an introduction to THEORIES OF LEARNING

Second Edition

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Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632

Library of Congress Cataloging in Publication Data

HERGENHAHN, B. R.
An Introduction to theories of learning.

Bibliography:
Includes index.

1. Learning, Psychology of. I. Title.
LB1051.H42-1982 370.15'23 81-5908
ISBN 0-13-498725-X AACR2

Printed in the United States of America

10 9 8 7 6 5

Editorial/production supervision
and interior design by Joyce Turner
Cover design by Suzanne Behnke
Manufacturing buyer: Edmund W. Leone
Cover photo by Roland Birke, The Image Bank

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall of Canada, Ltd., *Toronto*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Whitehall Books Limited, *Wellington, New Zealand*

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Burrhus Frederic Skinner

Skinner was born in Susquehanna, Pennsylvania, in 1904 and is considered by many to be the most famous, influential psychologist alive today. He received his Masters degree in 1930 and his Ph.D. in 1931 from Harvard University. His B.A. degree was obtained from Hamilton College in New York where he majored in English.

While at Hamilton, Skinner had lunch with Robert Frost, the great American poet, who encouraged Skinner to send him a sample of his writing. Frost reviewed favorably the three short stories that Skinner sent and Skinner decided definitely to become a writer. This decision was a great disappointment to his father who was a lawyer and who wanted his son to become a lawyer.

Skinner's early efforts to write were so frustrating that he thought of seeing a psychiatrist. He eventually went to work for the coal industry summarizing legal documents. In fact, his first book, coauthored by his father, concerned those legal documents and was entitled *A Digest of Decisions of the Anthracite Board of Conciliation.* After finishing this book, Skinner moved to Greenwich Village in New York City where he lived like a Bohemian for six months before going to Harvard to study psychology. By that time he had developed a distaste for most literary pursuits. In his autobiography, he says (1967):

> I had failed as a writer because I had had nothing important to say, but I could not accept that explanation. It was literature which must be at fault [p. 395].

When he failed in describing human behavior through literature, Skinner attempted to describe human behavior through science. Clearly, he was much more successful at the latter pursuit.

Skinner taught psychology at the University of Minnesota between 1936 and 1945, during which time he wrote his highly influential text, *The Behavior of Organisms* (1938). One of Skinner's students at the University of Minnesota was W. K. Estes, whose work has had a considerable impact on psychology (see Chapter 9). In 1945 Skinner went to the University of Indiana as chairman of the psychology department, and in 1948 he returned to Harvard where he has been ever since.

As we shall see, Skinner's position is similar to Thorndike's position after 1930 in that it emphasizes the effects of a response on the response itself. Moreover, like Thorndike, Skinner concludes that the effects of reward and punishment are not symmetrical, that is, reward changes the probability of a response's recurring, but punishment does not.

Through the years, Skinner has been a highly prolific writer. One of his main concerns has been to relate his laboratory findings to the solution of human problems. His work has led to the development of programmed learning and teaching machines. Two representative articles in this area are "The Science of Learning and the Art of Teaching" (1954), and "Teaching Machines" (1958). Following his own ideas on this topic, he and his co-author, Holland, produced a programmed text on his theoretical notions entitled *The Analysis of Behavior* (1961). In 1948 he wrote a Utopian novel called *Walden Two*. The title paid tribute to Thoreau's *Walden*. In *Walden Two*, which Skinner wrote in only seven weeks, he attempted to utilize his principles of learning in the building of a model society. Skinner has recently written *Beyond Freedom and Dignity* (1971) where he shows how a technology of behavior can be used in designing a culture. In *Beyond Freedom and Dignity* he discusses many reasons why the idea of cultural engineering is met with so much opposition. Skinner's writings have been extended into the area of child development through the efforts of Bijou and Baer (1961, 1965). His thoughts have been related to the area of personality through the writings of Lundin, who wrote *Personality: A Behavioral Analysis* (1974), and to child rearing by Hergenhahn, who wrote *Shaping Your Child's Personality* (1972).

Most students of psychology are well aware of the widespread utilization of Skinnerian notions in the area of psychotherapy. For example, Lovaas's early work with autistic children relied heavily on Skinner's ideas. Today the behavior modification approach, based on Skinner's ideas, has become the most widely used and most effective way of working with autistic or retarded children. Behavioral engineering, however, is by no means limited to children. The technique has been successfully applied to the alleviation of a number of adult problems such as stuttering, phobias, homosexuality, and psychotic behavior.

During the Second World War, while at the University of Minnesota, Skinner attempted to apply his theory to the problem of national defense. He trained pigeons to peck at discs upon which moving pictures of enemy targets were being shown. The discs and the motion pictures were ultimately to be contained in a glider loaded with high explosives. The glider was called the *Pelican,* thus, the name of the article describing these events, "Pigeons in a Pelican" (1960). The pecking of the pigeons closed various electronic circuits and thereby kept the vehicle on target. This American version of kamikaze fighter planes would involve no losses of human lives. Although Skinner demonstrated to a group of America's top scientists that he and his co-workers had perfected a homing device that was practically immune to electronic jamming, was capable of reacting to a wide variety of enemy targets, and was simple to build, their proposed project was turned down. Skinner speculates that the whole idea was simply too fantastic for the committee to cope with.

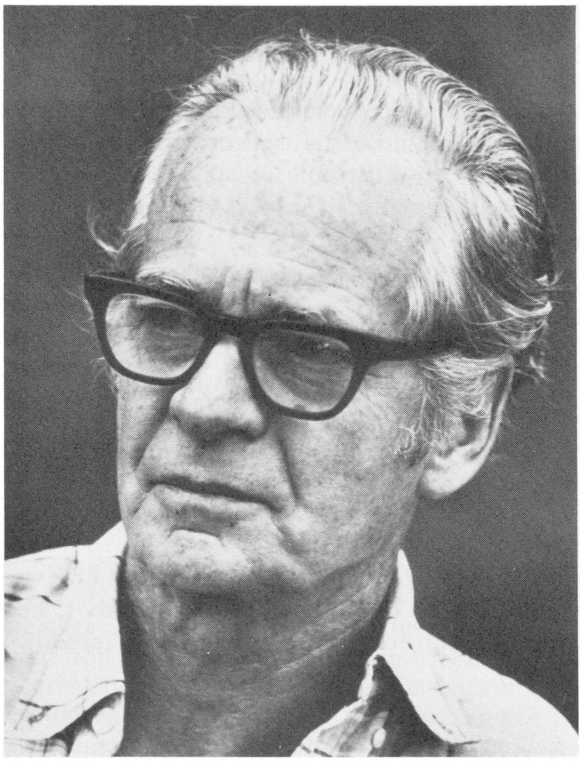
MAJOR THEORETICAL NOTIONS

Respondent and Operant Behavior

Skinner distinguishes two kinds of behavior: **respondent behavior,** which is elicited by a known stimulus, and **operant behavior,** which is not elicited by a known stimulus but is simply emitted by the organism. Unconditioned responses would be examples of respondent behavior since they are elicited by unconditioned stimuli. Examples of respondent behavior would include all reflexes, such as jerking one's hand when jabbed with a pin, the constriction of the pupil of the eye when it is exposed to bright light, and salivation in the presence of food. Because operant behavior is *not* initially correlated with known stimuli it seems to appear spontaneously. Examples include beginning to whistle, standing up and walking about, a child abandoning one toy in favor of another, and moving one's hands, arms, or legs arbitrarily. Most of our everyday activities would be operant behaviors. Note that Skinner does not say that operant behavior occurs independently of stimulation; rather, he says that the stimulus causing such behavior is unknown and that it is not important to know its cause. Unlike respondent behavior which is dependent on the stimulus that preceded it, operant behavior is controlled by its consequences. We will say more about how consequences influence operant behavior.

Type S and Type R Conditioning

Along with the two kinds of behavior described above, there are two kinds of conditioning. Type S conditioning is also called **respondent conditioning** and it is identical to classical conditioning. It is called Type S condi-



Burrhus Frederic Skinner
Courtesy of B. F. Skinner

tioning to emphasize the importance of the stimulus in eliciting the desired response. The type of conditioning that involves operant behavior is called Type R because of the emphasis on the response. Type R conditioning is also called **operant conditioning.**

It is important to note that in Type R conditioning the strength of conditioning is shown by *response rate,* whereas in Type S conditioning, strength of conditioning is usually determined by the *magnitude* of the conditioned response. We see, then, that Skinner's Type R conditioning very closely resembles Thorndike's instrumental conditioning, and Skinner's Type S conditioning is identical to Pavlov's classical conditioning. After making the distinction between Type S and Type R conditioning, Skinner's research has been concerned almost entirely with Type R, or operant conditioning.

Although Skinner and Thorndike are in close agreement on a number of important issues, there are still important differences between them. For example, the dependent variable in Thorndike's learning experiments, (his measure of the extent to which learning took place) was *time to solution.* Thorndike was interested in measuring how long it took an animal to perform whatever task was necessary to release it from confinement. Skinner, on the other hand, uses *rate of responding* as his dependent variable. Although Skinner sometimes talks about how reward affects the probability of a response's recurring, his main concern is with how reward affects the rate with which an operant response occurs. In other words, Thorndike was mainly interested in noting how long it took an animal to make a certain response, whereas Skinner is interested mainly in what variables affect rate or pattern of responding.

Operant Conditioning Principles

Two general principles are associated with Type R conditioning: (1) any response that is followed by a reinforcing stimulus (reward) tends to be repeated; and (2) a reinforcing stimulus (reward) is anything that increases the rate with which an operant response occurs. Or, as we saw above, we can say that a reward is anything that increases the probability of a response's recurring.

Skinner does not provide a rule that one would follow in discovering what would be an effective reinforcer. Rather, he says that whether or not something is reinforcing can only be ascertained by its effect on behavior. He says (1953):

> In dealing with our fellow men in everyday life and in the clinic and laboratory, we may need to know just how reinforcing a specific event is. We often begin by noting the extent to which our own behavior is reinforced by the same event. This practice frequently miscarries; yet it is still commonly believed that reinforcers can be identified apart from their effects upon a particular organism. As the term is used here, however, the only defining characteristic of a reinforcing stimulus is that it reinforces [p. 72].

In operant conditioning, the emphasis is on behavior and its consequences; with operant conditioning, the organism must respond in such a way as to produce the reinforcing stimulus. This process also exemplifies contingent reinforcement, because getting the reward is contingent (dependent) upon the organism's emitting a certain response. We will have more to say about contingent reinforcement in our subsequent discussion of superstitious behavior.

The principles of operant conditioning can apply to a variety of situations. To modify behavior, one merely has to find something that is rewarding for the organism whose behavior one wishes to modify, wait until the desired behavior occurs, and then immediately reward the organism. When this is done, the rate with which the desired response occurs goes up. When the behavior next occurs, it is again rewarded, and the rate of responding goes up even more. Any behavior that the organism is capable of performing can be manipulated in this manner.

The same principles are thought to apply to the development of human personality. According to Skinner, we are what we have been rewarded for being. What we call personality is nothing more than consistent behavior patterns that summarize our reinforcement history. We learn to speak English, for example, because we have been rewarded for approximating the sounds of the English language in our early home environment. If we happened to be brought up in a Japanese or Russian home, we would learn to speak Japanese or Russian because when we approximated sounds in that language, we would have been attended to or rewarded in some other way. Skinner (1971) says:

> The evidence for a crude environmentalism is clear enough. People are extraordinarily different in different places, and possibly just because of the places. The Nomad on horseback in Outer Mongolia and the astronaut in outer space are different people, but, as far as we know, if they had been exchanged at birth, they would have taken each other's place. (The expression "change places" shows how closely we identify a person's behavior with the environment in which it occurs.) But we need to know a great deal more before that fact becomes useful. What is it about the environment that produces a Hottentot? And what would need to be changed to produce an English conservative instead [p. 185]?

Skinner defines culture as a set of reinforcement contingencies. His answers to the above questions would be that a particular set of reinforcement contingencies produce a Hottentot and another set produces the English conservative. Different cultures reward different behavior patterns. This fact must be clearly understood before an adequate technology of behavior can be developed. Skinner (1971), says:

> The environment is obviously important, but its role has remained obscure. It does not push or pull, it *selects,* and this function is difficult to discover and analyze. The role of natural selection in evolution was formulated only a little more than a hundred years ago, and the selective role of the environment in shaping and maintaining the behavior of the individual is only beginning to be recognized and studied. As the interaction between organism and environment has come to be understood, however, effects once assigned to states of mind, feelings, and traits are beginning to be traced to accessible conditions, and a technology of behavior may therefore become available. It will not solve our problems, however, until it replaces traditional prescientific views, and these are strongly entrenched [p. 25].

If one controls reward, one can also control behavior. However, this need not be looked upon as a negative statement, since behavior is constantly being influenced by reward whether we are aware of that fact or not. It is never a question of *whether* behavior is going to be controlled, but who or what is going to control it. Parents, for example, can decide to give direction to their child's emerging personality by rewarding certain behavior, or they can let society rear their child by letting the TV, peers, school, books, and babysitters reward him or her. Giving direction to a child's life is difficult, however, and any parents wishing to do so must take at least the following steps (Hergenhahn, 1972):

1. Decide the major personality characteristics you want your child to possess as an adult. Let's say, for example, you want the child to grow up to be a creative adult.
2. Define these goals in behavioral terms. In this case, you ask, "What is the child doing when he or she is being creative?"
3. Reward behavior that is in accordance with these goals. With this example, you would reward instances of creativity as they occurred.
4. Provide consistency by arranging the major aspects of the child's environment so that they too reward the behavior you have deemed important [p. 152].

Without a knowledge of these principles, a parent could easily misapply them without knowing it. Skinner says (1951):

> The mother may unwillingly promote the very behavior she does not want. For example, when she is busy she is likely not to respond to a call or request made in a quiet tone of voice. She may answer the child only when it raises its voice. The average intensity of the child's vocal behavior therefore moves up to another level. . . . Eventually the mother gets used to this level and again reinforces only louder instances. This vicious circle brings about louder and louder behavior. . . . The mother behaves, in fact, as if she has been given the assignment of teaching the child to be annoying [p. 29].

According to Skinner, living organisms are constantly being conditioned by their environment. We can either allow the principles of learning to operate capriciously on our children, or by systematically applying those principles, we can give some direction to their development.

The Skinner Box

Most of Skinner's early animal work was done in a small test chamber which has come to be called the Skinner box. It is a direct descendant of the puzzle box used by Thorndike. The Skinner box usually has a grid floor, a light, a lever, and a food cup. It is arranged so that when the animal depresses the lever, the feeder mechanism is activated and a small pellet of food is released into the food cup. A typical Skinner box is shown in Figure 5-1.

