of Pavlov and accepted the basic principles underlying classical conditioning. But he viewed these principles as applicable only to the learning of physiological and emotional responses—those responses (for example, salivation) that are elicited by some type of stimulus (food) and can be conditioned to another type of stimulus (bell). He called this class of behavior *respondent behavior* because it occurred in response to a stimulus.

Skinner was most interested in the learning principles governing a different class of behavior, which he called *operant behavior*. Operant behavior, in contrast to respondent behavior, is not a physiological or emotional response to something that happens in the person's environment. Rather, operant behaviors are actions that a person uses to meet the demands of the environment.

For example, riding a bicycle, going to a movie theater, pushing a vacuum cleaner, turning on the stereo, visiting a friend's house, cooking a meal, painting a picture, tuning a car engine, and writing a poem are examples of operant behaviors. These behaviors are called "operant" because they are operations that the individual carries out to help him or her deal with the environment in some

way. Rather than being reactions to stimuli in the environment, they are actions or operations that the person purposely performs on the environment.

Many if not most of the operant behaviors we perform are complex, the result of years of skill acquisition. Speaking, writing, reading, problem solving, running, sewing, and making friends are complex skills, the building blocks of which can be traced to simple behaviors that the person first performed as an infant or toddler. These simple behaviors—grasping at a mobile, looking at a face, uttering a sound, pulling oneself up, balancing on two feet—were gradually shaped into more complex skills as a result of the interaction between the person performing the behavior and the people reacting to it.

Skinner used the expression **operant conditioning** to describe the process whereby simple operant behaviors are gradually transformed or shaped into more complex ones. Let's examine this paradigm to see first how an animal can learn a skill such as pressing a lever to get food, and then how humans can learn to speak, write, and even problem solve.

How Operant Conditioning Works

Figure 4.3 shows a "Skinner box"—an experimental chamber used for operant conditioning. A hungry rat is placed in the box. Inside the box is a lever, which, if pressed, releases a food pellet into a tray. There are also a red light, a green light, and an electric grid on the floor.

Suppose that your goal is to teach the rat to press the lever. When placed in the box, the rat will move about randomly. It will stand up, sniff, turn left, turn right, bump into walls, and so forth. These are all operant behaviors.

Given sufficient time, the rat will press the lever by accident and release a food pellet into the tray. Most rats will quickly learn the association between lever-

pressing and food release, and they will keep pressing the lever again and again. In other words, operant conditioning will take place. If the rat is removed from the box after 30 minutes of lever-pressing and is placed back in the box the next day, it will press the lever to get food in a shorter period than it took the first time.

Now let's examine some of the basic features of operant conditioning. Figure 4.1, which illustrates the ABC model of learning, is really just another way to describe the operant conditioning process.

Reinforcement. Skinner emphasizes that what happens following a behavior determines whether it will be repeated and strengthened. He used the term **reinforcement** to refer to any event following a behavior that makes it more likely that the behavior will be repeated: the food the rat obtains reinforces the lever-pressing behavior. When the event following the behavior is desirable, so that the behavior is repeated in anticipation of a reward, **positive reinforcement** has occurred. Again, the food pellet is a positive reinforcer that makes the behavior more likely to recur.

Schedules of Reinforcement. Skinner discovered that to get the rat to repeatedly press the lever, reinforcement had to occur on a continuous schedule—after every occasion when the rat pressed the lever. He also showed that once reinforcement stopped, the rat would soon stop pressing the lever, a process called extinction. **Extinction** is the gradual disappearance of a learned behavior when it is no longer being reinforced. This naturally led to the question of how to reinforce behavior so as to increase or speed up the initial rate of learning and make it more resistant to extinction once reinforcement was discontinued.

Skinner studied how to increase the rate of response and make learned behavior more resistant to extinction by manipulating what he called schedules of

reinforcement. A **schedule of reinforcement** is a rule for when reinforcers will be given after the desired behavior is performed. Reinforcers can be given every time a behavior occurs (a **continuous reinforcement schedule**), or every now and then (an **intermittent reinforcement schedule**).

If reinforcers are given intermittently, you may choose, for example, to reinforce every other response or every third response (thus creating a **ratio schedule**), or you may decide to give the reinforcer after a set period of time, such as at the end of each 30-second or 60-second period during which the rat presses the lever (an **interval schedule**).

Ratio and interval schedules can be fixed or variable. A *fixed ratio schedule* is a rule that says, for example, "reinforce every fourth time the rat presses the lever." A *variable ratio schedule,* on the other hand, directs the experimenter to reinforce a certain proportion of responses in such a way that, on average, one out of every four responses is reinforced.

Interval schedules can also be fixed (for example, every minute) or variable (so that, on average, the rat is reinforced every 60 seconds). Figure 4.4 summarizes the various schedules of reinforcement and suggests their practical effects in the classroom.

Skinner discovered that each schedule of reinforcement had a predictable effect on rate of learning and resistance to extinction. His results are summarized in Table 4.1.

Punishment. What would happen to the rate of lever-pressing if, after the rat pressed the lever, a mild electric shock was delivered by means of the electric grid at the bottom of the box? Skinner found that the rat would quickly stop pressing the lever. The speed with which it learned to stop pressing would depend on both the immediacy of the shock and its intensity. Skinner defined **punishment** as any

action, following a response, that makes that response less likely to occur again. The key part of this definition is that punishment makes a response *less* likely to recur.

Negative Reinforcement. Punishment, which we described above, is distinguished from **negative reinforcement,** which is a way of making a response *more* likely to recur by removing an aversive (unpleasant) stimulus. For example, suppose you wanted to teach the rat to jump over a fence that divided the box in half. One means of accomplishing this would be to send an electric current through the floor on the side of the box where the rat was standing. The rat would become agitated and would eventually jump the barrier and land in the unwired portion of the box. The next time the rat was placed in the wired section and the shock was delivered, it would jump much sooner than the first time. Eventually, the rat would jump the barrier even before the shock was administered.

The rat learned to jump by means of negative reinforcement. The rat escaped or avoided a shock by performing a new behavior. In general, we tend to repeat behaviors that help us avoid, postpone, delay, or alter situations we find aversive or unpleasant. For example, when you postpone or cancel assignments or tests because students complain about them, you are negatively reinforcing their complaining behavior. If a student doesn't want you to call on her, and finds that she can get you to call on someone else by looking away, then you are negatively reinforcing her behavior.

Stimulus Control. Let's say that you want the rat to press the lever for food only when the green light comes on. In other words, you want the green light, but not the red one, to elicit or control lever-pressing behavior. This could be accomplished by reinforcing the rat with food pellets when the green light was on, but not the red one. Eventually, the rat would learn to press the lever for a reward

only in the presence of a green light. This is an example of **stimulus control**—the rat's lever-pressing response has been brought under the control of the conditioned stimulus (the green light). Skinner called this type of training **discrimination training.** By reinforcing the rat only in the presence of a particular stimulus, the rat learns to discriminate the occasions when it will be rewarded from those when it will not.

In the classroom, this would be analogous to expecting learners to raise their hands to ask questions only when you have finished an explanation, which you signal by pausing and looking around the room. You then could bring hand raising under stimulus control by calling only on those who raise their hands and ignoring students who speak out without permission. Students quickly learn that when they raise their hands following your signal, they are more likely to be called on. Figure 4.5 provides examples of some other ways the principles of operant conditioning can apply to human behavior. Note the parallels between this figure and the components in the ABC model of learning, which were illustrated in Figure 4.1.

Relevance of Operant Conditioning for Teachers

Skinner points out that most of the behaviors that we want learners to acquire in school can be classified as operants. Complying with rules, following important routines such as lining up or changing learning groups, completing homework, writing legibly, speaking in complete sentences, dissecting a frog, reciting a poem, performing a cartwheel, getting along with others, and working independently are behaviors that teachers can gradually strengthen, shape, and refine. In addition, through discrimination training, you bring these behaviors under stimulus control—you let learners know when and under what circumstances it is appropriate to perform them.

In the remainder of this chapter, we will examine how to apply the principles of operant conditioning to help learners acquire important academic skills.

Using the Behavioral Science Approach

In the introduction to this unit we asked the question, “What does a classroom teacher need to know about learning?” According to the behavioral science approach, the teacher must be able to:

1. Focus instruction on observable learner performance.
2. Assure that learners can perform the skills that are prerequisites to that performance.
3. Elicit a rapidly paced, correct performance.
4. Use appropriate consequences following performance.

Figure 4.6 illustrates these important components of the behavioral science approach to instruction. Let’s examine each of them in more detail.

Focus on Learner Performance

Behavioral scientists have traditionally defined learning as a stable change in behavior brought about by the environment. Cognitive theorists have expanded this traditional definition of learning to include such topics as cognitive changes in memory capacity, thinking, and mental processing. Behavioral scientists are opposed to this definition. Their opposition stems less from a denial that changes in cognitive (mental) activity occur than from a concern about the difficulty of measuring them.

Behaviorists believe that in order to establish a true science of instruction we must be able to explain how what teachers do affects what learners do—not what or how they think. Cognitive activity is something we cannot measure directly.

We can only infer it from observing performance—and inferences about cognitive activity can be wrong. Behaviorists believe that a focus on observable performance avoids incorrect inferences about learning and allows us to build a science of instruction on a firm foundation.

Distinctions between learning and performance and between cognitive and observable changes are important for teaching. By their strong advocacy of observable outcomes and performance objectives, behavioral scientists challenge teachers not to take learning for granted. This means that you should plan lessons with a clear vision of the important outcomes you want learners to achieve (as we will discuss in Chapter 10), and end your instruction with an assessment of those outcomes (as we will discuss in Chapters 12 and 13). Both of these recommendations are consistent with the behavioral science approach to learning. This premise of behavioral science—that the only valid measure of learning is observable performance—has been criticized by some educators and psychologists (Pasch, Sparks-Langer, Gardner, Starks, & Moody, 1991), who believe that this emphasis encourages teachers to write only those objectives that are easy to measure and thus to ignore educational outcomes involving complex intellectual skills.

Behavioral scientists, on the other hand, believe that a concern for performance will have the opposite effect—that it will persuade teachers to give more serious thought to what they want their learners to accomplish. This, in turn, will help teachers devise authentic ways to assess learning in terms of performance and thinking skills, not just the acquisition of facts. As we will see in Chapters 10 and 13, you can write clear, detailed instructional goals and objectives that can be measured reliably in the context of classroom performance and performance on real-world assessment tasks.

Ensure the Learning of Prerequisite Skills

You may be wondering how someone's intelligence, abilities, aptitudes, or learning style enters into a behavioral scientist's theory of learning. After all, if someone lacks an aptitude for math or writing, or possesses little musical or painting ability, doesn't that affect his or her learning?

What characteristics of learners should classroom teachers be concerned about when planning their lessons? Behavioral scientists have a straightforward and (given their concern for observable performance) predictable answer to these questions: Other than a learner's physical capabilities to perform the learning task, the only characteristic that is relevant to a student's learning a skill is whether the learner possesses the prerequisites for it. In other words, if you expect your students to learn how to write a paragraph, you must first ask yourself whether they can write a complete sentence, a topic sentence, and transitions between sentences. At an even more basic level, can they spell words and form letters correctly? If some of your learners cannot learn to write a paragraph skillfully and effortlessly, behavioral scientists would attribute this to a lack of prerequisite skills (or poorly designed instruction)—not to a lack of ability, aptitude, or intelligence.

Behavioral scientists believe that the source of almost all learning failures can be identified if teachers analyze both the *internal conditions* (prerequisite skills) and the *external conditions* (instructional events) of learning. For example, if one of your learners can't seem to master long division, is it because he hasn't learned how to subtract? If he is having difficulty learning subtraction skills, has he learned how to regroup? If he hasn't learned to regroup, can he identify which of two numbers is larger? At no point would the behavioral scientist conclude that the learner lacks ability or intelligence. If the teacher analyzes and probes deeply

enough, eventually she can identify the source of the problem and teach or reteach the skills necessary for learning to continue.

The idea of breaking complex behaviors into smaller component behaviors originated with Skinner (1954). As we saw earlier, Skinner's experiments on shaping the behavior of rats demonstrated the usefulness of this method. Gagné (1970), however, more so than any other behavioral scientist, demonstrated the importance to classroom learning of such an analysis.

Task Analysis. The process of analyzing the internal conditions necessary for learning is called **task analysis.** The outcome of a task analysis is an arrangement of prerequisite skills into a *learning hierarchy.* You begin a task analysis by identifying what task you want your learners to perform at the end of a lesson or unit of instruction. Then ask, "In order to perform this task, what prerequisite skills must my learners already have mastered?" The answer should be the most complex, highest-level prerequisite skills.

Next, for each of these skills, identify further prerequisites. Eventually a learning hierarchy emerges, such as that shown in Figure 4.7. The questioning process you might follow for an individual learner is illustrated in this figure.

If you have trouble conducting a task analysis using the logical questioning process described above, do the task yourself and write down what you did, or observe someone doing the task and write down what you saw. Some curriculum guides are sufficiently detailed as to provide a task analysis for you.

Sequencing. Constructing a learning hierarchy is dependent on identifying the prerequisite skills in the correct sequence: you can't teach subtraction with regrouping before you teach place value. Behavioral scientists consider the sequence in which skills are taught to be especially important. They place a premium on correct responses, rapid responding, and efficiency. Therefore,

incorrectly sequenced instruction results in errors, frustration, and inefficiency. Englemann (1991) cautions that the sequence of skills presented in the published curriculum you use may create problems for your learners. Thus, it will be worth your while to examine this sequence and adjust it when necessary.