The Cumulative Recording

Skinner uses a **cumulative recording** to keep track of an animal's behavior in the Skinner box. A cumulative recording is quite different from other ways of graphing data in learning experiments. Time is recorded on the *X*-axis and total number of responses is recorded on the *Y*-axis. The cumulative recording never goes down—the line either climbs or remains parallel to the *X*-axis. Let's say we are interested in how often the animal presses the lever. When the cumulative recording shows a line parallel to the *X*-axis, it indicates no responding, that is, the animal is not pressing the lever. When the animal makes a lever-pressing response, the pen goes up a notch and remains at that level until the animal makes another response. If, for example, the animal presses the lever when it is first placed in the Skinner box, the pen will go up a notch and remain there until the animal responds again, at which time the pen will go up another notch, and so on. If the animal responds very rapidly, the line will rise very rapidly. The rate with which the line ascends indicates rate of responding; a very steep line indicates very rapid responding, and a line parallel to the *X*-axis indicates no responding. If at any time you want to know the total number of responses made by the animal, you just measure the distance between the line of the graph and the *X*-axis, and this can easily be transformed into total number of responses. Sample cumulative recordings are shown in Figure 5-2.

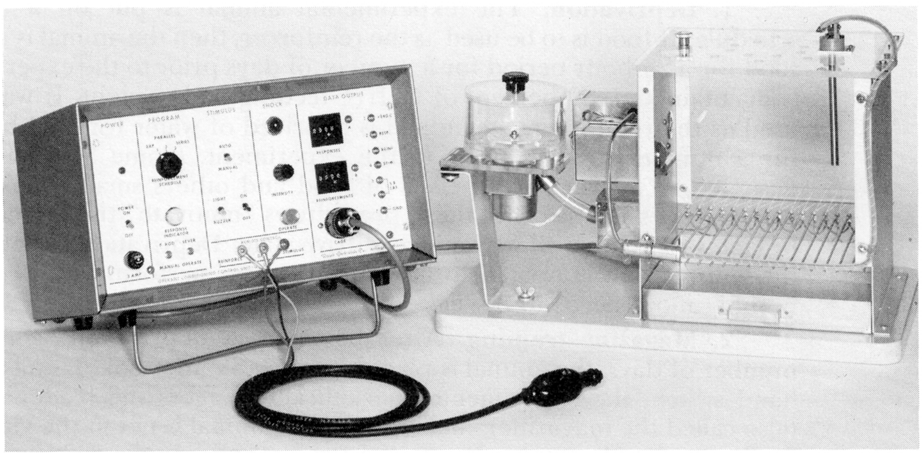


FIGURE 5-1. A typical Skinner box.
Courtesy of the Gerbrands Company, Inc.

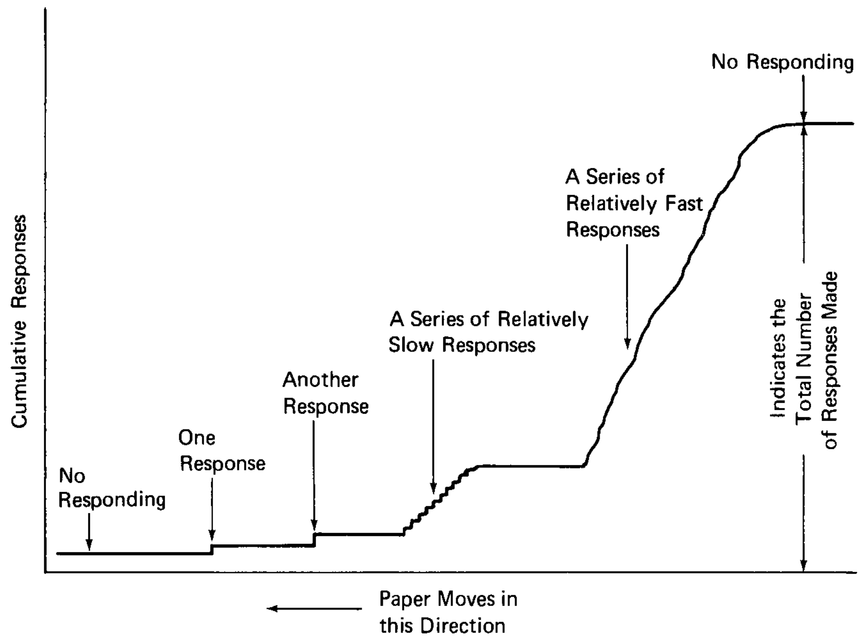


FIGURE 5-2. A cumulative recording. Note that the steeper the line, the faster is the rate of responding. A line parallel to the baseline indicates no responding.

Conditioning the Lever Press Response

Typically, conditioning the lever press response involves the following steps:

1. **Deprivation.** The experimental animal is put on a deprivation schedule. If food is to be used as the reinforcer, then the animal is deprived of food for a 23-hour period for a number of days prior to the experiment, or it is maintained at 80 percent of its free-feeding body weight. If water is to be used as the reinforcer, the animal is deprived of water for a 23-hour period for a number of days prior to the experiment. (Some Skinner boxes are designed to deliver small pellets of food and others small drops of water.) Skinner does not say that these procedures "motivate" the animal; he even hesitates to say that they produce a drive state. Deprivation is simply a set of procedures that is related to how an organism performs on a certain task; nothing more needs to be said.

2. **Magazine training.** After being on a deprivation schedule for a number of days, the animal is placed into the Skinner box. Using an external hand switch, the experimenter periodically triggers the feeder mechanism (also called the magazine), making sure the animal is not in the vicinity of the food cup when he or she does so (otherwise the animal would learn to remain near the food cup). When the feeder mechanism is activated by the hand

switch, it produces a fairly loud clicking sound prior to delivering a pellet of food into the food cup. Gradually the animal associates the click of the magazine with the presence of a food pellet. At that point, the click has become a secondary reward through its association with a primary reward (food). (We will discuss secondary reinforcement in a later section). The click also acts as a cue or signal indicating to the animal that if it responds by going to the food cup, it will be rewarded.

3. Now the animal can be left in the Skinner box on its own. Eventually, it will press the lever, which will fire the food magazine, producing a click that reinforces the bar press, and also signals the animal to go to the food cup where it is reinforced by food. According to operant conditioning principles, the lever press response, having been rewarded, will tend to be repeated and when it is, it is again rewarded, which further increases the probability that the lever press response will be repeated, and so on. A typical cumulative recording generated by an animal placed in a Skinner box after magazine training is shown in Figure 5-3.

Shaping

The process of operant conditioning we have described so far takes considerable time. As we saw above, one way to train the lever press response is to place the deprived animal in the Skinner box and simply leave it there. The experimenter merely checks the cumulative recording periodically to see if the lever press response has been learned. Under these conditions the animal either learns or it dies.

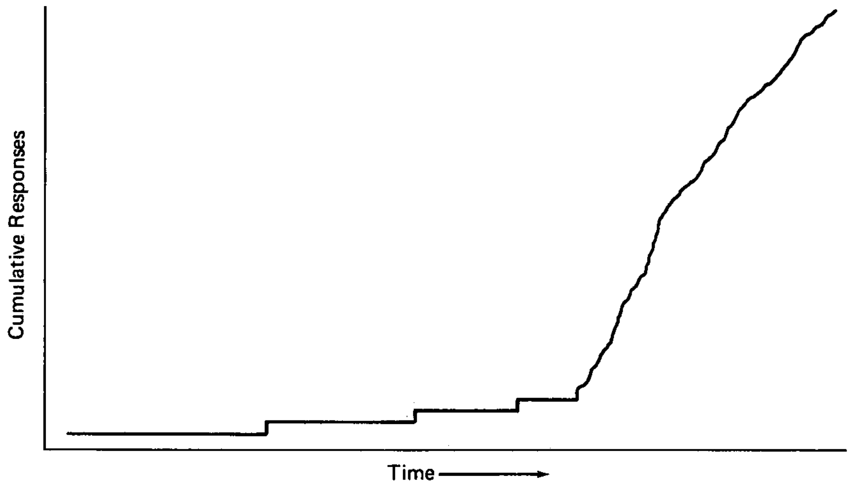


FIGURE 5-3. A typical cumulative recording which reflects the acquisition of a lever press response.

There is another approach to operant conditioning that does not take as long as the procedure described above. Again, the animal is placed on a deprivation schedule and is magazine trained, and again, the experimenter uses the hand switch to trigger the feeder mechanism externally. This time, however, the experimenter decides to fire the feeder mechanism only when the animal is in the half of the Skinner box containing the lever. When the animal gets rewarded for being near the lever, it will tend to remain in that part of the test chamber. Now that the animal remains in the vicinity of the lever, the experimenter begins to reward it only when it is still closer to the lever. Next it is rewarded only when it touches the lever, then only when it is putting pressure on it, and finally, only when it is pressing it by itself.

The process is similar to a childhood game called "You're Hot, You're Cold," where a child hides something and her or his playmates try to find it. As they get closer to the hidden object, the child who hid the object says, "You're getting warm, you're warmer, you're boiling hot, you're on fire." As they get farther from the object the child says, "You're getting cold, colder, very cold, you're freezing." When this game is played in the laboratory, it is called **shaping.** In the shaping procedure described above, the lever press response was shaped rather than waiting for it to happen.

Shaping has two components: **differential reinforcement,** which simply means some responses are reinforced and others are not; and **successive approximation,** which refers to the fact that only those responses are reinforced that become increasingly similar to the one the experimenter wants. In our example, only those reponses which successively approximated the lever press response were differentially reinforced.

Recently it has been found that under certain circumstances some organisms seem to be able to shape their own behavior. This phenomenon is called autoshaping, which we will have more to say about later in this chapter.

Extinction

As with classical conditioning, when we remove the reward from the operant conditioning situation, we produce **extinction.** During acquisition, the animal gets a pellet of food whenever it presses the lever. Under these circumstances, the animal learns to press the lever and persists in doing so until it is satiated with food. If the feeder mechanism was suddenly disconnected, thus preventing a lever press from producing a pellet of food, we would note that the cumulative recording would gradually become shallower and would eventually become parallel to the X-axis, indicating that no lever press responses are being made. At that point, we say that extinction has occurred.

We are being somewhat inaccurate when we say that after extinction a response is no longer made; it is more accurate to say that after extinction, the response rate goes back to where it was before reward was introduced. This baseline rate is the frequency with which the response occurs naturally in the life of the animal without the introduction of reward. This is called the **operant level** for that response. When we remove reward from the experimental arrangement, as in extinction, the response tends to go back to its operant level.

Spontaneous Recovery

After extinction, if the animal is returned to its home cage for a period of time and then brought back into the experimental situation, it will again begin to press the lever for a short period of time without any additional training. This is referred to as spontaneous recovery. A cumulative recording showing both extinction and **spontaneous recovery** is shown in Figure 5-4.

Superstitious Behavior

In our earlier discussion of operant conditioning, we briefly mentioned **contingent reinforcement.** Reward following the lever press response is an example of contingent reinforcement since the reward is dependent on the

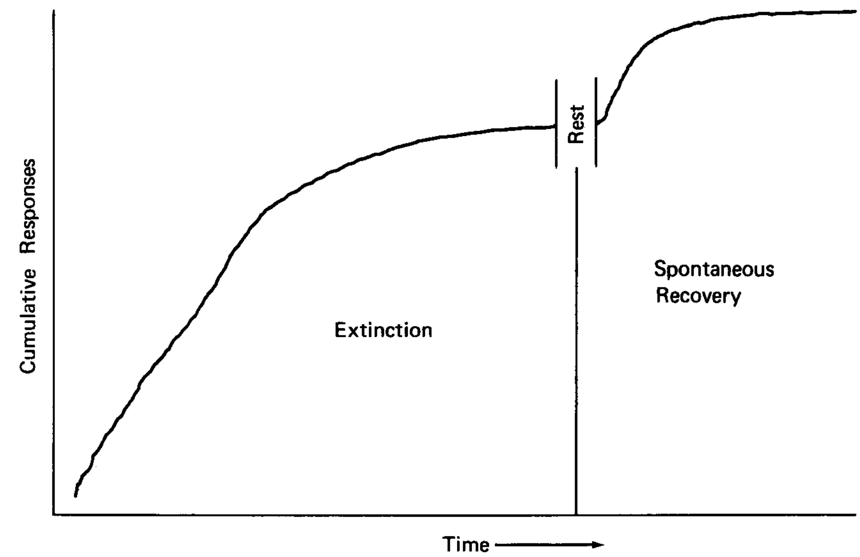


FIGURE 5-4. A cumulative recording which depicts the extinction and spontaneous recovery of a lever press response.

response. What would happen, however, if the situation was arranged so that the feeder mechanism would fire every now and then, independently of the animal's behavior? In other words, we are now going to arrange the situation so that the feeder mechanism delivers a pellet of food periodically *regardless of what the animal is doing.*

According to the principles of operant conditioning, we can predict that whatever the animal is doing when the feeder mechanism is activated will be rewarded, and the animal will tend to repeat the rewarded behavior. At some time the rewarded behavior will be repeated when the feeder mechanism randomly fires again, and the response will be strengthened. Thus the animal is apt to develop strange ritualistic responses; it may bob its head, turn in a circle, stand up on its back legs, or perform a series of actions according to what it was doing when the feeder mechanism fired. This ritualistic behavior is referred to as superstitious because the animal looks as if it believes that what it is doing is causing a pellet of food to appear. Because the reward in this situation is independent of the animal's behavior, it is referred to as **noncontingent reinforcement.**

One can think of numerous examples of **superstitious behavior** on the part of humans. Organized sports, for example, are filled with many examples. Imagine what happens to the baseball player who, after stepping to the plate, adjusts his hat in a certain way, and hits the very next pitch out of the ball park. There will be strong tendency on his part to adjust his hat in a similar way the next time he is at bat.

It is interesting to speculate as to the effects of Christmas or birthday presents on children. It is clear that rewards influence behavior and no doubt presents are rewards. It is not clear, however,what behavior is being rewarded. Are we rewarding a child for becoming a year older, for example, or for what he or she did just prior to receiving the reward? In the former case, it seems impossible for "getting a year older" to increase in frequency. In the latter case, if the behavior prior to the reward is strengthened, we have an example of noncontingent reinforcement, since the response preceding the reward did not produce the reward. Obviously it is not what children receive that is important in shaping their personality, but when they receive it.

Discriminative Operant

Now we return to the Skinner box and discuss the light that we referred to earlier. After we have conditioned the animal to press the lever, we can make the situation more complex. We can arrange the situation so that the animal receives a pellet of food only when the light in the Skinner box is on, but not when the light is off. Under these conditions, we refer to the light as S^D or a **discriminative stimulus.** The light being on defines the S^D condition and the light being off defines the S^{Δ} condition (Δ = delta). With this arrangement, the animal learns to press the lever when the light is on and not to press when the light is off. The light, therefore, has become a signal (cue) for the lever press response. We have developed a **discriminative operant,** which is an operant response given to one set of circumstances but not to another. The arrangement can be symbolized as follows: $S^D \rightarrow R \rightarrow S^R$ where R is the operant response and S^R is the reinforcing stimulus or the reward.

The concept of the discriminative stimulus allows for a more detailed statement about which association is of interest in operant conditioning. For Thorndike, the association of interest was between a general environmental situation and a response effective in solving a problem. For Skinner, the association of interest can be diagrammed as follows:

discriminative stimulus → operant response → reinforcing stimulus
(S^D) (R) (S^R)

association of interest

Except for slight differences in terminology, Skinner's views of learning are quite similar to those of Thorndike after 1930. In fact, except for the way each researcher measured the dependent variable, which was pointed out earlier in this chapter, instrumental conditioning and operant conditioning can be considered the same procedures.