Also, solving complex problems in math, writing compositions, and interpreting difficult reading passages are all tasks that require learners to perform prerequisite skills automatically and effortlessly (Mayer, 1987). Imagine the difficulty your learners would have writing an essay if they could not form letters, spell, punctuate, and construct grammatical sentences. Learners who cannot perform prerequisite skills effortlessly and with minimal errors find it difficult to transfer new learning to unfamiliar problem contexts. One of the key ingredients for transfer of new learning is the mastery of prerequisite skills.

Elicit Rapidly Paced, Correct Performance

As we saw in our study of operant conditioning, Skinner was able to elicit rapid correct performance by the skilled use of reinforcement and stimulus control. As you will recall, the basic elements of operant conditioning are (a) a response or behavior that you want to teach or shape, (b) an effective reinforcer, and (c) the delivery of that reinforcer immediately after performance of the desired response. The challenge—both to psychologists in the lab and to teachers in the classroom—is to elicit a correct response. Let's analyze this challenge and explore further the topic of rapidly paced, correct performance.

The skilled teacher gets learners to respond correctly by bringing correct responses under stimulus control. Exactly how is this done? How does a teacher deliver instruction in a manner that minimizes the likelihood that learners will make mistakes? Four important factors are involved.

1. Assure the learning of prerequisite skills.

2. Present instructional material effectively.
3. Use prompts.
4. Use reinforcement.

We have already discussed the first of these factors. In this section, we explain the remaining three.

Effective Presentation. Behavioral scientists point out three areas for you to consider as you decide how to present instructional material: specific directions, opportunities for learner responses, and the pacing of response opportunities (Cooper, Heron, & Heward, 1987; Englemann, 1991).

Specific Directions. Let's say that you want to teach some sight words to your learners. You want them to look at a word and pronounce it correctly. Here are two examples of possible directions:

> **Example 1:** This is the word "rabbit." Say "rabbit" and point to the word.
>
> **Example 2:** This is the word "rabbit." A rabbit is a small, furry animal with big ears. It likes to eat carrots. Point to the word "rabbit" and say it.

Example 1 is a better set of directions if your objective is to bring the response "saying and pointing to the word 'rabbit'" under the stimulus control of the word "rabbit." Example 2 contains information that may distract the learner from making the correct response.

Whether you are teaching word recognition to first-graders, subtraction to second-graders, paragraph construction to sixth-graders, or problem solving in physics to eleventh-graders, instructional directions should be specific to the behavior you want your learners to acquire. So think carefully about what you want learners to do and how you will direct them to do it. Discard information and explanations that are extraneous and serve only to distract the learner.

Opportunities for Learner Response. Behavioral scientists have conducted extensive research on the idea of opportunity to respond (Delguardi, Greenwood, & Hall, 1979; Hall, Delguardi, Greenwood, & Thurston, 1982; Lindsley, 1992b). They make a useful distinction between active and passive responding. **Active responding** requires the learner to do something: write sentences, calculate answers, focus a microscope, balance a scale, weigh rocks, and record observations. **Passive responding,** on the other hand, includes such activities as listening to lectures, paying attention to peers while they are reading, watching television, and waiting for teacher assistance.

Greenwood, Delguardi, and Hall (1984) report that nearly half of a learner's day is involved in passive responding. This is unfortunate, because their research also demonstrates a strong relationship between learner achievement and active responding. Behavioral scientists, therefore, urge you to plan your lessons so that learners spend at least 75 percent of their time engaged in active responding.

Research on opportunity to respond has also found that correct responses are more likely to come under stimulus control when you design your practice material (worksheets, seatwork drills, homework assignments, and so forth) to elicit correct responses 70 to 90 percent of the time (Borich, 1996; Stephens, 1976). Many teachers purposely design materials for learner practice to be challenging—in other words, they design it so there is a strong likelihood that the learners will make mistakes. Behavioral scientists have demonstrated that learners acquire basic facts and skills faster when their opportunities for practice result in success most of the time.

Pacing of Response Opportunities. Recall Ogden Lindsley's description of the ideal classroom from the beginning of this chapter. In it, Lindsley drew our attention to the rapidity with which the learners were responding—they were "shouting correct answers as fast as they can at 200 words per minute." It is a

cardinal principle of behavioral science that when instruction is focused on basic academic skills, stimulus control of correct responses is more likely to occur when learners are encouraged to respond rapidly.

Although you might predict that more errors would result from fast-paced lessons, research indicates just the opposite for the acquisition of facts and action sequences. In a series of studies on the pace of reading instruction, Carnine found that rapid presentations by teachers produced greater achievement, fewer errors, and more sustained attention by learners during letter and word identification tasks than did slower presentations (Carnine, 1976; Carnine & Fink, 1978).

In summary, the behavioral science approach to learning suggests that you deliver instruction in the following ways:

- Give directions that focus only on the response you want learners to make.
- Allow learners to engage in active responding during the majority of class time.
- Design instructional material for both initial learning and practice so that learners can produce correct answers 70 to 90 percent of the time.

Use of Prompts. During instruction teachers often provide **prompts**—hints and other types of supplementary instructional stimuli to help learners make the correct responses. Because, as we have seen, the behavioral science approach is concerned with minimizing mistakes, it places a high value on the use of prompts that increase the likelihood that learners will respond correctly.

Behavioral scientists identify three categories of prompts used by teachers to shape the correct performance of their learners: verbal prompts, gestural prompts, and physical prompts. We will discuss the use of all three kinds in the following sections.

Verbal Prompts. Verbal prompts can be cues, reminders, or instructions to learners that help them perform correctly the skill you are teaching. For example, saying “Leave a space between words” to a first-grader as he is writing reminds him what you previously said about neat handwriting. Or saying “First adjust the object lens” to a learner as she is looking at a microscope slide prompts her as she is learning how to use a microscope. Verbal prompts help guide the learner to correct performance and prevent mistakes and frustration.

Gestural Prompts. Gestural prompts model or demonstrate for learners a particular skill you want them to perform. For example, if you were to point to the fine adjustment knob on the microscope and make a turning gesture with your hand, you would be prompting the student to perform this step of the process. Gestural prompts are particularly helpful when you anticipate that the learner may make a mistake. Teachers use gestural prompts routinely to remind learners how to fold a piece of paper, to grasp a pair of scissors, to raise a hand before asking a question, or to hold a pen properly when writing.

Physical Prompts. Some learners lack the fine muscle control needed to follow a demonstration and imitate the action that is being modeled. For example, the teacher might verbally describe how to form the letter “A” and demonstrate this for the learner, and the learner may still be unable to write “A” correctly. In such a case, the teacher might use her hand to guide the learner’s hand as he writes. This is called a physical prompt. With a physical prompt you use hand-over-hand assistance to guide the learner to the correct performance. Teachers routinely use physical prompts to assist learners with handwriting, cutting out shapes, tying shoelaces, correctly holding a dissecting tool, or performing a complex dance routine.