There is some slight similarity between the discriminative operant and respondent conditioning. You will recall that respondent behavior is elicited by a known stimulus. The behavior occurs because of its association with the stimulus. Such behavior, as we have seen, is not under the control of its consequences. In the case of the discriminative operant, the light becomes a signal associated with a certain response that the organism has learned will be followed by reward.

Operant behavior is emitted behavior, but Skinner (1953) says:

> Most operant behavior . . . acquires important connections with the surrounding world. We may show how it does so in our pigeon experiment by reinforcing neck-stretching when a signal light is on and allowing it to be extinguished when the light is off. Eventually stretching occurs only when the light is on. We can then demonstrate a stimulus-response connection which is roughly comparable to a conditioned or unconditioned reflex: the appearance of the light will be quickly followed by an upward movement of the head. But the relation is fundamentally quite different. It has a different history and different current properties. We describe the contingency by saying that a *stimulus* (the light) is the occasion upon which a *response* (stretching the neck) is followed by reinforcement (with

> food). We must specify all three terms. The effect upon the pigeon is that eventually the response is more likely to occur when the light is on. The process through which this comes about is called *discrimination.* Its importance in a theoretical analysis, as well as in the practical control of behavior, is obvious: when a discrimination has been established, we may alter the probability of a response instantly by presenting or removing the discriminative stimulus [pp. 107–8].

Thus, the discriminative operant involves a signal which leads to a response which, in turn, leads to reward.

There are numerous examples of discriminative operants in everyday life. A certain time of the day (S^D) indicates that you must be in a certain place (R) in order to transact some business (S^R). As you're driving down the street, you encounter a red light (S^D), which causes you to stop (R), thereby avoiding a ticket or an accident (S^R). You see someone you don't care for (S^D), causing you to change the direction you are walking in (R), thereby avoiding the person (S^R).

Secondary Reinforcement

Any neutral stimulus paired with a primary reward (e.g., food or water) takes on reinforcing properties of its own; this is the principle of secondary reinforcement. It follows then that every S^D must be a secondary reinforcer since it consistently precedes primary reinforcement.

One way to demonstrate the reinforcing properties of a previously neutral stimulus is to wire the Skinner box so that a light comes on prior to the animal's receiving food for making a lever press response. According to the principle of secondary reinforcement, the pairing of the light with food should cause the light to take on reinforcing properties of its own. One way to test this notion is to extinguish the lever press response so that the animal presses the lever and neither light nor food is produced. When the response rate decreases to its operant level, we arrange for the lever press to turn on the light but not deliver a pellet of food. We note that the response rate goes way up. Since the light alone has increased the response rate and thereby prolonged extinction, we say it has developed secondary reinforcing characteristics through its association with food during acquisition (training). A light not associated with a primary reward will not produce a similar effect during extinction.

In addition to maintaining the lever press response, we can now use the light to condition other responses. Once a previously neutral stimulus takes on rewarding properties through its association with primary reinforcement, it can be used to reward any number of responses.

Keller and Schoenfeld (1950) provide an excellent summary of secondary reinforcement:

> 1. A stimulus that occasions or accompanies a reinforcement acquires thereby reinforcing value of its own, and may be called a conditioned, secondary, or derived reinforcement. A secondary reinforcement may be extinguished when repeatedly applied to a response for which there is no ultimate primary reinforcement.
> 2. A secondary reinforcement is positive when the reinforcement with which it is correlated is positive, and negative when the latter is negative.
> 3. Once established, a secondary reinforcement is independent and nonspecific; it will not only strengthen the same response which produced the original reinforcement, but it will also condition a new and unrelated response. Moreover, it will do so even in the presence of a different motive.
> 4. Through generalization, many stimuli besides the one correlated with reinforcement acquire reinforcing value—positive or negative [p. 260].

Generalized Reinforcers

A **generalized reinforcer** is a secondary reinforcer that has been paired with more than one primary reinforcer. Money is a generalized reinforcer because it is ultimately associated with any number of primary rewards. The main advantage of the generalized reinforcer is that it does not depend upon a certain condition of deprivation to be effective. Food, for example, is only reinforcing for an organism deprived of food, but money can be used as a reward whether or not someone is deprived of food. Grades, trophies, medals, and awards would also classify as generalized reinforcers.

Moreover, the very activities that once led to reward may themselves become reinforcing. Skinner (1953) says:

> Eventually generalized reinforcers are effective even though the primary reinforcers upon which they are based no longer accompany them. We play games of skill for their own sake. We get attention or approval for its own sake. Affection is not always followed by a more explicit sexual reinforcement. The submissiveness of others is reinforcing even though we make no use of it. A miser may be so reinforced by money that he will starve rather than give it up [p. 81].

With these comments, Skinner comes very close to Gordon Allport's concept of **functional autonomy.** Allport (1961) maintains that although an activity may once have been engaged in because it led to reward, after awhile the activity itself may become rewarding. In other words, the activity may become independent of the reward upon which it was originally dependent.

For example, a person might originally join the merchant marines in order to make a living, but later in life go sailing because it is enjoyable to do so even though sailing no longer provides an income. In the latter case, we say that sailing has become functionally autonomous, that is, it continues in the absence of the original motive. Skinner would say that such an activity must ultimately result in primary reinforcement or it would extinguish. Allport, on the other hand, would say that the activity no longer depends on primary reinforcement.

Chaining

One response can bring the organism into contact with stimuli that act as an S^D for another response, which in turn causes it to experience stimuli that cause a third response, and so on. This process is referred to as **chaining.** In fact, most behavior can be shown to involve some form of chaining. For example, even the lever press in the Skinner box is not an isolated response. The stimuli in the Skinner box act as S^Ds, causing the animal to turn toward the lever. The sight of the lever causes the animal to approach it and press it. The firing of the feeder mechanism acts as an additional S^D which elicits the reponse of going to the food cup. Consuming the food pellet acts as an S^D causing the animal to return to the lever and again press it. This sequence of events (chain) is held together by the food pellet, which, of course, is a primary positive reinforcer. It can be said that various elements of a behavioral chain are held together by secondary reinforcers, but that the entire chain depends upon a primary reinforcer.

In order to explain how chaining comes about from Skinner's point of view, one must utilize the concepts of secondary reinforcement and associative shifting. Because of their association with the primary reinforcer, the events prior to the delivery of the food pellet take on secondary reinforcing properties. Thus, the sight of the lever itself becomes a secondary reinforcer, and the response of looking at the lever is reinforced by the sight of the lever. Now, through a process similar to associative shifting (or higher order conditioning which we will discuss in Chapter 7), other stimuli more remote from the lever develop reinforcing properties. Thus, after considerable training, when the animal is placed in the Skinner box, the initial stimuli it encounters will act as an S^D, causing the animal to orient toward the lever. The sight of the lever at this point acts both as a reinforcer and an S^D eliciting the next response in the chain. The situation is diagrammed in Figure 5-5.

It is important to note that the development of a chained response always acts from the primary reward backwards. As more and more related stimuli take on reinforcing properties, the chain is extended. It is possible, for example, for the chain to gradually extend all the way back to the animal's home cage.

S^D →	R →	S^D / S^R →	R →	S^D / S^R →	R →	S^R
General Stimuli in the Test Chamber	Orient Toward Lever	Sight of Lever Rewards Response of Turning Toward It and Acts as a Cue for the Next Response	Approach Lever	Contact With Lever Rewards Approaching and Acts as Cue to Press	Press Lever	Food Pellet

FIGURE 5-5. An example of chained behavior.

Occasionally rats have been trained to perform complex chained responses such as climbing a staircase, riding in a cart, crossing a bridge, playing a note on a toy piano, entering a small elevator, pulling a chain, riding the elevator down, and receiving a small pellet of food. This chain, too, is developed backwards so that the events that precede the primary reward gradually become secondary reinforcers. When they do, they reward the responses prior to them, and so on along the chain of behaviors.

Chained responses can also occur between two people. For example, seeing someone you know acts as an S^D to say "hello." Your hello acts as an S^D for your friend to say "hi." The response of "hi" acts not only as a reward for your "hello" but also acts as an S^D for you to say "How are you?" This two-person chain can be diagrammed as follows:

You:	S^D → Seeing friend	R → Hello ↓	S^D / S^R → ↑	R → How are you? ↓	S^D / S^R → ↑	R → etc.
Your friend:		S^D →	R → Hi	S^D / S^R →	R Fine	

Not only do the consequences of certain responses act as cues for other responses, but certain thoughts can act as S^Ds for other thoughts. Skinner (1953) says,

> A response may produce or alter some of the variables which control another response. The result is a "chain." It may have little or no organization. When we go for a walk, roaming the countryside or wandering idly through a museum or store, one episode in our behavior generates conditions responsible for another. We look to one side and are stimulated by an object which causes us to move in its direction. In the course of this movement, we receive aversive stimulation from which we beat a hasty retreat. This generates a condition of satiation or fatigue in which,

once free of aversive stimulation, we sit down to rest. And so on. Chaining need not be the result of movement in space. We wander or roam verbally, for example, in a casual conversation or when we "speak our thoughts" in free association [p. 224].

Positive and Negative Reinforcers

To summarize Skinner's position on reward, we have first of all **primary positive reinforcement.** This is something that is naturally rewarding to the organism and is related to survival, such as food, or water. Any neutral stimulus associated with primary positive reinforcement takes on positive secondary reinforcing characteristics. A *positive reinforcer, either primary or secondary, is something which, when added to the situation by a certain response, increases the probability of that response's recurring.*

A **primary negative reinforcer** is something naturally harmful to the organism, such as an aversive high pitched tone or an electric shock. Any neutral stimulus associated with a primary negative reinforcer takes on negative secondary reinforcing characteristics. A *negative reinforcer, either primary or secondary, is something which, when removed from the situation by a certain response, increases the probability of that response's recurring.* For example, if a Skinner box is arranged so that an aversive tone is discontinued when the lever is pressed, the lever press response will soon be learned. In this case, by pressing the lever, the animal avoids experiencing an aversive stimulus.

Thus, reinforcement consists of either giving an organism something it wants, or taking away something it does not want. Each one increases the probability of a response's recurring. Negative reinforcement, however, should not be confused with punishment. Skinner (1953) says:

> Events which are found to be reinforcing are of two sorts. Some reinforcements consist of *presenting* stimuli, of adding something—for example, food, water, or sexual contact—to the situation. These we call *positive* reinforcers. Others consist of *removing* something—for example, a loud noise, a very bright light, extreme cold or heat, or electric shock—from the situation. These we call *negative* reinforcers. In both cases the effect of reinforcement is the same—the probability of response is increased. We cannot avoid this distinction by arguing that what is reinforcing in the negative case is the *absence* of the bright light, loud noise, and so on; for it is absence after presence which is effective, and this is only another way of saying that the stimulus is removed. The difference between the two cases will be clearer when we consider the *presentation* of a *negative* reinforcer or the *removal* of a *positive.* These are the consequences which we call punishment [p. 73].

Punishment

Punishment involves either taking away what is positively reinforcing to an organism or applying a negative reinforcer. Thus, punishment is either taking away something an organism wants, or giving it something it does not want. Skinner and Thorndike agree on the effectiveness of punishment: it does not decrease the probability of a response. Although punishment suppresses a response as long as it is applied, it does not weaken the habit. Skinner (1971) says:

> Punishment is designed to remove awkward, dangerous, or otherwise unwanted behavior from a repertoire on the assumption that a person who has been punished is less likely to behave in the same way again. Unfortunately, the matter is not that simple. Reward and punishment do not differ merely in the direction of the changes they induce. A child who has been severely punished for sex play is not necessarily less inclined to continue; and a man who has been imprisoned for violent assault is not necessarily less inclined toward violence. Punished behavior is likely to reappear after the punitive contingencies are withdrawn [pp. 61–62].

A typical experiment which led Skinner to this conclusion was done by one of his students, Estes (1944). Two groups of eight rats each were trained to press the lever in a Skinner box. After training, both groups were placed on extinction. One group was extinguished in the regular way, that is, food was withheld following a lever press. Rats in the second group, in addition to not receiving food, received a shock when they pressed the lever. Rats in this group were shocked an average of nine times. There were three extinction sessions and the rats were only shocked during the first of the three sessions. The second and third sessions were the same for both groups. The results indicated that the punished group made fewer responses during the first extinction session than did the nonpunished group. The number of responses made during the second extinction session was about the same for both groups, with the nonpunished group making slightly more responses. From the data of the first two sessions, one can conclude that punishment was effective since the number of responses to extinction was much lower for the punished group. During the third extinction session, however, the previously punished group made many more responses than did the nonpunished group. Thus, in the long run, the originally punished group caught up in the total number of responses to extinction to the nonpunished group. The conclusion was that simple nonreward (extinction) is as effective in extinguishing a habit as nonreward plus punishment. The results of the Estes study are summarized in Figure 5-6.

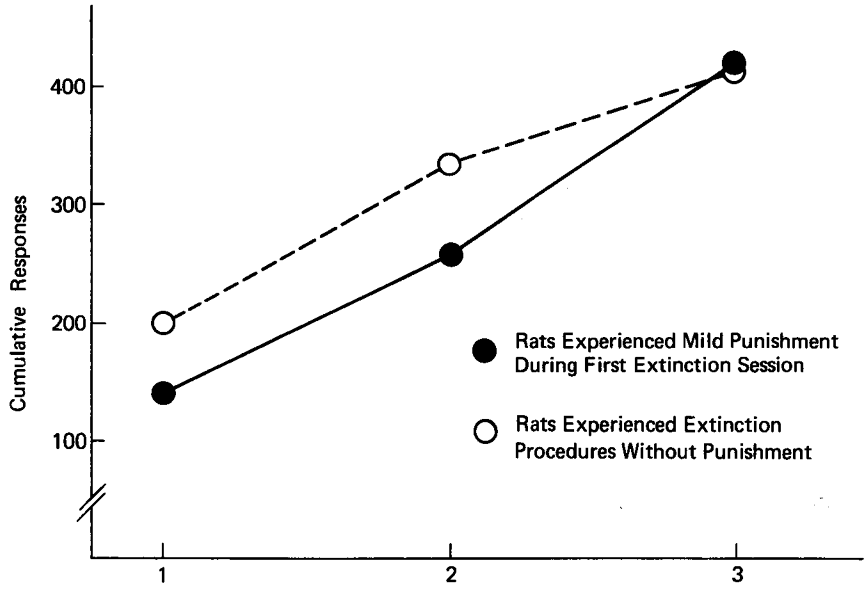


FIGURE 5-6. The results of Estes's research showing that the effect of punishment is to only temporarily suppress rate of responding.

From Estes, 1944, p. 5.

Skinner's main argument against the use of punishment is that it is ineffective in the long run. It appears that punishment simply suppresses behavior and when the threat of punishment is removed, the rate with which the behavior occurs returns to its original level. Thus, punishment often appears to be very successful when, in fact, it has produced only a temporary effect. Other arguments against the use of punishment follow.

1. **It causes unfortunate emotional by-products.** The punished organism becomes fearful and this fear generalizes to a number of stimuli related to those present as the punishment was occurring.

2. **It indicates what the organism should not do, not what it should do.** Compared to reward, punishment conveys practically no information to the organism. Reward indicates that what was done is effective in the situation; therefore, no additional learning is required. Very often punishment informs the organism only that the punished response is one that will not work to bring reward in a given situation, and additional learning is required to hit upon a response that will work.

3. **It justifies inflicting pain on others.** This, of course, applies to the use of punishment in child rearing. When children are spanked, the only thing they may be learning is that under some circumstances it is justifiable to inflict pain on others.

4. **Being in a situation where previously punished behavior could be**

engaged in without being punished may excuse a child to do so. Thus, in the absence of a punishing agent, children may swear, break windows, be disrespectful to elderly people, push smaller children around, etc. These children have learned to suppress these behaviors when they could lead to punishment, but in the absence of a punishing agent, there is no reason to avoid engaging in these activities.

5. **Punishment elicits aggression toward the punishing agent and others.** Punishment causes the punished organism to become aggressive and this aggression may cause additional problems. For example, our penal institutions which use punishment as their major means of control, are filled with highly aggressive individuals who will continue to be aggressive as long as punishment or the threat of punishment is used to control their behavior.

6. **Punishment often replaces one undesirable response with another undesirable response.** For example, a child who is spanked for making a mess may now cry instead, just as a person punished for stealing may now become aggressive and commit even more crimes when he or she has the opportunity.

In their study of how 379 New England suburban mothers brought up their children from birth to kindergarten age, Sears, Maccoby, and Levin (1957) concluded the following concerning the relative effects of emphasizing reward as opposed to punishment in child rearing:

> In our discussion of the training process, we have contrasted punishment with reward. Both are techniques used for changing the child's habitual ways of acting. Do they work equally well? The answer is unequivocally "no"; but to be truly unequivocal, the answer must be understood as referring to the kind of punishment we were able to measure by our interview method. We could not, as one can with laboratory experiments on white rats or pigeons, examine the effects of punishment on isolated bits of behavior. Our measures of punishment whether of the object-oriented or love-oriented variety, referred to *Levels of Punitiveness* in the mothers. Punitiveness, in contrast with rewardingness, was a quite ineffectual quality for a mother to inject into her child training.
>
> The evidence for this conclusion is overwhelming. The unhappy effects of punishment have run like a dismal thread through our findings. Mothers who punished toilet accidents severely ended up with bedwetting children. Mothers who punished dependency to get rid of it had more dependent children than mothers who did not punish. Mothers who punished agressive behavior severely had more aggressive children than mothers who punished lightly. They also had more dependent children. Harsh physical punishment was associated with high childhood aggressiveness and with the development of feeding problems.
>
> Our evaluation of punishment is that *it is ineffectual over the long term as a technique for eliminating the kind of behavior toward which it is directed* [p. 484].

Why, then, is punishment so widely used? Because, says Skinner, it is rewarding to the punisher (1953).

> Severe punishment unquestionably has an immediate effect in reducing a tendency to act in a given way. This result is no doubt responsible for its widespread use. We "instinctively" attack anyone whose behavior displeases us—perhaps not in physical assault, but with criticism, disapproval, blame, or ridicule. Whether or not there is an inherited tendency to do this, the immediate effect of the practice is reinforcing enough to explain its currency. In the long run, however, punishment does not actually eliminate behavior from a repertoire, and its temporary achievement is obtained at tremendous cost in reducing the over-all efficiency and happiness of the group [p. 190].

It is interesting to note that Skinner himself was never physically punished by his father and only once by his mother, who washed his mouth out with soap for swearing (Skinner, 1967, p. 390).

Alternatives to Punishment

Skinner lists a number of alternatives to the use of punishment. The circumstances causing the undesirable behavior can be changed, thereby changing the behavior. For example, removing fine china from the living room will eliminate the problem of a child's breaking fine china. The undesirable response can be satiated by letting the organism perform the undesired response until it is sick of it, such as letting a child continue to light matches or eat candy (advice similar to that given by Guthrie as we shall see in Chapter 8). If the undesirable behavior is a function of the child's developmental stage, it can be eliminated by simply waiting for the child to outgrow it. Skinner says about the latter approach (1953):

> It is not always easy to put up with the behavior until this happens, especially under the conditions of the average households, but there is some consolation if we know that by carrying the child through a socially unacceptable stage we spare him the later complications arising from punishment [p. 192].

Another method is simply to let time pass, but this approach may take too long. Habits are not soon forgotten. For example, in his "Pigeons in a Pelican" project, mentioned earlier, Skinner found that his trained animals "immediately and correctly" performed their task after six years of inactivity.

Still another alternative to punishment is to reinforce behavior incompatible with the undesirable behavior, e.g., a child is rewarded for reading in the presence of matches rather than striking them.

The best way to discourage an undesirable habit, however, is to ignore it. Skinner says (1953):

> The most effective alternative process (to punishment) is probably *extintion.* This takes time but is much more rapid than allowing the response to be forgotten. The technique seems to be relatively free of objectionable by-products. We recommend it, for example, when we suggest that a parent "pay no attention" to objectionable behavior on the part of his child. If the child's behavior is strong only because it has been reinforced by "getting a rise out of" the parent, it will disappear when this consequence is no longer forthcoming [p. 192].

Generally speaking, behavior persists because it is being rewarded; this is true of undesirable as well as desirable behavior. To eliminate objectionable behavior one needs to find the source of reward and remove it. Behavior that does not lead to reward extinguishes.

Schedules of Reinforcement

Although Pavlov had done some work with partial reinforcement, using classical conditioning (1927, pp. 384–86), it was Skinner who has thoroughly investigated the topic. Skinner had already published data on the effects of partial reinforcement when Humphreys (1939a, 1939b) startled the psychological world by showing that the extinction process was more rapid following 100 percent reinforcement than after partial reinforcement. That is, if an organism receives a reward every time it makes an appropriate response during learning, and then is placed on extinction, it will extinguish faster than an organism who had only a certain percent of its correct responses rewarded during acquisition. In other words, partial reinforcement leads to greater resistance to extinction than continuous, or 100 percent reinforcement, and this fact is called the **partial reinforcement effect (PRE).**

Skinner studied the partial reinforcement effect extensively and eventually wrote a book with Ferster called *Schedules of Reinforcement* (1957). This book summarized years of research on various types of partial reinforcement. Five schedules of reinforcement have become the most common and they are described below.

1. **Continuous Reinforcement Schedule (CRF).** Using a continuous reinforcement schedule, every correct response during acquisition is rewarded. Usually in a partial reinforcement study, the animal is first trained on a

100 percent reinforcement schedule and then switched to a partial reinforcement schedule. It is difficult to bring about the acquisition of any response when partial reinforcement is used during the initial training period.

2. **Fixed Interval Reinforcement Schedule (FI).** Using a fixed interval reinforcement schedule, the animal is reinforced for a response made only after a set interval of time. For example, only a response following a 3-minute interval is reinforced. At the beginning of the fixed time interval the animal responds slowly, or not at all. As the end of the time interval approaches the animal gradually increases its speed of responding, apparently anticipating the moment of reward. This kind of responding produces a pattern on the cumulative recording referred to as the *fixed-interval scallop.* Such a pattern is shown in Figure 5-7.

The behavior of an animal under this schedule is somewhat similar to the way a person behaves as a deadline approaches. After putting off a certain task as long as possible, the due date is rapidly approaching and activity increases accordingly. Often a student preparing a term paper will act in this manner.

3. **Fixed Ratio Reinforcement Schedule (FR).** An FR schedule of reinforcement occurs when every *n*th response that the animal makes is rewarded. FR5, for example, means that the animal will get rewarded at every fifth response. Here the important factor in determining when a response is re-

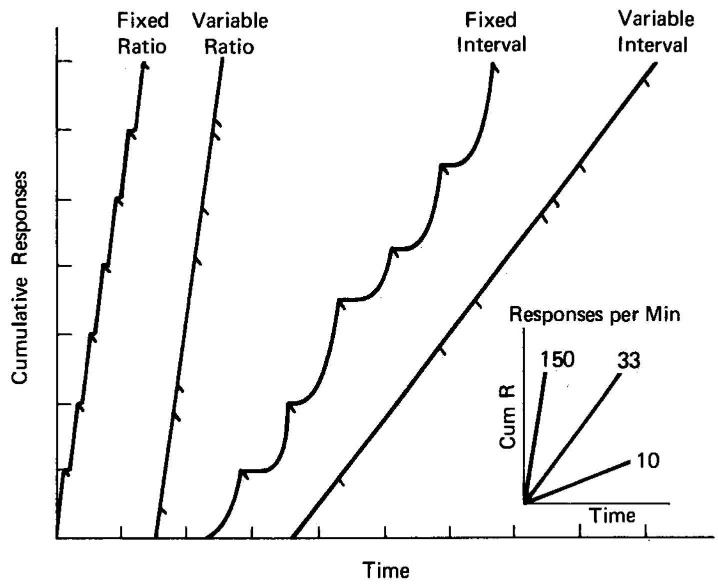


FIGURE 5-7. Typical cumulative recordings generated by fixed ratio, variable ratio, fixed interval and variable interval reinforcement schedules. The slash marks in the recordings indicate a reinforced response.

warded is the number of responses made. Theoretically, an animal on a fixed interval schedule could make just one response at the end of the interval and be rewarded each time it responds. With a fixed ratio schedule, this is not possible; the animal *must* respond a fixed number of times before it is rewarded.

For both the FI and FR reinforcement schedules, a rewarded response is followed by a depression in the rate of responding. This is called the *post-reinforcement pause.* There is considerable speculation as to why such a pause exists. Perhaps the animal learns that the responses immediately following a rewarded response are never rewarded. However, the scallop on the cumulative recording of an FI schedule is usually not found on that of an FR schedule. The FR schedule usually generates a steplike cumulative recording, indicating that the animal temporarily stops responding after a rewarded response and then, at some point, resumes responding at a rapid rate. Such behavior has been characterized as "break and run." In fact, recent evidence suggests that with overtraining on an FI schedule, the scalloping effect gradually disappears and is replaced by the break and run behavior characteristic of FR schedules of reinforcement. A cumulative recording generated by an animal under an FR schedule is shown in Figure 5-7.

4. **Variable Interval Reinforcement Schedule (VI).** With the VI schedule, the animal is rewarded for responses made at the end of time intervals of variable durations. That is, rather than having a fixed time interval, as with FI schedules, the animal is rewarded on the *average* of say, every three minutes, but it may be rewarded immediately after a prior reinforcement, or it may be rewarded after thirty seconds or after seven minutes. This schedule eliminates the scalloping effect found in FI schedules and produces a steady, moderately high response rate. A typical cumulative recording generated by an animal on a VI schedule is shown in Figure 5-7.

5. **Variable Ratio Reinforcement Schedule (VR).** With the FR schedule, an animal is rewarded after making a specific number of responses, say five. With the VR5 schedule, the animal is rewarded on the *average* of every five responses; thus it might receive two rewards in a row or may make ten or fifteen responses without being rewarded. The VR schedules eliminate the steplike cumulative recording found with the FR schedule and produce the highest response rate of the five schedules we are considering. A cumulative recording produced by an animal under a VR schedule is shown in Figure 5-7.

The VR reinforcement schedule is the one governing the behavior of gamblers at a place like Las Vegas. The faster one pulls the handle of a slot machine, for example, the more frequently one is rewarded.

To summarize, continuous reinforcement yields the least resistance to extinction and the lowest response rate during training. All partial reinforcement schedules produce greater resistance to extinction and higher response rates during training than continuous reinforcement. Generally speaking, the VR schedule produces the highest response rate, FR produces the next highest rate, then VI, followed by FI, and finally CRF.

Verbal Behavior

Skinner believes that verbal behavior (language) can be explained within the context of reinforcement theory. Talking and listening are responses that are influenced by reward just as any other response. Any utterance, therefore, will tend to be repeated if it is rewarded.

Skinner classified verbal responses in terms of how they were related to reward, that is, in terms of what was being done in order to be rewarded. These classifications are discussed briefly below.

1. **Mand.** About the mand, Skinner says (1957):

> A mand is characterized by the unique relationship between the form of the response and the reinforcement characteristically received in a given verbal community. It is sometimes convenient to refer to this relation by saying that a mand "specifies" its reinforcement. *Listen!*, *Look!*, *Run!*, *Stop!*, and *Say yes!* specify the behavior of a listener; but when a hungry diner calls *Bread!*, or *More soup!*, he is specifying the ultimate reinforcement. Frequently both the behavior of the listener and the ultimate reinforcement are specified. The mand *pass the salt!* specifies an action (pass) and an ultimate reinforcement (the salt) [p. 37].

The word *mand* comes from the fact that a demand is being made. When the demand is met, the utterance (mand) is rewarded and next time the need arises, the person is likely to repeat the mand.

2. **Tact.** About the tact, Skinner says (1957):

> . . . this type of operant is exemplified when, in the presence of a doll, a child frequently achieves some sort of generalized reinforcement by saying *doll;* or when a teleost fish, or picture thereof, is the occasion upon which the student of zoology is reinforced when he says *teleost fish.* There is no suitable term for this type of operant. "Sign," "symbol," and more technical terms from logic and semantics commit us to special schemes of reference and stress the verbal response itself rather than the controlling relationship. The invented term "tact" will be used here. The term carries a mnemonic suggestion of behavior which "makes contact with" the physical world. A tact may be defined as a verbal operant in which a response of given form is evoked (or at least strengthened) by a particular object or event or property of an object or event. We account for the

strength by showing that in the presence of the object or event, a response of that form is characteristically reinforced in a given verbal community [pp. 81-82].

Generally speaking the tact involves naming objects or events in the environment appropriately, and its reinforcement comes from other people's rewarding the match between the environment and the verbal behavior.

3. **Echoic Behavior.** This is verbal behavior that is rewarded when someone else's verbal response is repeated verbatim. Echoic behavior is often a prerequisite to a more complicated verbal behavior; for example, first a child must imitate a word before he or she can learn how that word is related to other words or other events. Thus, repeating something someone else has said is rewarded, and when this response is learned, it permits the speaker to learn more complex verbal relationships.

4. **Autoclitic Behavior.** According to Skinner (1957), "the term 'autoclitic' is intended to suggest behavior which is based upon or depends upon other verbal behavior" [p. 315]. The main function of autoclitic behavior is to qualify responses, express relations, and provide a grammatical framework for verbal behavior.