Least-to-Most Prompting. Behavioral scientists generally recommend that you use the least intrusive prompt first when guiding a learner's performance. This is referred to as **least-to-most prompting.** Verbal prompts are considered the least intrusive, while physical prompts are considered the most intrusive (Cooper et al., 1987). Thus it would be more appropriate to first say to a learner "Don't forget the fine adjustment!" when guiding her in the use of a microscope than to take her hand and physically assist her. The reasoning behind using a least-to-most order of prompts to assist learners is that verbal prompts are easier to remove or fade than are physical prompts. Learners who are dependent on physical prompts to perform correctly will find it more difficult to demonstrate a skill independently of the teacher.

At this point, let's summarize what we've learned about stimulus control and its relationship to correct responses. So far, we have learned that behavioral scientists view the eliciting of a correct response as one of the four basic elements of learning. Correct responses followed by reinforcement results in more permanent learning then correct responses intermixed with incorrect responses. Mistakes slow down the learning process and often lead to frustration and attempts by learners to avoid, or passively respond to, a learning activity.

Establishing stimulus control over learner performance is the key to errorless learning. In order to elicit rapidly paced, correct performance, you must pay particular attention to four important factors when planning your lessons:

1. Make sure your learners have mastered prerequisite skills.
2. Present your lessons in a way that will give learners frequent opportunities to make correct responses.
3. Use prompts to ensure correct responding.
4. Reinforce correct responses immediately.

Let's turn now to the fourth basic element of the behavioral science approach, which tells us how to deliver consequences to learners following their performance.

Use Appropriate Consequences Following Performance

Picture the following situation: You have just begun a unit on converting fractions to decimals with your fifth-graders. After demonstrating how to perform this skill, you pass out a worksheet with 20 problems. You give your learners 10 minutes to complete the task. As the students work, you move from desk to desk checking on their answers. You notice several students getting answers wrong. What should you do? Here are some alternatives.

1. Circle the incorrect answers, show them what they did wrong, and encourage them to do better.
2. Circle just the correct answers, point out what they did right, and encourage them to do better.
3. Circle the correct answers, and praise the students for their good work.
4. Circle the incorrect answers, admonish the students, and have them do the problems again.
5. 1 and 4.
6. 2 and 3.
7. All of the above.

Educational psychologists using the behavioral science approach have researched the issue of how best to respond to the correct and incorrect responses of learners. They have arranged the possible consequences into three general categories: (1) informational feedback, (2) positive consequences, and (3) negative consequences.

Let's examine each and see what behavioral scientists have learned about their effectiveness in promoting learning.

Informational Feedback: Correct Responses. If a learner correctly recalls the major historical events leading up to the Civil War, legibly forms a lowercase cursive letter, or accurately solves an algebra equation with two unknowns showing her work, you should do two things immediately: (1) tell the learner the answer is correct, and (2) briefly describe what she did to obtain the correct answer. For example:

"That's right. You listed the five major events."

"Those letters are slanted correctly and you wrote them on the line."

"The answer is right and you showed all the required steps."

Behavioral scientists remind us that better learning results when you tell learners not only what they got right, but also *why* they got it right (Cooper et al., 1987).

Informational Feedback: Incorrect Answers. Learners give incorrect answers for several different reasons: carelessness, lack of knowledge, or lack of understanding. In the first case, some teachers scold or use some form of verbal punishment. Behavioral scientists and many educators strongly advise against these consequences for careless performance. Instead, they recommend that you use the following types of feedback whenever students give incorrect answers, regardless of the reason:

1. If the problem involves only knowledge of factual information, simply give the correct response.
2. If the problem involves more complex intellectual skills, point out the rules, procedures, or steps to follow.
3. Ask the learner to correct the answer.

4. Ask the learner to practice some extra problems.

Here is an example of each:

"The correct spelling is *t-h-e-i-r*."

"End every sentence with a period, question mark, or exclamation point."

"First draw the base. Then, draw the altitude. Now, retrace your steps."

"Ask yourself: 'Who are the more talked-about people in this story?' Then answer the next set of questions."

Note that these examples do not include preaching, scolding, or focusing extensively on the student's error—even if the learner was being careless. Such responses often create feelings of anxiety and distaste for schoolwork, which encourage disengagement from the learning activity. Learning will occur more quickly if you simply tell your students what to do, have them try again, and provide practice with additional problems when an incorrect response is given (Rodgers & Iwata, 1991).

Cautions for Correcting Mistakes. Research on feedback and error correction has shown that the recommendations given above improve learning for most students. However, there are two groups of learners for whom these procedures may not be beneficial: (1) those who make a lot of mistakes and (2) those who are excessively dependent on adult guidance.

When given material that is too difficult, low-achieving learners make many errors. Such learners experience low rates of positive consequences and high rates of negative ones. Consequently, they are likely to ignore corrective feedback and simply stop working. Research on low achievers affirms that when error rates are high, little is learned from informational feedback (Kulik & Kulik, 1988;

McKeachie, 1990). This finding underscores the importance of designing your instruction to produce as few errors as possible in all learners.

The second case, learners who depend greatly on adult guidance, may involve attention-seeking behavior. In other words, some learners may persist in making mistakes because of the attention they receive after doing so. Hasazi and Hasazi (1972) and Stromer (1975) speculated that when a teacher's response focuses on the mistake itself rather than on the correct answer (for example, circling reversals of letters when the learner writes *b* for *d,* or circling digits when the learner writes *32* for *23*), it may inadvertently reinforce incorrect responses.

These researchers carried out experiments in which teachers circled only correct responses and drew no attention to those that were incorrect. They found dramatic improvements in the learners' ability to write digits and letters correctly after teachers made this change alone. This surprising finding reminds us that focusing on mistakes may actually reinforce the wrong response. This may be especially true in classrooms where teachers pay more attention to children who are misbehaving (talking out of turn, not following instructions) than to those who routinely follow class rules.

Positive Consequences Following Performance. Behavioral scientists have conclusively demonstrated the crucial role played by positive consequences in promoting and strengthening learning in animals. They have shown that positive consequences play an equally critical part in the classroom learning of children (Sulzer-Azaroff & Mayer, 1986). Thus, for the classroom teacher today, the important question is not whether to use positive consequences in the classroom, but what type of consequence to use and how.

Behavioral scientists make a distinction between positive consequences and positive reinforcers. *Positive consequences*, such as smiles, praise, happy faces,

“happy-grams” (see Chapter 16), and prizes are enjoyable or pleasurable things that teachers (or parents) do for children to encourage their good efforts and motivate them to do better. They may or may not serve as positive reinforcers.

Something can be called a *positive reinforcer* only when it can be conclusively shown that it increases the frequency of a target behavior. When you praise a learner’s correct punctuation with the intention of increasing the likelihood that she will continue her progress, you are using a positive consequence. In order to classify this consequence as a positive reinforcer, you must show that the learner continues to make progress and that your praise was the causal factor. Some teachers develop elaborate systems of positive rewards, hoping that they will energize their learners to achieve increasingly higher levels of both social and academic skills (Canter, 1989). However, the teachers believe they are using positive reinforcers when they are simply using positive consequences.

We will now extend our discussion of positive consequences following learning to address two additional issues: (1) how to use positive consequences to promote and maintain learning and (2) how to establish natural reinforcers (i.e., intrinsic motivators) for learners who require extrinsic ones.

The Expert Practice of Positive Reinforcement

Recall from our discussion of operant conditioning that positive reinforcement is the process of strengthening behavior by the presentation of a desired stimulus or reward. While this definition appears simple, reinforcement is nevertheless easily misunderstood and misused. Before we expand on the use of positive reinforcement in the classroom, let’s see some examples of what it is *not.* These will help you grasp the complexity of positive reinforcement.

Mr. Russo has snack time at 10:15 and 10:30 for his first-grade class. He gives his learners juice, cookies, fruit bits, and other types of reinforcers.

Mr. Baker, the principal, decided to start a positive reinforcement program. At the end of the week, each teacher would nominate his or her "best student" to receive the "Principal's Pride Award" at a ceremony each Monday morning. Parents would be invited to attend.

Mrs. Knipper allows students who finish assignments early to use the computer in the back of the room.

Mr. French has a popcorn party every Friday if the class has not broken more than five major rules the entire week.

Mrs. Reimer has a basketful of inexpensive trinkets and school supplies. She lets learners who have been particularly helpful on a given day select a prize from the basket.

Learners who read more than five books a year are treated to a special roller skating party at the end of the school year, hosted by the principal.

There is nothing wrong or inappropriate about these activities. Learners, their teachers, and parents generally like and support them. They even may have some beneficial outcomes on learning, but they are not necessarily examples of positive reinforcement. Positive reinforcement is a complex process that demands a substantial commitment of the teacher's time and effort, as we will now see.

The Process of Positive Reinforcement

When behavioral scientists speak of positive reinforcement they refer to a sequence of actions by a teacher, trainer, or behavioral specialist that has a beginning, middle, and end. When you decide to use positive reinforcement you commit yourself to this specific sequence of steps, which we describe in the

accompanying box, *Administering Positive Reinforcement.* Note that very few of these steps were followed in the examples given earlier. Reread the examples now, and ask yourself how many included: baseline measurement of specific behaviors; assessment of reinforcer preferences; immediate, continuous reinforcement for the performance of specific behaviors; and a gradual fading of the use of extrinsic reinforcers to natural reinforcers.

The point is that the expert practice of positive reinforcement is a demanding intellectual and physical challenge. When you decide to use it, you are committing yourself to a process that involves measurement, consistent delivery of reinforcers, and the responsibility to fade them. Because of this commitment, there may be few examples in regular school classrooms today where the science of reinforcement, as developed by behavioral scientists, is consistently and appropriately applied.

Therefore, it is important to recognize that most reward, recognition, and incentive systems used in today's schools do not constitute positive reinforcement as behavioral scientists use the term. In either case, users of positive reinforcement should be aware of the ethical issues involved in the use of extrinsic rewards, such as paying students for reading books or for staying off drugs.

Natural Reinforcers: Alternatives to Extrinsic Reinforcers

Behavioral scientists have often been criticized for creating a generation of learners who are hooked on artificial or extrinsic consequences in order to learn and behave in the classroom (see, for example, de Charms, 1968, 1976). However, an analysis of the writings of early behaviorists like B. F. Skinner (1953, 1974), or other behavioral scientists like Ogden Lindsley (1991, 1992a, 1992b) and Baer, Wolf, and Risley (1968), challenges this criticism. Such behavioral scientists have advocated the use of **natural reinforcers,** those that are

naturally present in the setting where the behavior occurs. Thus, there are natural reinforcers for classrooms (grades), ballfields (the applause of fans), the workplace (money), and the home (story hour, parent attention). Examples of unnatural reinforcers are paying children or giving them treats for achievement in schools, or buying toys for children who behave well at home.

Skinner makes a further distinction in his definition of a natural reinforcer: he sees it as a change in stimulation resulting from the behavior itself. In other words, natural reinforcers occur when the behavior itself produces an environmental change that gives the person pleasure. For example, the natural reinforcer for hitting the correct keys on a piano is the pleasurable sound that the behavior brings. Similarly, the natural reinforcer for writing correct letters is the satisfaction the first-grader experiences when she sees the letters forming on the page. Thus to Skinner a natural reinforcer is a consequence that results from the very performance of the behavior we want the child to learn; that consequence in turn motivates the child to want to perform these behaviors again.

Children who enjoy solving puzzles are receiving natural reinforcement for doing so. Likewise, learners who write poetry, play the guitar, study history, read novels, or compete in gymnastics are receiving natural reinforcement. What these examples have in common is that children are engaging in the behaviors again and again without the need for external praise or other reinforcers delivered by another person.

Some learners are naturally reinforced by learning to write, read, color, answer questions, play sports, solve equations, answer textbook questions, and write essays, but others are not. Many learners require external reinforcers to engage in certain classroom activities that they do not find naturally reinforcing. For such children, external reinforcers have an important role to play. They can accomplish two things. They enable you to (1) shape and improve the behaviors you desire

through the use of positive reinforcement and (2) transfer their control over the learner's behavior to natural reinforcers. Behavioral scientists refer to this process as *conditioning* (Horcones, 1992).

Conditioning a Natural Reinforcer. Over the past decade, the Communidad Los Horcones (Horcones, 1985, 1987, 1991, 1992) has developed a strategy for transferring the control of extrinsic reinforcers to that of natural, or intrinsic reinforcers. This process as a whole is referred to as **intrinsic reinforcement.** The group's recommendations are listed in the accompanying box, *Conditioning a Natural Reinforcer.* Note how the use of natural reinforcers relies on the learner's intrinsic motivation and thus allows you to transfer control of the behavior to the learner herself.

Positive Consequences: A Final Comment. Behavioral scientists emphasize that there is nothing wrong with extrinsic reinforcers, particularly when they are used as a means to get learning started and to condition natural reinforcers. But there are drawbacks to their use. Some learners stop studying when they are removed (Emmer, Evertson, Clements, & Worsham, 1994). They are not always available for all learners at the same time nor available for individual learners when they are needed. This is not the case with natural reinforcers.

Moreover, extrinsic reinforcers can be effective only when they are consistently delivered by another person. It is impractical to expect teachers to reinforce the most important behaviors of all learners at the right moment. Natural reinforcers allow for this possibility.

We will return to the subject of reinforcement when we study motivational theories in Chapter 7. Let's turn now to a discussion of the third type of consequence that teachers can use following learner performance: negative consequences.

The Use of Negative Consequences

We will end our discussion of the use of the behavioral science approach with the final type of consequence teachers can use: negative consequences. Here are some examples of negative consequences:

> Mr. Holt's fourth-period math class was just before lunch. His students often failed to complete their seatwork during this period. He decided to delay the lunch period for any learners who did not finish their work.
>
> Ms. Tolbert wanted to help her learners spell more accurately. She made them write each misspelled word 25 times in their notebooks.
>
> Mr. Blandon was a stickler for correct punctuation. Any student who failed to capitalize a sentence or place a period at the end received a firm lecture on carelessness.
>
> Mr. Thomas decided to do something about students who weren't doing homework—students who didn't turn in homework assignments were required to do them after school.
>
> Mr. Altman sent "sad-grams" home to the parents of students who were doing poorly in his math class.