The most severe critic of Skinner's explanation of verbal behavior has been Noam Chomsky (1959). Chomsky contends that language is too complex for a child to have learned. Some process other than learning must explain all the verbal utterances that, say, a three-year-old is capable of making. Miller (1956) in fact, points out that there are 10^{20} possible 20-word sentences in the English language, and it would take 1,000 times the estimated age of the earth just to listen to them all. Obviously, says Chomsky, operant conditioning just does not explain the complexity of our language capabilities. Chomsky's explanation of language development is that our brain is structured to generate language. The underlying grammatical structure of all human languages reflects an underlying brain structure. That is, we are "wired" to produce grammatical utterances just as a computer can be wired to produce moves in a chess game. Chomsky and Skinner seem to be continuing the nature-nurture debate launched by Plato and Aristotle: Chomsky's deep brain structures theory of language acquisition represents the nature, or Platonic, side and Skinner's view that verbal behavior is shaped by the environment represents the nurture, or Aristotelian, side.

Programmed Learning

Skinner, like Thorndike, was very interested in applying his theory of learning to the process of education. To Skinner, learning proceeds most effectively if (1) the information to be learned is presented in small steps; (2)

the learners are given rapid feedback concerning the accuracy of their learning, i.e., they are shown immediately after a learning experience whether they have learned the information correctly or incorrectly; and (3) the learners are able to learn at their own pace.

Skinner learned firsthand that these principles were not being used in the classroom. He reflects upon a visit he made in 1953 to one of his daughter's classes (1967):

> On November 11, as a visiting father, I was sitting in the back of the room in an arithmetic class. Suddenly the situation seemed perfectly absurd. Here were twenty extremely valuable organisms. Through no fault of her own, the teacher was violating almost everything we knew about the learning process [p. 406].

It is interesting to note that the most common teaching technique is the lecture, and the lecture technique violates all three of the above principles. Skinner proposes an alternative teaching technique, **programmed learning,** which does incorporate all three principles. A device invented to present programmed material has been called a **teaching machine.** The advantages of using a teaching machine are outlined by Skinner as follows (1958):

> The machine itself, of course, does not teach. It simply brings the student into contact with the person who composed the material it presents. It is a labor-saving device because it can bring one programmer into contact with an indefinite number of students. They may suggest mass production, but the effect upon each student is surprisingly like that of a private tutor. The comparison holds in several respects. (i) There is a constant interchange between program and student. Unlike lectures, textbooks, and the usual audio-visual aids, the machine induces sustained activity. The student is always alert and busy. (ii) Like a good tutor, the machine insists that a given point be thoroughly understood, either frame-by-frame or set-by-set, before the student moves on. Lectures, textbooks, and their mechanized equivalents, on the other hand, proceed without making sure that the student understands and easily leave him behind (iii) Like a good tutor, the machine presents just that material for which the student is ready. It asks him to take only that step which he is at the moment best equipped and most likely to take (iv) Like a skillful tutor, the machine helps the student to come up with the right answer. It does this in part through the orderly construction of the program and in part with techniques of hinting, prompting, suggesting, and so on, derived from an analysis of verbal behavior. . . (v) Lastly, of course, the machine, like the private tutor, reinforces the student for every correct reponse, using this immediate feedback not only to shape his behavior most efficiently but to maintain it in strength in a manner

which the laymen would describe as "holding the student's interest" [p. 971].

We will have more to say about programmed learning in Chapter 15.

Contingency Contracting

Contingency contracting is a fairly recent extension of Skinnerian thinking. Briefly, it involves making arrangements so that a person gets something he or she wants when he or she acts in a certain way. Some arrangements can be simple and cover simple behavior, such as when a teacher says to a child, "If you sit quietly for five minutes, you can go out and play." Other arrangements can extend over a much longer period of time. For example, if a person has a weight problem, and has difficulty losing weight on his own, he may wish to arrange the environment so that he is rewarded for losing weight. One may, for example, sign over to another person something personally important such as money, a record collection, a stamp collection, or favorite clothes. Taking money as an example, the person trying to lose weight may put up, say, one hundred dollars and draw up an agreement whereby the other person gives back ten dollars each week if three pounds are lost. Each week that one does not lose at least three pounds, one loses ten dollars. The same kind of arrangement can be made utilizing anything important to the person, and the behavior involved could as easily be smoking as losing weight.

The term "contingency contracting" comes from the fact that an agreement (contract) is made that certain activities will be rewarded that otherwise may not have been. In other words, the contract rearranges the reinforcement contingencies in the environment causing them to be responsive to behavior patterns that one hopes to modify in some way.

Many behavior problems occur because our behavior is influenced more by immediate reinforcers than by distant ones. For example, for some the taste of food in the present is more rewarding than the distant promise of a longer life if one eats in moderation. Likewise, the immediate effect of nicotine is more rewarding than the promise of a longer life without smoking. Contingency contracting is a way of modifying behavior through current reinforcing contingencies rather than distant ones. It is hoped that as desirable behavior is shaped using this procedure, the desirable behavior itself will be functional in obtaining rewards from the social environment. Not being overweight and not smoking both can be very rewarding, but the problem is switching the overweight person and the smoker to another class of rewarding experiences. Contingency contracting can be a very effective tool in accomplishing this switchover. Once the switch in reward systems has been made, however, the desired behavior is usually sustained by the social environment and, therefore, the artificial reinforcement contingencies are no longer needed.

Contingency contracting need not involve a second person; one can follow these procedures alone by giving oneself a "treat" of some kind each day one goes without smoking, or drinking, or overeating. For a more detailed discussion of contingency contracting see Homme, Csanyi, Gonzales, and Rechs (1970).

Skinner's Attitude Toward Learning Theory

Skinner believes that it is unnecessary to formulate complicated theories to study human behavior, and he believes it is unnecessary to know the physiological correlates of behavior. He believes that behavioral events must be described in terms of things that directly affect behavior, and that it is logically inconsistent to attempt to explain behavior in terms of physiological events. For this reason, Skinner's method of research has been called "the empty organism approach."

Skinner also thinks that complex theories of learning, such as Hull's (Chapter 6), are time-consuming and wasteful. Some day such theories may be useful in psychology, but not until we have collected much more basic data. Our main concern at this time should be, Skinner believes, to discover basic relationships between classes of stimuli and classes of responses. Therefore, the use of theory in studying the learning process cannot be justified. Skinner says (1950):

> Research designed with respect to theory is also likely to be wasteful. That a theory generates research does not prove its value unless the research is valuable. Much useless experimentation results from theories, and much energy and skill are absorbed by them. Most theories are eventually over-thrown, and the greater part of the associated research is discarded. This could be justified if it were true that productive research requires a theory—as is, of course, often claimed. It is argued that research would be aimless and disorganized without a theory to guide it. The view is supported by psychological texts which take their cue from the logicians rather than empirical science and describe thinking as necessarily involving stages of hypothesis, deduction, experimental test, and confirmation. But this is not the way most scientists actually work. It is possible to design significant experiments for other reasons, and the possiblity to be examined is that such research will lead more directly to the kind of information which a science usually accumulates [pp. 194–95].

Skinner's approach to research is to do a **functional analysis** between stimulating events and measurable behavior. Skinner says (1953):

> The external variables of which behavior is a function provide for what may be called a causal or functional analysis. We undertake to predict and control the behavior of the individual organism. This is our "dependent variable"—the effect for which we are to find the cause. Our "independent variables"—the causes of behavior—are the external conditions of which behavior is a function. Relations between the two—the "cause-and-effect relationships" in behavior—are the laws of a science. A synthesis of these laws expressed in quantitative terms yields a comprehensive picture of the organism as a behaving system [p. 35].

Thus, Skinner manipulates hours of food or water deprivation and notes the effect on the rate with which the lever press response is learned; or he observes the effect of schedules of reinforcement on response rate or resistance to extinction. In interpreting the results of his research, Skinner stays very close to the data, that is, if partial reinforcement produces greater resistance to extinction than does 100 percent reinforcement, that is a fact and that is all that can be said. In other words, Skinner does not attempt to explain why this is the case.

Even in deciding *what* to investigate, Skinner claims he is not guided by theoretical notions, but rather uses a hit-and-miss process. He tries first one thing and then another. If he sees one line of research is not producing anything worthwhile, he will shift to something that looks more fruitful and will continue in this trial-and-error fashion until he hits upon something of value. This rather liberal attitude toward scientific investigation is summarized in Skinner's article, "A Case Study in Scientific Method" (1956).

The Need for a Technology of Behavior

Skinner feels very strongly that a carefully worked out behavior technology could solve many human problems; yet many people would oppose such a technology because it seems to challenge a number of our cherished beliefs about ourselves, especially that human beings are rational, free, and dignified. Skinner believes that these beliefs are now interfering with the solution of our major problems and also preventing the development of the very tool that could solve them. Skinner says (1971):

> What we need is a technology of behavior. We could solve our problems quickly enough if we could adjust the growth of the world's population as precisely as we adjust the course of a spaceship, or improve agriculture and industry with some of the confidence with which we accelerate high-energy particles, or move toward a peaceful world with something like the steady progress with which physics has approached absolute zero

> (even though both remain presumably out of reach). But a behavioral technology comparable in power and precision to physical and biological technology is lacking, and those who do not find the very possibility ridiculous are more likely to be frightened by it than reassured. That is how far we are from "understanding human issues" in the sense in which physics and biology understand their fields, and how far we are from preventing the catastrophe toward which the world seems to be inexorably moving [p. 5].

Elsewhere, Skinner says (1953):

> . . . the traditional view of human nature in Western culture is well known. The conception of a free, responsible individual is embedded in our language and pervades our practices, codes, and beliefs. Given an example of human behavior, most people can describe it immediately in terms of such a conception. The practice is so natural that it is seldom examined. A scientific formulation, on the other hand, is new and strange. Very few people have any notion of the extent to which a science of human behavior is indeed possible. In what way can the behavior of the individual or of groups of individuals be predicted and controlled? What are laws of behavior like? What over-all conception of the human organism as a behaving system emerges? It is only when we have answered these questions, at least in a preliminary fashion, that we may consider the implications of a science of human behavior with respect to either a theory of human nature or the management of human affairs [pp. 9–10].

Skinner's theory of learning has had, and is having, a profound influence on psychology. No matter what area of psychology one studies, one is apt to find reference to some aspect of Skinner's work. As we noted in Chapter 2, a characteristic of any good theory is that it generates research, and Skinner's theory has certainly done that. In the next section we shall review the work of an important researcher who has been influenced by Skinner's work.

DAVID PREMACK

Traditionally, reinforcers have been thought of as stimuli. A primary reinforcer is usually thought of as being related to an organism's survival, and a secondary reinforcer is a stimulus that has been consistently paired with a primary reinforcer. Premack, however, has suggested that all *responses* be thought of as potential reinforcers. Specifically, he suggests that any response that occurs with a fairly high frequency can be used to reinforce a response

David Premack
Courtesy of David Premack

that occurs with a relatively lower frequency. Using Premack's notion of reward, one would allow an organism to engage freely in whatever activities it wanted to and carefully record what activities were engaged in, and with what frequency. Afterwards, the various activities that the organism engaged in would be arranged in a hierarchy. The activity that was engaged in most frequently would be listed first, the next frequently engaged in activity would be listed next, and so on. By referring to this list, the experimenter would know exactly what could and could not be used to reinforce that particular organism. Say, for example, it was found that in a twenty-four hour period, the activity engaged in most frequently by a rat was eating, then drinking, then running in an activity wheel, then grooming, and finally, gazing out of the cage. According to Premack, allowing the animal to eat could be used to reinforce any of the other activities. For example, if the animal was allowed to eat each time it groomed itself, grooming would increase in frequency. Likewise, allowing the animal to groom itself could be used to reward the animal for looking outside the cage. The opportunity to look outside the cage, however, could not be used to reward any of the other activities, because they all occurred with a greater frequency than the response of looking outside the cage.

According to Premack, the way to find out what can be used as a reinforcer is to observe the organism's behavior while it has the opportunity to engage in any number of activities, and the activities that it engages in most often can be used to reward the activities that it engages in less often.

In summary we can say that if one activity occurs more often than another, it can be used to reinforce the activity that occurs less often. This is called the *Premack principle* and it seems to hold for humans as well as for lower organisms.

In order to test his theory, Premack (1959) allowed thirty-one first-grade children to either play a pinball machine or to operate a candy dispenser as often as they wanted. Some of the children played mainly with the pinball machine, and they were called "manipulators." The children who were primarily interested in the candy dispenser were called "eaters." The first phase of the study merely determined the children's preferences for these two events.

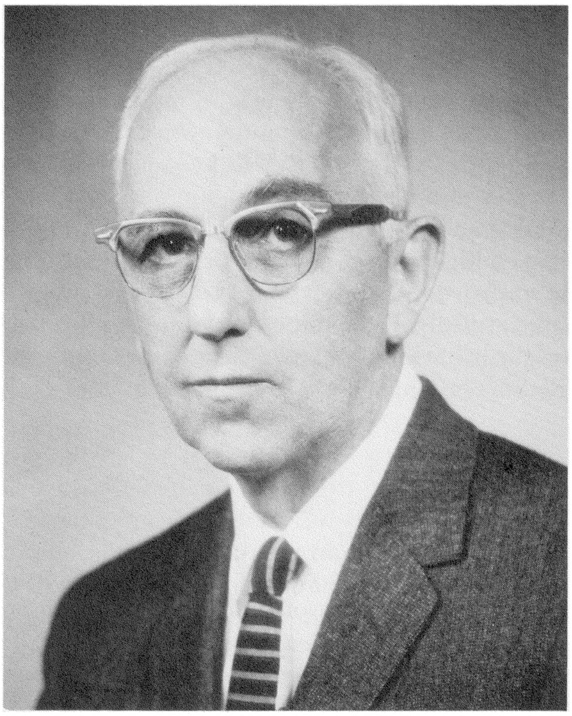
In the second phase of the study, the groups of "manipulators" and "eaters" were each subdivided into two groups. One group was placed on "manipulate-eat" contingencies, where the children had to play the pinball machine before they were allowed to operate the candy dispenser. The other group was placed on "eat-manipulate" contingencies, where they had to operate the candy dispenser before they could play the pinball machine. It was found that for the "manipulators" the "manipulate-eat" arrangement made little difference in their behavior. They simply went right on playing the pinball machine as before. Under the "eat-manipulate" conditions, however, the frequency of eating went way up for the manipulators, since they now had to eat in order to play the pinball machine. Likewise, for the "eaters" the "eat-manipulate" condition made little difference. They simply went on eating candy as before. But under the "manipulate-eat" conditions, their frequency of playing the pinball machine went way up. Thus, Premack found support for his contention that a less frequently engaged in activity can be rewarded by the opportunity to engage in a more frequently engaged in activity.

When preferences change, the reinforcers also change. For example, as long as an animal is hungry, it will eat frequently, and therefore the opportunity to eat can be used to reinforce any number of activities. When the animal is satiated, however, the frequency of its eating will decrease and the opportunity to eat will become ineffective as a reinforcer. Premack demonstrated the reversibility of reinforcement in a study involving a running response and a drinking response (1962). It was found that if animals were deprived of water for a considerable length of time, they will turn an activity wheel in order to gain access to water. But they would not increase their drinking in order to run in the activity wheel. That is, drinking reinforces running, but running did not reinforce drinking. This is what one would predict from traditional reinforcement theory. Premack also found that if an animal was allowed to drink all the water it wanted but was prevented from running in the activity wheel, the situation was reversed. Under these circumstances, drinking activity increased if it resulted in the animal having the opportunity to run, but running did not increase if it allowed the animal to drink. That is, now running could reinforce drinking, but not vice versa.