These are all examples of negative consequences, things that teachers (or other adults) do to learners after inappropriate behaviors in the hope that such behaviors will not occur again. Types of negative consequences typically used in schools are these:

> **Verbal reprimands:** Speaking harshly to the student: "That work is sloppy and careless, and you should be ashamed of yourself for doing it."

Overcorrection: The learner not only corrects what he did wrong but engages in repetitive, boring practice on the same skill: “After you correct all the spelling mistakes, write each misspelled word correctly 50 times.”

Response cost: The teacher takes away some right or privilege: “Whoever fails to complete the assignment loses the first 15 minutes of recess.”

Exclusion: The learner is removed from one setting and placed in another, often called “time out”: “If you don’t cooperate in your groups, you will be removed and put in the back of the room for the rest of the period.”

Negative Consequences Versus Punishers

Negative consequences may or may not be punishers. As we have seen, to a behavioral scientist, a **punisher** is something you do following a behavior to reduce the frequency of that behavior for as long as the punisher is used. In other words, your overcorrection of spelling mistakes is a punisher only if you keep good records that show that spelling mistakes have been substantially reduced. If not, then overcorrection is not a punisher—it is simply a negative consequence, which has no real effect on mistakes and may or may not cause the learner discomfort.

Behavioral scientists are very particular about what they call a punisher (just as they are very particular about what they call a reinforcer). Something is a punisher only if you have demonstrated that it reduces the behavior you targeted. Scolding, overcorrection, sending someone to the principal’s office (exclusion), taking away recess (response cost), and even corporal punishment are all negative consequences, but they may not be punishers.

The distinction between a negative consequence and a punisher is significant for two reasons. First, some teachers persist in the use of negative consequences in

the belief that they are helping their learners in some way. However, after a scolding, a learner may appear chastened and remorseful. He may even stop the inappropriate behavior for the next hour or day. But the same behavior soon reappears; the teacher, in frustration, scolds or reprimands again; and the cycle repeats itself.

Scolding in this case does not reduce the target behavior. It is not a punisher. It is simply a negative consequence, which the teacher uses to relieve frustration with the learner and which gives the illusion of effectiveness. By distinguishing between negative consequences and punishers, behavioral scientists remind us of the importance of gathering evidence that a behavior is changing before we persist in the use of any technique. They highlight an important ethical question: What is the justification
for the continued use of negative consequences in the absence of proof of their effectiveness?

Second, the distinction between negative consequences and punishers is also significant because it raises the question of what is required to turn a negative consequence into an effective punisher.

The Use of Punishment

As often as you hear the lament “I tried positive reinforcement and it didn’t work,” you will hear the assertion “Punishment isn’t effective.” And just as we can attribute the failure of positive reinforcement to ineffective practice, so we can attribute the failure of punishment to ineffective application.

Many myths have arisen over the past two decades concerning the use of punishment in schools. These myths pertain to both the effectiveness and the ineffectiveness of punishment in reducing undesirable behavior. In the former case, we often hear statements like these: Punishment stops unwanted behavior.

When all else fails, use punishment! Children must experience negative consequences for misbehavior! Spare the rod and spoil the child! In the latter case, punishment is frequently criticized because it makes children hate school or teachers, creates emotional problems, only temporarily suppresses behavior, or deals only with the symptom of the problem and not the cause.

In response to these beliefs, behavioral scientists cite hundreds of studies, carried out with both animal and human subjects over the past half century, that have led
to a set of tested conclusions about punishment and its use (Cooper et al., 1987; Sulzer-Azaroff et al., 1988). Here is what these studies tell us about the use of punishment:

- Punishment can result in long-term elimination of undesirable behavior, but so can techniques that involve the exclusive use of positive reinforcement to strengthen appropriate behavior.
- Some individuals engage in severe, chronic, life-threatening behaviors that cannot be eliminated by positive reinforcement alone.
- When punishment to eliminate inappropriate behaviors is used in conjunction with positive reinforcement to teach alternative behaviors, emotional side effects such as fear and dislike of teachers, attempts to escape or avoid school or schoolwork, or anxiety are less likely to occur.
- The failure of some nonaversive and positive reinforcement techniques to suppress undesirable behavior does not automatically justify the use of punishment. Usually this failure is due to the ineffective use of positive reinforcement.
- The failure of less intense punishment to suppress behavior does not necessarily justify the use of more intense punishment. In fact, increasing

the ratio of positive reinforcement to create a contrast with punishment usually precludes the need for increased punishment.

From their studies on the effective use of punishment, behavioral scientists have identified several conditions as essential for the suppression and eventual elimination of undesirable behavior. Not surprisingly, these conditions are similar to those we identified for the successful use of positive reinforcement earlier in this chapter. They include the following:

1. Precise identification and baseline measurement of the target behavior.
2. Precise identification of an alternative, positive behavior.
3. An assessment of the most effective potential punisher for the target behavior prior to its use.
4. Consistent, immediate reinforcement and punishment on a continuous schedule until changes in both the target behavior and the alternative behavior are evident.
5. Fading of both reinforcers and punishers.

In Chapter 9, when we consider the topic of conduct management, we will return to the concept of reinforcement and examine its impact in the classroom more thoroughly.

Some Concluding Remarks

Our goal in this chapter was to present what you need to know about behavioral learning theory in order to be an effective classroom teacher. Although American educational practice is experiencing a resurgence of interest in cognitive approaches to classroom instruction, there is much of merit in the behavioral

science approach that should not be lost. First, the behavioral approach emphasizes that changes in observable behavior should be the focus of your instruction and the criteria by which you judge its success. Second, behavioral scientists remind us that the most direct path to learning requires that your students have the prerequisite skills to achieve your objectives; that you design instruction that brings rapid, correct responses under stimulus control; and that you accelerate learning through the skilled use of positive reinforcement.

We have included in this chapter a description of some of the techniques involved in effective punishment. However, the behavioral scientist does not advocate the use of punishment—not because it is necessarily ineffective, but because the requirements for its expert and consistent implementation are often beyond the time constraints and resources of most classroom teachers. Also, the ineffective use of punishment raises serious ethical and legal issues.

Summing Up

This chapter introduced you to the behavioral science approach to classroom learning. Its main points were these:

- According to the behavioral science approach, the basic conditions required for learning are (1) a focus on observable performance, (2) an environment that stimulates correct and rapid performance, (3) abundant opportunities for practice and feedback, and (4) provision for positive reinforcement.
- The ABC model of learning refers to antecedents in the environment (A) that elicit desired behavior (B), which then becomes strengthened when followed by appropriate consequences (C).

- The behavioral science approach holds that the source of almost all learning failures can be identified if teachers analyze the internal conditions (prerequisite skills) and external conditions (instructional events) of learning.
- Classical conditioning is the transformation of a neutral stimulus (for example, a bell) into a conditioned stimulus (a bell that can elicit salivation), and an unconditioned response (salivation) into a conditioned response (salivation at the sound of a bell).
- Operant conditioning is reinforcement of a correct response after it has already occurred to increase the likelihood that the response will occur again.
- Stimulus control occurs when stimuli in the environment automatically bring about a response. Stimulus control is achieved by using rules, reminders, hints, prompts, demonstrations, praise, and so forth to produce as few errors and as many correct responses as possible.
- Behavioral scientists recommend that lessons be planned so that learners spend at least 75 percent of their time engaged in active responding.
- It is recommended that practice opportunities be structured so that learners can obtain the correct answer 70 to 90 percent of the time.
- Positive reinforcement occurs when increases in a desired target behavior are observed. It requires a baseline measurement of specific behavior; an assessment of reinforcer preferences; immediate, continuous reinforcement; and the gradual fading of extrinsic reinforcers.
- Natural reinforcers are those that are naturally present in the setting where the behavior occurs. They can also represent a change in stimulation due to the behavior itself; for example, hitting the correct keys on the piano.
- Negative consequences that reduce the frequency at which behavior occurs are called punishers. Verbal reprimands, overcorrection, response costs, and

exclusion become punishers when they reduce the frequency of the targeted behavior.

For Discussion and Practice

*1. What three basic conditions does Ogden Lindsley believe are required for learning in an ideal classroom? Show how these are incorporated in the ABC model of learning.

*2. Define operant conditioning and give an example of how you would use it to present a lesson in your teaching area.

*3. According to the behavioral science approach to learning, other than a learner's physical capabilities to perform the task, what characteristic is relevant to student learning?

*4. What do Skinner and Gagné call the activity by which complex behaviors are broken into smaller component behaviors? How is this activity used by the classroom teacher?

*5. What is the behavioral scientist's primary goal regarding mistakes or errors in learning?

*6. Define "stimulus control" and provide an example of its use in a classroom of learners where you are likely to teach.

7. Choose an objective in your teaching area, and provide good and bad examples of directions to learners. Why is one example better than the other?

*8. Provide three examples each of active and passive responding, and indicate the results of the research regarding their use in the classroom.

*9. During lesson presentation, on what three conditions does the behavioral scientist place most emphasis? Provide an example of each.

*10. For a topic of your own choosing, provide an example of the informational feedback you would provide after (a) a correct response and (b) an incorrect response.

*11. Distinguish between a positive consequence and a positive reinforcer, and provide an example of each.

*12. Positive reinforcement in the classroom requires what conditions of the teacher? With an example behavior in your teaching area, show how each would be implemented.

*13. In your own words, what are natural reinforcers? Provide one example relevant to the age of learners you will teach and one example relevant to your own learning.

*14. Identify and give an example of four types of negative consequences. What condition would have to be met for each to become a “punisher”?

Suggested Readings

Journal of Applied Behavior Analysis 25 (1) (1992). This volume contains articles by present-day behavioral scientists addressing the current educational crisis. They point out how behavioral science approaches to education can improve American education.

Phillips, D. C., & Soltis, J. E. (1991). *Perspectives on learning* (2nd ed.). New York: Teachers College Press. Presents a highly readable and concisely written synopsis of all the major learning theories. It is written for classroom teachers.

Sulzer-Azaroff, B., et al. (1988). *Behavioral analysis in education,* reprint series, vol. III. Lawrence, KS: Society for the Experimental Analysis of Behavior, Inc. Describes how to use behavioral science learning techniques in schools. Many of these articles contain precise descriptions of techniques that teachers can easily read and implement.

Whaley, D. L., & Malott, R. W. (1971). *Elementary principles of behavior.* Englewood Cliffs, NJ: Prentice-Hall. One of the most readable texts available on the use of behavioral science learning theory to change behavior. It contains many examples and anecdotes.

ABC model of learning. A model that considers antecedents in the environment that elicit desired behavior, which is then strengthened when followed by appropriate consequences.

Classical conditioning. The process by which an unconditioned, neutral stimulus and an unconditioned response are paired repeatedly to become a conditioned stimulus that elicits a conditioned response.

Unconditioned stimulus. A stimulus that naturally or automatically elicits an unconditioned response.

Unconditioned response. A reaction that automatically follows an unconditioned stimulus.

Figure 4.1

The ABC model of learning.

Conditioned stimulus. A stimulus that through the conditioning process has acquired the power to generate a conditioned response.

Conditioned response. In classical conditioning, a response that is elicited by some previously neutral stimulus; occurs by pairing the neutral stimulus with an unconditioned stimulus.

Figure 4.2

The three phases of classical conditioning. In the preconditioning phase, the unconditioned stimulus (UCS) elicits an unconditioned response (UCR). During the conditioning phase, the neutral stimulus and the UCS are paired repeatedly. In the postconditioning phase, the neutral stimulus (now called a conditioned stimulus, or CS) will elicit the original response (now called a conditioned response, or CR). *Source:* Adapted from *Developmental Psychology: Childhood and Adolescence*, by D. Shaffer, 1993, Pacific Grove, CA: Brooks/Cole.

How can I help my learners develop a positive attitude toward what I teach?

Many complex processes can be shaped by means of operant conditioning techniques.

Operant conditioning. A type of learning in which the probability or likelihood of a behavior occurring is changed as a result of procedures that follow that behavior.

Figure 4.3
The experimental chamber referred to as the Skinner box.

Reinforcement. In operant conditioning, actions taken following a response that increase the likelihood that the response will occur again. Reinforcement can be both positive and negative.

Positive reinforcement. The condition of administering a stimulus, following a response, that increases the likelihood of that response occurring again.

Extinction. A procedure that involves identifying and eliminating the specific reinforcer for a particular inappropriate behavior.

Schedule of reinforcement. A rule for when reinforcers will be given following performance of a desired behavior.

Continuous reinforcement schedule. Reinforcement of every occurrence of a behavior.

Intermittent reinforcement schedule. A procedure by which only certain responses are followed by the delivery of a reinforcer.

Ratio schedule. Application of reinforcers after a set number of responses, such as every third response.

Interval schedule. Delivery of reinforcers after the first response made following a predetermined period of elapsed time.

How can I help my learners become more persistent in their efforts to learn?

Figure 4.4
Schedules of reinforcement.

Punishment. In operant conditioning, an action taken following a response that decreases the likelihood that the response will happen again.

Negative reinforcement. A procedure that increases the likelihood of a response being repeated by removing an aversive stimulus immediately following that response.