The implications of Premack's research are far-reaching. For one thing, what can act as a reward becomes a very personal and continuously changing thing. The teacher can apply this knowledge by noticing individual children's preferences in a free choice situation and determining their rewards accordingly. For one child, the opportunity to run and play may be a reinforcer; for another child, playing with clay may be a reinforcer. The idea of recess as a way to improve the performance of the class as a whole will need to be looked at more carefully. For examples of how the Premack principle can be used to control the behavior of school children, see Homme, deBaca, Divine, Steinhorst, and Rickert (1963).

HARRY HELSON

Although Harry Helson cannot be considered a Skinnerian, or even a reinforcement theorist, his work clearly shows the relativity of reinforcement. Briefly, Helson's **adaptation-level theory** states that for any class of experiences, there are two extremes with a neutral point in between them. The neutral point is the adaptation level (AL). For example, if one is asked to judge weights, some weights will be thought of as heavy, some light, and some in between. In fact, those weights falling on one side of the AL will tend to be judged as heavy, and those falling on the other side of the AL will tend to be judged as light. The magnitude of the lightness or heaviness is determined by the distance from the AL. In other words, a weight falling right on the AL will be judged as neither heavy nor light but in between; a weight that falls just to the right of the AL will tend to be judged as "slightly heavy"; and a weight that falls way to the right of the AL will tend to be judged as "very heavy." Clearly the extremes for any experience will change and therefore, one's adaptation-level will change. How one interprets a social date, or pain, or a meal, or the difficulty of a test will depend upon one's total experiences with dates, pain, meals, or tests. When reacting to a test, for example, one places it somewhere on a continuum between the easiest test ever taken and the hardest test ever taken. If the test is between the two extremes, that is, at the adaptation-level, the person will say the test was neither easy nor hard. But any test that falls on one side of the adaptation-level will be interpreted as hard, and any test that falls on the other side of the adaptation-level will be interpreted as easy. Thus, according to Helson's theory, what is rewarding and what is not is based to a large extent on the individual's experiences. (See Helson, 1964, for a review of adaptation-level theory.) No doubt, the topic of the relativity of reinforcement will generate considerable research in the future.



Harry Helson
Courtesy of Harry Helson

There is no doubt that Skinnerian notions have had, and are having, far reaching theoretical and practical implications. Recently, however, there has been a growing recognition of the limitations of operant principles in modifying behavior. In the next section we will examine a few of the reasons why operant principles seem to have limited applicability.

THE MISBEHAVIOR OF ORGANISMS

We saw in the last chapter that Thorndike concluded that the same laws of learning apply to all mammals, including humans. Skinner, like many other learning theorists, agrees with Thorndike's conclusion. After observing how different species of animals performed under a certain schedule of reinforcement, Skinner commented (1956):

> Pigeon, rat, monkey, which is which? It doesn't matter. Of course, these species have behavioral repertories which are as different as their

> anatomies. But once you have allowed for differences in the ways in which they make contact with the environment, and in the ways in which they act upon the environment, what remains of their behavior shows astonishingly similar properties [pp. 230–231].

Skinner goes on to say that one can also add the performance of mice, cats, dogs and human children and the curves would still have more or less the same characteristics.

The alternative to believing that the same laws of learning apply to all mammals seems to necessitate going back to the concept of instinct, which the behaviorists attempted to bury forever. Those believing in the existence of instincts say that different species have different inborn behavior tendencies which interact or even negate the laws of learning. In other words, because of their innate behavior tendencies, certain species can be conditioned to do some things but not others. According to this point of view, some responses should be easier to condition for some species than for others, because the responses of interest may occur more naturally for some species than for others.

Current interest in how innate behavior tendencies interact with learning principles has been stimulated by two of Skinner's ex-associates, Marian and Keller Breland. Armed with a knowledge of operant principles, the Brelands moved from Minnesota, where they had worked with Skinner, to Arkansas, where they started a business called Animal Behavior Enterprises. By using operant techniques the Brelands were able to train a wide variety of animals to perform many different tricks, and their trained animals were put on display at fairs, conventions, amusement parks, and on television. As of 1961, the Brelands reported having conditioned 38 species (totaling over 6,000 animals), including chickens, pigs, raccoons, reindeer, cockatoos, porpoises, and whales.

Everything seemed to be going fine for the Brelands until they began to experience breakdowns of conditioned behavior. Their problems became so pronounced that they were moved to report them in an article whose title, **"The Misbehavior of Organisms"** (1961), was a parody of the title of Skinner's first major work, *The Behavior of Organisms* (1938).

The Brelands found that although their animals were initially highly conditionable, eventually instinctive behavior would appear and interfere with what had been learned. For example, an attempt was made to train raccoons to pick up coins and deposit them into a 5-inch metal box. Conditioning a raccoon to pick up a single coin was no problem. Next, the metal box was introduced and that is when the problem began. The raccoon seemed to have trouble letting the coin fall into the box. The animal would rub the coin inside of the container, take it back out, and hold it firmly for several seconds. Eventually, however, the raccoon released the coin into the box and received its food reinforcement. The next phase in training required that the raccoon place *two* coins into the metal box before receiving reinforcement. It was found that the raccoon could not let go of the two coins. Instead, it would rub them together, dip them into the container, and then remove them. The rubbing behavior became more and more pronounced even though such behavior delayed or even prevented reinforcement. The Brelands concluded that conditioning a raccoon to place two coins into a metal box was not feasible. It seemed that the innate behaviors associated with eating were too powerful to be overcome by operant conditioning principles. In other words, in this case, a raccoon's innate tendency to wash and manipulate its food competed successfully with the learned response of placing one or more coins into a container.

Another example involved the training of pigs to pick up large wooden coins and deposit them in a large "piggy bank." The coins were placed several feet from the bank and the pig had to transport them to the bank before receiving reinforcement. Early conditioning was very effective and the pigs seemed eager to perform the task. As time went on, however, the animals performed more slowly, and on their way to the "piggy bank" they would repeatedly drop the coin, root it (push it along the ground with their snouts), pick it up, drop it, root it, toss it in the air, and so on. The Brelands first believed that such behavior may have been the result of low drive so they intensified the deprivation schedule that the animals were on, which only intensified the animals' misbehavior. Eventually it took the pigs about 10 minutes to transport the coins a distance of about six feet, even when such delays postponed or eliminated reinforcement. Again, it appears that the animal's instinctive behavior associated with eating became more powerful than the behavior it had learned.

From these and other similar observations, the Breland's concluded (1961):

> It seems obvious that these animals are trapped by strong instinctive behaviors, and clearly we have here a demonstration of the prepotency of such behavior patterns over those which have been conditioned [p. 185].

The Brelands called the tendency for innate behavior patterns to gradually displace learned behavior patterns **instinctual drift,** which they elaborate as follows (1961):

> The general principle seems to be that wherever an animal has strong instinctive behaviors in the area of the conditioned response, after continued running the organism will drift toward the instinctive behavior to the detriment of the conditioned behavior and even to the delay or

preclusion of the reinforcement. In a very boiled-down, simplified form it might be stated as "Learned behavior drifts toward instinctive behavior" [p. 185].

The Brelands feel that their work challenges three assumptions made by the behaviorists, namely, (1) that animals come to the learning situation as a *tabula rasa* (blank tablet), (2) that differences among various species are unimportant, and (3) that any response can be conditioned to any stimulus. Rather than making these assumptions, the Breland's conclude (1961):

> After 14 years of continuous conditioning and observation of thousands of animals, it is our reluctant conclusion that the behavior of any species cannot be adequately understood, predicted, or controlled without knowledge of its instinctive patterns, evolutionary history, and ecological niche [p. 126].

Thus, we are once again confronted with the age-old empiricism/nativism controversy, that is, is behavior learned or is it genetically determined? The phenomenon of instinctual drift seems to indicate that, at least for some species, behavior can be nudged only a limited amount from its instinctual basis before instinctual tendencies override learned tendencies as the most powerful determiners of behavior. What about humans? Do we have within us the remnants of our evolutionary past toward which we periodically drift? Can culture, society, or circumstances push us only so far before we resort to more primitive forms of behavior? The answer depends on who is being asked. Many learning theorists such as Skinner would say no. Others such as Freud would say yes.

Autoshaping. Another phenomenon that seems to show the importance of instinctive behavior in a learning situation is autoshaping. We saw earlier in this chapter that the shaping process can be used to encourage an animal to make a response that it ordinarily would not make in a situation. To do so, the experimenter reinforces increasingly closer approximations to the desired behavior until the desired behavior is performed by the animal. In the case of autoshaping, however, the animal seems to shape its own behavior. For example, Brown and Jenkins (1968) found that if a pigeon was reinforced at certain intervals, regardless of what it was doing (noncontingent reinforcement), and if a disc was illuminated just prior to the presentation of the reinforcer (in this case food), the pigeon learned to peck at the disc. The question is, why did the pigeon learn to peck the disc when it had never been reinforced for doing so?

One attempt to account for autoshaping has likened it to superstitious behavior, saying that the pigeon may have been pecking at the disc just prior to when food was delivered and therefore pecking the disc would be maintained as a superstitious response. One problem with this explanation is that almost all pigeons peck the disc under these circumstances. It seems that if superstitious behavior were involved, some pigeons would peck the disc, others would turn in circles, others would peck other parts of the test chamber, and so on. A second explanation of autoshaping has been based on classical conditioning principles. According to this explanation, the illuminated disc becomes a secondary reinforcer because of its proximity to food, a primary reinforcer. Under the circumstances described thus far, this explanation is reasonable, except it does not explain why the pigeon would peck at the disc. Earlier in this chapter we saw that, indeed, discriminative stimuli (S^D's) become secondary reinforcers, and thus can be used to maintain behavior, but why the animal should respond overtly to the secondary reinforcer as if it were the primary reinforcer is not clear.

An experiment by Williams and Williams (1969) casts further doubt on explanations of autoshaping as either a superstitious or a classical conditioning phenomenon. In their experiment, Williams and Williams arranged the situation so that pecking at the lighted disc actually *prevented* reinforcement from occurring. Food was presented to the pigeons every fifteen seconds, unless the pigeon pecked the illuminated disc, in which case food was withheld on that trial. In this study pecking the illuminated disc was *never* followed by reinforcement. In fact, the more the pigeon pecked the disc, the less food it received. According to the explanations of autoshaping in terms of both superstitious behavior and of classical conditioning, the experimental arrangement in this study should have eliminated or, at least, drastically reduced disc pecking. It did not, however. The pigeons went right on pecking the disc at a high rate. In fact, for some pigeons disc pecking occurred so frequently that it virtually eliminated all reinforcement.

A study by Jenkins and Moore (1973) further complicates the situation. In their study it was found that if food was used as a reinforcer, pigeons responded to the disc with an eating posture and if water was used as a reinforcer, pigeons responded to the disc with a drinking posture. In other words, when food was used as a reinforcer the pigeons seemed to be eating the disc, and when water was used as a reinforcer they seemed to be drinking the disc.

By the process of elimination, one is forced to view the autoshaping phenomenon as involving instinctive behavior patterns. It can be assumed, for example, that a hungry organism in a situation where eating is possible will most likely give responses related to eating. In the case of pigeons, pecking is such a response. Furthermore, it may be assumed that while in a high drive state, such behaviors can be easily elicited by any stimulus in the animal's environment which is vivid and on which an eating-related response could be easily released. A lighted disc in the environment of a hungry pigeon could be such a stimulus. According to this explanation, the lighted disc is simply eliciting instinctive behavior which has a high probability of occurring under the circumstances. Since, in autoshaping experiments, disc pecking is typically what the experimenter is looking for, it is not referred to as misbehavior as were certain instinctive responses in the Brelands' work.

If one accepts the instinctive explanation of autoshaping, one needs to conclude that no learning takes place at all. The animal simply becomes hypersensitive in the situation and releases innate responses which are appropriate under the circumstances to the most vivid stimuli in its environment.

The work of the Brelands and the work on autoshaping are but two examples of a growing recognition in psychology that the innate response tendencies of an organism interact with the laws of learning. In other words, what may hold true for one type of organism may not hold true for another type or organism. Furthermore, what may hold true for a given organism at one developmental level may not hold true for that organism at another developmental level. For a more detailed elaboration of these points see Seligman and Hager (eds.) *Biological Boundaries of Learning* (1972).

DISCUSSION QUESTIONS

1. Outline the procedure you would use while following Skinner's theory to increase the probability of a child's becoming a creative adult.
2. Would you use the same rewards to manipulate the behavior of both children and adults? If not, what would make the difference?
3. Are there some forms of adult human behavior for which you feel Skinner's theory is not applicable? Explain.
4. What would characterize the classroom procedures suggested by Skinner's theory of learning? List a few differences between these procedures and those now being followed in our schools.
5. Assuming the conclusions Skinner reached concerning the effectiveness of punishment are valid, what major change would they suggest in the area of child rearing? Criminal behavior? Education?
6. What is the partial reinforcement effect? Briefly describe the basic reinforcement schedules that Skinner studied.
7. Propose an explanation for the partial reinforcement effect.
8. What is contingency contracting? Give an example of how it could be used.
9. From Skinner's point of view, what are the advantages of programmed learning and teaching machines over the traditional lecture technique of teaching?
10. According to Skinner, why have we not developed a more adequate technology of behavior in this country? What would need to be done before we would be willing to utilize such a technology in solving our problems?

11. Discuss the relativity of reinforcement from the point of view of both Premack and Helson.
12. Discuss chaining from Skinner's point of view.
13. Explain language development from Skinner's point of view. Explain Chomsky's opposition to Skinner's explanation of language development.
14. Distinguish among positive reinforcement, negative reinforcement, and punishment.
15. Describe the phenomenon of instinctual drift.
16. Describe autoshaping and attempt to account for it.

CHAPTER HIGHLIGHTS

Adaptation-level theory. The theory proposed by Helson that between extremes in experience there is a neutral point or what he calls an adaptation level. For example, a weight that corresponds to the individual's adaptation level for weights will be interpreted as neither heavy nor light but in between the two.

Autoclitic Behavior. Provides a grammatical framework for verbal behavior.

Autoshaping. The observation that under certain circumstances the behavior of some organisms seems to be shaped automatically.

Chaining. According to Skinner, chaining occurs when one response brings the organism into proximity with stimuli that both reward the last response and cause the next response. That response in turn causes the organism to experience stimuli that both reward the response and cause the next response, and so on.

Contingency contracting. Making arrangements, sometimes with another person, so that certain behavior will be rewarded. For example, each time the person goes a week without smoking he or she receives ten dollars.

Contingent reinforcement. Reinforcement that only occurs if a specific response is made. If the response is not made, the organism is not rewarded.

Continuous Reinforcement Schedule (CRF). The condition where the organism is rewarded each time it makes an appropriate response.

Cumulative recording. A special kind of graphing technique used by Skinner. Each time a response is made, the cumulative recording rises one notch and remains at that level until another response is made. The steepness of the line, therefore, indicates rate of responding.

Differential reinforcement. The condition where some responses made by the organism are reinforced and others are not.

Discriminative operant. An operant response that is made selectively to one set of circumstances but not to another set of circumstances.

Discriminative stimulus (S^D). A cue or signal indicating that if a certain operant response is made it will be rewarded.

Echoic Behavior. Repeating someone else's verbal utterances.

Extinction of an operant response. In operant conditioning, extinction involves the gradual decrease in the *frequency* with which a conditioned response occurs after it is no longer rewarded, whereas in classical conditioning, the extinction of a conditioned response involves the gradual decrease in *amplitude* of the conditioned response following the removal of reward. When the frequency of an operant response returns to its operant level, it is said to be extinguished.

Fixed Interval Reinforcement Schedule (FI). The condition where only the response made after a certain interval of time has passed is rewarded.

Fixed Ratio Reinforcement Schedule (FR). The condition where only the *n*th response made is rewarded.

Functional analysis. The investigation of how certain stimuli and certain responses vary together. Skinner's approach to research was to avoid theorizing and to deal only with the manipulation of observable stimuli and note how their manipulation affected behavior; sometimes called the "empty organism" approach to research.

Functional autonomy. A term introduced by Gordon Allport to explain behavior that apparently occurs independently of external reward. Such behavior, according to Allport, was originally dependent upon reward, but eventually becomes autonomous or self-rewarding.

Generalized reinforcers. Stimuli that derive their reinforcement properties from being paired with more than one primary reinforcer. Generalized reinforcers have wide application since their effectiveness does not depend on any particular need of the organism.

Instinctual drift. The tendency for the behavior of some organisms, after prolonged conditioning, to revert back to instinctual patterns of behavior.

Magazine training. Training the animal to approach the food cup when it hears the feeder mechanism operate. This way, the click of the feeder mechanism is associated with food and thereby becomes a secondary reinforcer.

Mand. A verbal command that is rewarded when the listener carries out the command. For example, the mand "pass the salt" is rewarded when the person receives the salt.

Misbehavior of organisms. The term used by the Brelands to describe the tendency that some organisms have to behave instinctually instead of in a way that they had been conditioned to behave.

Noncontingent reinforcement. Reinforcement that occurs independently of the organism's behavior.

Operant behavior. Behavior that is simply emitted by the organism rather than elicited by a known stimulus. Operant behavior is under the control of its consequences.

Operant conditioning. Increasing the rate with which a response occurs or the probability of a response by arranging the situation so that the occurrence of that response is followed by reward. Also called type R conditioning.

Operant level. The frequency with which an operant response occurs before it is systematically reinforced.

Partial reinforcement effect (PRE). The fact that a response that has been rewarded only sometimes takes longer to extinguish than a response that had been rewarded each time it occurred.

Primary negative reinforcer. A stimulus related to the organism's survival which, when removed from the situation following a response, increases the probability of the response's recurring.

Primary positive reinforcer. A stimulus related to an organism's survival which, when added to the situation following a response, increases the probability of the response's recurring.

Programmed learning. A procedure that provides information to the learner in small steps, guarantees immediate feedback concerning whether or not the material was learned properly and allows the learner to determine the pace with which he or she goes through the material.

Punishment. The procedure whereby a negative reinforcer is made to be contingent on a response.

Resistance to extinction. The number of nonreinforced responses that occur before an operant response returns to its operant level.

Respondent behavior. Behavior elicited by a known stimulus.

Respondent conditioning. The same as classical conditioning; also called type S conditioning.

Secondary negative reinforcer. A previously neutral stimulus that has taken on reinforcing properties through its pairing with a primary negative reinforcer.

Secondary positive reinforcer. A previously neutral stimulus that has taken on reinforcing properties through its pairing with a primary positive reinforcer.

Shaping. The process whereby a desired response is encouraged through the use of differential reinforcement and successive approximation rather than simply waiting for it to occur.

Skinner box. An experimental test chamber usually consisting of a grid floor, a lever, a light, and a food cup.

Spontaneous recovery of an operant response. The increased frequency with which a conditioned operant response occurs following a delay after extinction and with no further training.

Successive approximation. Rewarding only those responses that become increasingly similar to the response that is finally desired; a component of the process of shaping.

Superstitious behavior. Behavior that looks as if it is governed by the belief that it must be engaged in before reward can be obtained, whereas, in reality, the behavior has nothing to do with the presence or absence of reward. Superstitious behavior results from noncontingent reinforcement.

Tact. The verbal behavior of naming things. Such behavior results in reward when objects or events are named correctly.

Teaching machine. A device used to present programmed material.

Variable Interval Reinforcement Schedule (VI). The condition where only the response made after the passage of some *average* interval of time is rewarded.

Variable Ratio Reinforcement Schedule (VR). The condition where a certain *average* number of responses need to be made before the organism is rewarded.

7
Ivan Petrovich Pavlov

Pavlov was born in Russia in 1849 and died there in 1936. His father was a priest and originally Pavlov himself studied to become a priest. He changed his mind, however, and spent most of his life studying physiology. In 1904 he won a Nobel Prize for his work on the physiology of digestion. He did not begin his study of the conditioned reflex until he was fifty years of age.

With Thorndike we saw that scientists are obliged to change their views when the data require it, an important characteristic of the scientific enterprise. With Pavlov, we see the importance of serendipity, or accidental discovery, in science. Pavlov's method of studying digestion involved a surgical arrangement on a dog that allowed gastric juices to flow through a fistula to the outside of the body where it was collected. This arrangement is shown in Figure 7-1.

Pavlov was measuring stomach secretions as the dog's response to such things as meat powder when he noticed that the mere sight of the food caused the dog to salivate. In addition, the mere sight of the experimenter or the sound of his or her footsteps would cause salivation. Originally Pavlov called such responses "psychic" reflexes. Being an extremely objective scientist and at heart a physiologist, Pavlov originally resisted investigating the "psychic" reflex. After a long personal struggle, however, and contrary to the advice of some of his colleagues, he finally decided to delve into the issue. He decided to study it, however, as a purely physiological problem to guard against any subjective element entering into his research. In fact, Pavlov's coworkers were fined if they used subjective, nonphysiological language in describing their research (Watson, 1978, p. 441). The apparatus used by Pavlov to study the "psychic" reflex is shown in Figure 7-2.

Just as Pavlov started a second career at age fifty when he turned to the

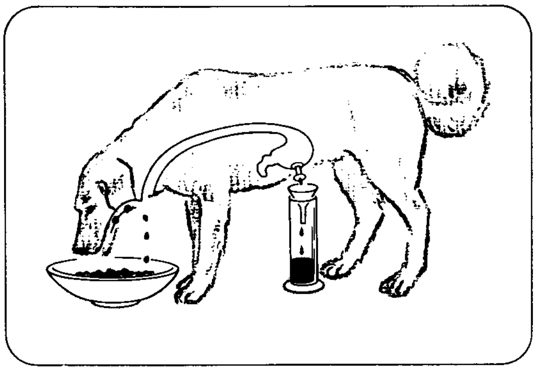


FIGURE 7-1. The figure shows a dog with esophageal and gastric fistulae. Such an arrangement allowed the dog to be fed, but prevented the food from reaching the stomach. Also, gastric juices flowing from the stomach could be measured (from Kimble, Garmezy & Zigler 1974, p. 208).

From G. A. Kimble, N. Garmezy, and E. Zigler, "Principles of General Psychology," New York, N.Y.: John Wiley & Sons, Inc., 1974.

study of the psychic reflex, he started a third career at age eighty when he turned to the application of his work on conditioning to mental illness. This work resulted in a book entitled *Conditioned Reflexes and Psychiatry* (1941), which many consider a monumental contribution to psychiatry.

At the time Thorndike was developing his theory, American psychology was struggling to be objective. Structuralism, with its introspective method,

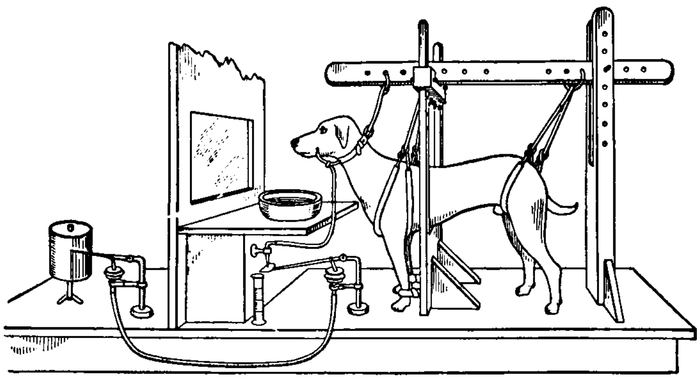


FIGURE 7-2. The figure shows a dog with a tube entering its cheek. When the dog salivates, the saliva is gathered in the test tube and its quantity is recorded on the rotating drum on the left.

From Garrett, H. E., "Great Experiments in Psychology," New York: Appleton-Century-Crofts, 1951.

was losing influence. In fact, consciousness per se was becoming a highly questionable subject matter. With his blending of associationism, Darwinism, and experimental science, Thorndike represented the best in American objective psychology. He was an important part of the functionalist movement which, as we have seen, was the first major psychological movement in America. Under the influence of Darwin, the functionalist's main concern was survival which, of course, involved adapting to the environment. The functionalists tried to discover how human actions as well as thought processes contribute to adaptation and survival.

At the time Thorndike was doing his major research, Pavlov was also investigating the learning process. He, too, was impatient with subjective psychology, and in fact, had almost decided not to study the conditioned reflex because of its "psychic" nature. Although Pavlov did not have a high opinion of psychologists, he had considerable respect for Thorndike and acknowledged him as the first to do systematic research on the learning process in animals (Pavlov, 1928):

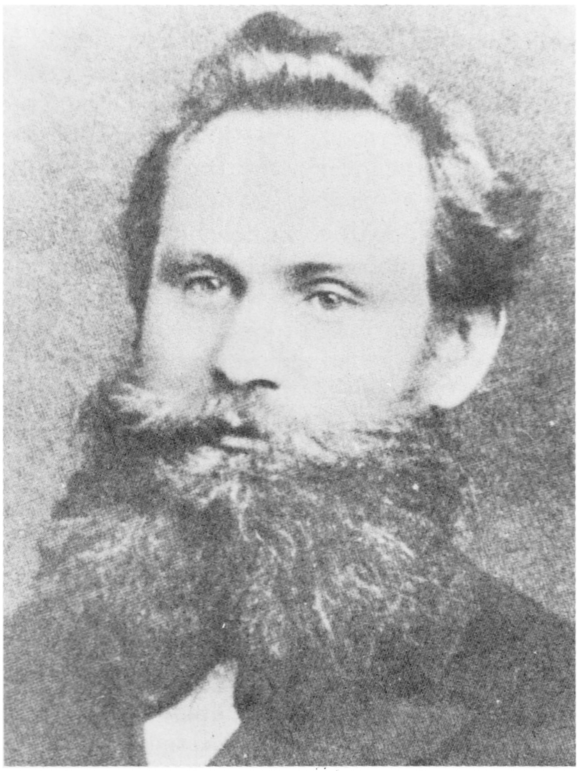
> Some years after the beginning of the work with our new method I learned that somewhat similar experiments on animals had been performed in America, and indeed not by physiologists but by psychologists. Thereupon I studied in more detail the American publications, and now I must acknowledge that the honour of having made the first steps along this path belongs to E. L. Thorndike. By two or three years his experiments preceded ours, and his book must be considered as a classic, both for its bold outlook on an immense task and for the accuracy of its results [pp. 38–40].

Thorndike and Pavlov, although traveling two different paths in many respects, shared an enthusiasm toward science and a belief in its ultimate ability to solve major human problems (Pavlov, 1928):

> Only science, exact science about human nature itself, and the most sincere approach to it by the aid of the omnipotent scientific method, will deliver man from his present gloom, and will purge him from his contemporary shame in the sphere of interhuman relations [p. 28].

Pavlov never waivered from his scientific outlook and in 1936 at the age of 87 he wrote the following letter to the young scientists of his country (Babkin, 1949):

> This is the message I would like to give to the youth of my country. First of all, be systematic. I repeat—be systematic. Train yourself to be strictly systematic in the acquisition of knowledge. First study the rudiments of



Ivan Petrovich Pavlov

Pavlov, I.P.Experimental Psychology and Other Essays. New York: Philosophical Library, 1957.

science before attempting to reach its heights. Never pass on to the next stage until you have thoroughly mastered the one on hand. Never try to conceal the defects in your knowledge even by the most daring conjectures and hypotheses. Practice self-restraint and patience. Learn to do the drudgery of scientific work. Although a bird's wing is perfect, the bird could never soar if it did not lean upon the air. Facts are the air on which the scientist leans. Without them you will never fly upward. Without them your theories will be mere empty efforts. However, when studying, experimenting or observing, try not to remain on the surface of things. Do not become a mere collector of facts but try to penetrate into the mystery of their origin. Search persistently for the laws which govern them.

The second important requisite is modesty. Never at any time imagine that you know everything. No matter how highly you are appreciated by others, have the courage to say to yourself, "I am ignorant." Do not let pride possess you.

The third thing that is necessary is passion. Remember that science demands of a man his whole life. And even if you could have two lives, they would not be sufficient. Science calls for tremendous effort and great passion. Be passionate in your work and in your search for truth [p. 110].

MAJOR THEORETICAL NOTIONS

Development of a Conditioned Reflex

Exactly what is meant by a psychic or conditioned reflex is indicated by the following statement by Pavlov (1955):

> I shall mention two simple experiments that can be successfully performed by all. We introduce into the mouth of a dog a moderate solution of some acid; the acid produces a usual defensive reaction in the animal: by vigorous movements of the mouth it ejects the solution, and at the same time an abundant quantity of saliva begins to flow first into the mouth and then overflows, diluting the acid and cleaning the mucous membrane of the oral cavity. Now let us turn to the second experiment. Just prior to introducing the same solution into the dog's mouth we repeatedly act on the animal by a certain external agent, say, a definite sound. What happens then? It suffices simply to repeat the sound, and the same reaction is fully reproduced—the same movements of the mouth and the same secretion of saliva [p. 247].

The ingredients necessary to bring about conditioning include (1) an **unconditioned stimulus (UCS),** which elicits a natural and automatic response from the organism; (2) an **unconditioned response (UCR),** which is the natural and automatic response elicited by the UCS; (3) a **conditioned stimulus (CS),** which is a neutral stimulus in that it does not elicit a natural and automatic response from the organism. When these ingredients are mixed in a certain way, a **conditioned response (CR)** occurs. In order to produce a CR, the CS and the UCS must be paired a number of times. First the CS is presented and then the UCS. The order of presentation is very important. Each time the UCS occurs, a UCR occurs. Eventually the CS can be presented alone and it will elicit a response similar to the UCR. When this happens, a CR has been demonstrated. The procedure can be diagrammed as follows:

Training procedure: CS → UCS → UCR
Demonstration of conditioning: CS → CR

In Pavlov's example above, the UCS was acid, the UCR was salivation (caused by the acid), and the CS was a sound. The sound, of course, would not ordinarily cause the dog to salivate, but by being paired with the acid, the sound developed the capability to elicit salivation. Salivation as the result of hearing the sound was the CR.