Table 4.1

Reinforcement Schedules and Their Effect on Rate of Learning and Resistance to Extinction

Schedule	Example	Effect on Rate of Learning	Pattern of Response Following Extinction
Continuous	Reinforce the learner every time he completes a math problem.	Learner will rapidly learn to complete math problems.	Learner will quickly stop completing math problems once reinforcement stops.
Fixed interval	Reinforce the learner every 5 minutes for working on math problems.	Learner will complete more math problems as the time for reinforcement draws near but complete fewer immediately following reinforcement.	Learner will not persist long with daily math problems. He will quickly stop doing problems once 5-minute period ends and he doesn't receive reinforcement.
Variable interval	Reinforce after various lengths of time.	These schedules generate low to moderate rates of response. After a period of adjustment to the schedule, the learner will complete a constant, stable number of problems.	Once extinction starts, the learner will continue to do math problems for longer periods of time. But there will be a slow steady decline.
Fixed ratio	Reinforce after a set number of math problems are completed.	These schedules generate rapid rates. The learner will complete math problems quickly because she gets reinforced after a fixed number of problems are completed.	Learner will not persist in doing math problems for long once she doesn't get reinforced after the total number of problems are completed.

Variable ratio	Reinforce after a varying number of math problems are completed.	These schedules produce rapid, consistent rates of performance.	Learner will persist in doing math problems the longest with this schedule.

Stimulus control. In operant conditioning, the control of the occurrence of a response by a dependable signal or cue, which indicates that a reinforcer will occur if the correct response is emitted.

Discrimination training. Reinforcement that occurs only in the presence of a particular stimulus in order for the subject to discriminate the occasions when a reward will occur and when it will not.

Figure 4.5

Basic principles of operant conditioning, showing examples of reinforcement and punishment. *Source:* From *Developmental Psychology: Childhood and Adolescence,* by D. Shaffer, 1993, Pacific Grove, CA: Brooks/Cole. Copyright © 1993, 1989, 1982 by Brooks/Cole Publishing Company, a division of International Thomson Publishing, Inc., by permission of the publisher.

Figure 4.6

The behavioral science approach to instruction.

How will I know when my learners have attained the prerequisite skills required for new learning?

Task analysis. A process for identifying the behavioral components of more complex skills and arranging them in a hierarchical sequence.

Figure 4.7

A learning hierarchy for conservation skills. *Source:* From “Contributions of Learning to Human Development,” by R. M. Gagné, 1968, *Psychological Review,*

75, p. 184. Copyright © 1968 by the American Psychological Association. Adapted by permission.

How can I encourage errorless learning?

According to behavioral scientists, children learn best from instructional practices that prevent mistakes, allow rapid responding, and provide many opportunities for practice.

Active responding. Learner behavior that emphasizes asserting, volunteering, or actively seeking out information.

Passive responding. Learner behavior in which the learner receives or waits for information.

Prompts. Supplementary or additional aids that teachers use to increase the likelihood that learners will engage in successful practice.

Least-to-most prompting. Prompting learners with the least intrusive methods before progressing to relatively more intrusive forms of prompting.

Teachers guide student learning through the skillful manipulation of antecedents and consequences.

What types of practice and feedback are required for new learning to occur?

How will I know whether my lessons provide appropriate rewards and reinforcement?

Applying Your Knowledge:

Administering Positive Reinforcement

Step 1: Determine a specific, observable behavior to strengthen and decide at what level of strength or correctness you want the behavior to occur. Behavioral scientists emphasize that we reinforce observable behaviors, not people.

Step 2: Measure the frequency or duration of this behavior before beginning to reinforce it. Without a baseline measure of the behavior, it cannot be determined whether the behavior has changed.

Step 3: Determine what reinforcers for the given behavior are likely to be the most effective.

Step 4: Give the reinforcer to the learner immediately after he or she performs the desired behavior.

Step 5: Give the reinforcer to the learner every time he or she performs the desired behavior until it reaches the desired level of strength or correctness.

Step 6: Change reinforcers or alter the teaching if the behavior does not show progress.

Step 7: Change from a continuous schedule of delivery of reinforcers to an intermittent one. This will maintain the behavior at the desired level and prevent it from weakening as the behavior is reinforced less and less.

Step 8: Gradually transfer the control of the behavior from extrinsic reinforcers to natural reinforcers.

Natural reinforcers. Reinforcers that occur naturally in the setting where a behavior occurs; also, changes in stimulation due to the behavior itself, such as hitting the correct keys on a piano when trying to play a particular song.

Positive reinforcement doesn't end with the delivery of the reinforcer. Teachers also have a responsibility to decrease learner dependence on extrinsic sources of motivation.

How do I make my learners less dependent on external rewards and more motivated to learn for learning's sake?

Intrinsic reinforcement. A strengthening of behavior that occurs in the absence of any external uses of reinforcers.

Applying Your Knowledge:

Conditioning a Natural Reinforcer

Step 1: Select the target behavior. Examples are forming letters correctly, solving multiplication problems, drawing geometric figures, bisecting angles, and writing compositions.

Step 2: Identify the natural consequences of the selected behavior. For example, writing on a piece of paper produces many natural consequences: a scratching sound, the formation of letters, the filling up of a page, the gradual wearing away of a pencil point. Writing an essay has similar natural consequences, but in addition produces sentences that express thoughts, ideas, and images.

Step 3: Choose intrinsic consequences. From the list of natural consequences just given, select those that are likely to be reinforcing to the person and relevant to the purpose of the activity. For example, the formation of the letters is a more appropriate consequence to focus on than the scratching sound on the paper or the filling up of the page.

Step 4: Identify those consequences that can be more easily noticed by the learner. The more conspicuous the consequence to the learner, the easier it is to condition this as a natural reinforcer. For example, the shape of a printed word is a conspicuous consequence of correct handwriting that may serve as a natural reinforcer. Likewise, writing a complete thought, coming up with an answer that matches the one in the back of the textbook, or the satisfied feeling after finishing a task can all serve as natural reinforcers.

Step 5: Design your lessons in such a way that you make conspicuous the occurrence of natural consequences. Rather than focusing only on the right answer to a problem, point out and describe for the learner the sequence that was followed. In general, focus on how something was done, not just on the end result. Some learners may not notice or direct their attention to the natural consequences of their work. By setting up instructional conditions to do this, you allow for natural reinforcers to acquire power over behavior.

Step 6: Select appropriate backup reinforcers. In order to transfer the power of an extrinsic reinforcer over behavior to a natural consequence, you must select extrinsic or backup reinforcers. These reinforcers should have educational value, be typically available in your classroom, and, ideally, involve you in the reinforcing activity (Horcones, 1991).

Step 7: Condition the natural reinforcer. Have your learners engage in the behavior. As soon as possible, give informational feedback that points out the natural consequences you hope will become natural reinforcers. Immediately give the backup reinforcers. Gradually remove these reinforcers from the learning setting, but continue to point out and illustrate the natural consequences of what the learner did. Gradually point out the natural consequences less and less. Deliver and intermittently pair the backup reinforcers with the natural reinforcers.*Source:* From Horcones, 1992.

Punisher. A stimulus received following a response that decreases the likelihood that the response will happen again.

What are some cautions I should be aware of when considering the use of negative consequences in my classroom?

When used effectively, punishment reduces problem behavior, and, when it is used in conjunction with positive reinforcement, can promote long-term change. When used ineffectively, it raises serious ethical and legal issues.

Questions marked with an asterisk are answered in the appendix.