The UCR and the CR are always the same kind of response; if the UCR is salivation, then the CR must also be salivation. The magnitude of the CR, however, is always less than that of the UCR. For example, Pavlov, who measured the magnitude of a response by counting drops of saliva, found that the UCS elicited more drops of saliva than did the CS.

Experimental Extinction

A CR depends upon a UCS for its existence and that is precisely why Pavlov referred to the UCS as a *reinforcer*. Obviously, without the UCS, a CS would never develop the capability of eliciting a CR. Likewise, if after a CR has been developed, the CS is continually presented without the UCS's following the CR, the CR gradually disappears. When the CS no longer elicits a CR, experimental extinction is said to have occurred. Again, extinction results when the CS is presented to the organism and is not followed by reinforcement. In classical conditioning studies, reinforcement is the UCS. The terms Pavlovian conditioning and classical conditioning are synonomous.

Spontaneous Recovery

After a period of time following extinction, if the CS is again presented to the animal, the CR will temporarily reappear. The CR has "spontaneously recovered" even though there had been no further pairings between the CS and the UCS. Again, if there is a delay following extinction and the CS is presented to the organism, it will tend to elicit a CR. The extinction and **spontaneous recovery** of a CR are shown in Figure 7-3.

Higher Order Conditioning

After a CS has been paired with a UCS a number of times, it can be used much like a UCS. That is, through its pairing with the UCS, the CS develops reinforcing properties of its own and it can be paired with a second CS to bring about a CR. Let us pair, for example, a blinking light (CS) with the presentation of food powder (UCS). Food powder will cause the animal to salivate and after a number of pairings between the CS and the UCS, the blinking light presented alone will cause the animal to salivate. That the animal salivates to the blinking light is, of course, a conditioned response.

Now that the blinking light can elicit salivation, it can be paired with a second CS, say, a buzzer. The direction of the pairing is the same as in the original conditioning: first the new CS (buzzer) is presented and then the old

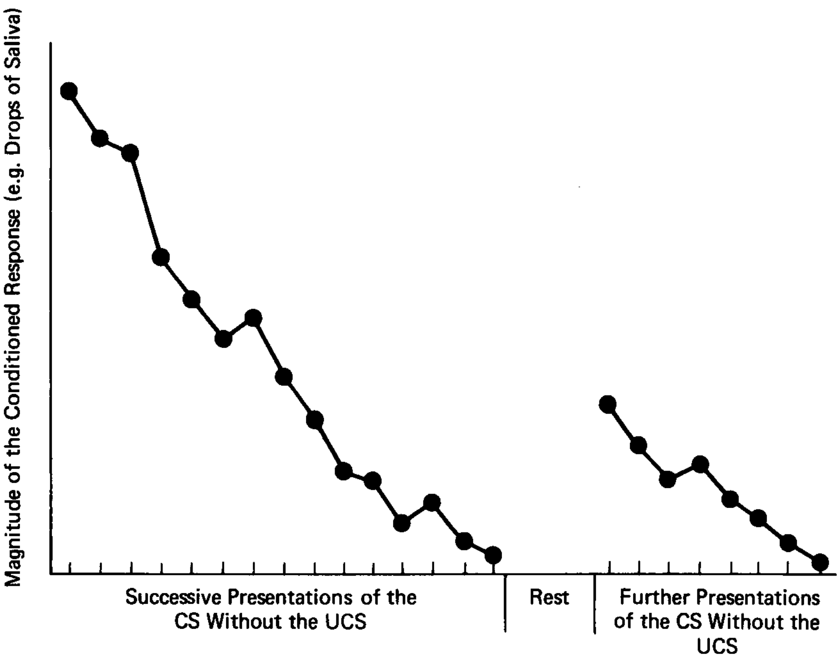


FIGURE 7-3. Typical curves showing the extinction and spontaneous recovery of a conditioned response.

one (blinking light). Note that food is no longer involved. After a number of such pairings, the buzzer, when presented alone, causes the animal to salivate. In this example, the first CS was used much like a UCS is used to bring about a conditioned response. This is called *second order conditioning.* We also say that the first CS developed *secondary reinforcing properties* since it was used to condition a response to a new stimulus. Therefore the CS is called a **secondary reinforcer.** Since secondary reinforcement cannot develop without the UCS, the UCS is called a **primary reinforcer.**

This procedure can be carried one more step. The second CS (buzzer) can be paired with one more CS, such as a 2000 cps tone. The direction of the pairing is the same as before: first the tone, then the buzzer. Eventually, the tone presented alone will cause the animal to salivate. Thus, through its pairing with the blinking light, the buzzer too became a secondary reinforcer and therefore could be used to condition a response to another new stimulus, the 2000 cps tone. This is *third order conditioning.* Both second and third order conditioning come under the general heading of higher order conditioning.

Since higher order conditioning must be studied during the extinction process, it is very difficult, if not impossible, to go beyond third order conditioning. In fact, such studies are quite rare. As one goes from first to third order conditioning, the magnitude of the CR becomes smaller and the CR lasts only for a few trials. In this example, the tone would only elicit a few drops of saliva and do so only the first few times it was presented to the animal.

Generalization

To illustrate **generalization,** we return to the basic conditioning procedure. We will use a 2000 cps tone for our CS and meat powder for our UCS. After a number of pairings, the tone alone causes the animal to salivate; thus we have developed a CR. Once this has been accomplished, we enter the extinction phase of the experiment, only this time we will expose the animal to tones other than the one it was trained on. Some of the new tones will have a frequency higher than 2000 cps and some will have a lower frequency. Using the number of drops of saliva as our measure of the magnitude of the CR, we find the CR has its greatest magnitude when the 2000 cps tone is presented, but CRs are also given to other tones. The magnitude of the CR given to the other tones depends on their similarity to the tone the animal was actually trained on; in this case, the greater the similarity to the 2000 cps tone, the greater the magnitude of the CR. An example of generalization is shown in Figure 7-4.

There is a relationship between Pavlov's concept of generalization and Thorndike's explanation of the transfer of training. With generalization, as the training and testing situations have more in common, there is a greater probability that the same response will be made to both. This could easily be subsumed under Thorndike's "identical elements" theory of transfer.

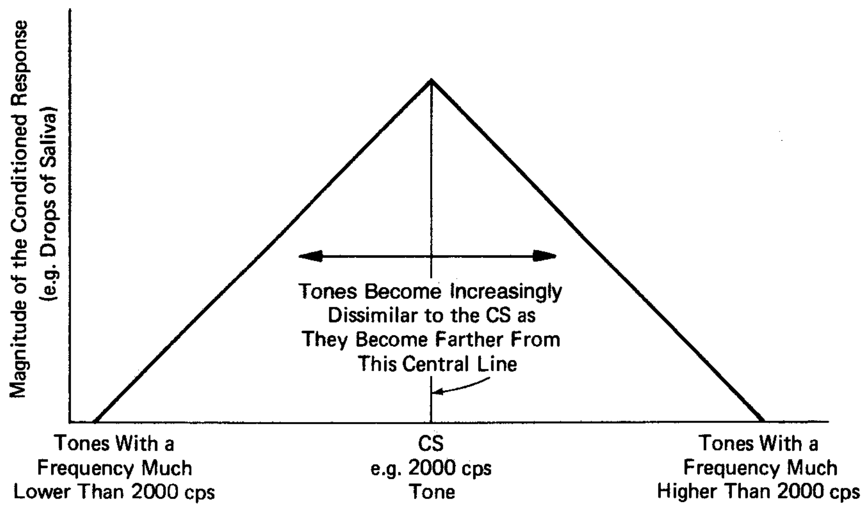


FIGURE 7-4. Idealized stimulus generalization curve showing that as stimuli become increasingly dissimilar to the one used as the CS during training the magnitude of the CR goes down.

Likewise, both generalization and transfer explain how we can have a learned reaction to a situation we have never encountered before; that is, we respond to a new situation as we would respond to a similar situation that we are familiar with.

It is important to note the distinction between Thorndike's spread of effect and Pavlov's generalization. The spread of effect refers to the influence of reinforcement on responses neighboring the reinforced response, regardless of their similarity to the reinforced response. With the spread of effect, proximity is the important thing. Generalization describes the increased capability of producing a CR of stimuli related to the stimulus which actually preceded reinforcement. With generalization, similarity and not proximity is the important thing.

Discrimination

The opposite of generalization is **discrimination.** As we saw above, generalization refers to the tendency to respond to a number of stimuli that are related to the one actually used during training. Discrimination, on the other hand, refers to the tendency to respond to a very restricted range of stimuli or to only the one used during training.

Discrimination can be brought about in two ways: prolonged training, and differential reinforcement. If a CS is paired with a UCS many times, the tendency to respond to stimuli related to the CS, but not identical to it, goes down. In other words, if the minimum number of pairings between the CS and UCS necessary to develop a CR is used, there is a relatively strong tendency to respond to stimuli related to the CS during extinction; that is, there is considerable generalization. However, if training is prolonged, there is a reduced tendency to respond to stimuli related to the CS during extinction. Thus, it is possible to control generalization by controlling training level: the greater the amount of training, the less generalization.

The second way of bringing about discrimination is through differential reinforcement. This procedure involves, using the above example, presenting the 2000 cps tone along with a number of other tones that will occur during extinction. Only the 2000 cps tone is followed by reinforcement. After such training, when the animal is presented with tones other than the 2000 cps tone during extinction, it tends not to respond to them. Thus, discrimination is demonstrated. Pavlov's attempt at providing a physiological explanation for generalization and discrimination will be considered later in this chapter.

Relationship Between the CS and the UCS

Two general considerations about classical conditioning must be mentioned. First, there appears to be an optimal interval of presentation between the CS and UCS for conditioning to take place most rapidly. A number of investigators have found that if the CS comes on a half-second before the

UCS, conditioning proceeds most efficiently. The most common procedure is to have the CS come on and stay on until the UCS comes on. If the time between these two events is greater or less than .5 seconds, conditioning is relatively more difficult to establish. This should be looked upon as an oversimplification, however, since the optimal interval of time between the onset of the CS and the onset of the UCS for conditioning to occur depends upon many factors, and it is the subject of a considerable amount of research. For example, when we consider research on taste aversion later in this chapter we will see that a phenomenon like classical conditioning occurs even when the delay between the CS and the UCS is several hours.

The second important matter is related to the first. If the CS comes on *after* the UCS is presented, conditioning is extremely difficult, if not impossible, to establish. This is referred to as **backward conditioning.** Recently it has been found that a CS must be "informative" to the organism before conditioning will occur. Clearly, a CS that comes on after the UCS has already been presented cannot be used by the organism to predict occurrence of the UCS. This would be true not only of the backward conditioning situation, but would also be true of redundant CSs and unreliable CSs. Evidence for this point of view is supplied by Egger and Miller (1962, 1963) who found that (1) if two CSs reliably predict a UCS, the first one presented will become a secondary reinforcer, and the second one, which is redundant, does not; and (2) if two signals precede a UCS but one is always followed by the UCS and the other only sometimes followed by the UCS, the more reliable signal becomes a more powerful secondary reinforcer than the unreliable signal. Stimuli that occur after the UCS or stimuli that are either redundant or unreliably correlated with the UCS cannot be used by the organism to predict the occurrence of primary reinforcements; that is, they have no **information value.** In general, Egger and Miller conclude that for classical conditioning to take place, the organism must be able to use the CS to predict whether or not reinforcement will occur. It appears that if a CS is not informative about major events in the environment, conditioning will not take place. When we consider the biological boundaries of learning later in this chapter, we will see also that recent evidence indicates that some CSs and UCSs are associated easier than others. It appears that those associations that are conducive to an organism's survival are easiest to form.

PAVLOV'S PHYSIOLOGICAL EXPLANATIONS OF CONDITIONING PHENOMENA

Pavlov considered himself to be an experimental physiologist and he therefore sought to explain his observations in physiological terms. Many of his physiological explanations were highly speculative and most have since been found erroneous, but correcting for the time and conditions under which they were made, his explanations were quite remarkable. It was obvious to Pavlov that a CS and UCS became associated through the consistent pairings of the two. The question was, "What is the physiological basis for this association?" Pavlov answered this question as follows: The unconditional stimulus sets up a dominant activity in some area of the cerebral cortex. All other stimuli present at the time also cause cerebral activity, but this activity is weaker and is drawn toward the area of dominant activity caused by the UCS. The weaker activity is drawn toward the stronger activity and a temporary connection is formed between these various centers in the brain. In this way, all the stimuli preceding the onset of the UCS become associated with it. Thus, when one of the stimuli that accompanied the UCS is presented to the organism, it causes activity in the area of the brain associated with it. If it is a visual stimulus, it will cause activity in the visual part of the brain. The activity in this area in turn causes activity in the area corresponding to the unconditioned stimulus because of the temporary connection between the two. The result is that the organism emits a response to the visual stimulus that is associated naturally with the UCS; that is, we have a conditioned response. To summarize, Pavlov simply said that brain centers that are repeatedly active together form temporary connections, and the arousal of one will cause the arousal of the others. Thus, if a tone is consistently presented to a dog just before it gets fed, the area of the brain aroused by the tone will form a temporary connection with the area of the brain which responds to food. When this connection is formed, the presentation of the tone will cause the animal to act as if food was present. At that point, we say a conditioned reflex has been developed.

Excitation and Inhibition

According to Pavlov, the two basic processes governing all central nervous system activity were **excitation** and **inhibition.** Babkin said (1949):

> The fundamental theoretical conception of Pavlov concerning the functional properties of the nervous system, and of the cerebral cortex in particular, was that they were based on two equally important processes: the process of excitation and the process of inhibition. Very often he compared the nervous system with the ancient Greek god Janus, who had two faces looking in opposite directions. The excitation and the inhibition are only sides of one and the same process; they always exist simultaneously, but their proportion varies in each moment, at times the one prevailing, at times the other. Functionally the cerebral cortex is, according to Pavlov, a mosaic, consisting of continuously changing points of excitation and inhibition [p. 313].

Pavlov believed that each environmental event corresponded to some point on the cortex and that as these events were experienced they tended to either excite or inhibit cortical activity. Thus, the cortex is constantly being excited or inhibited depending on what the organism is experiencing. This pattern of excitation and inhibition that characterizes the brain at any given moment is what Pavlov called the **cortical mosaic.** The momentary cortical mosaic determines how an organism will respond to its environment. As either the external environment or the internal environment changes, the cortical mosaic changes and behavior changes accordingly.

The Dynamic Stereotype

When events consistently occur in the environment, they come to have neurological representation and they become increasingly easy to respond to. Thus, responses to a familiar environment become rapid and automatic. When this happens, a **dynamic stereotype** is said to have been developed. Roughly, the dynamic stereotype is a cortical mosaic that has become stable because the organism has been in a highly predictable environment for a considerable length of time. As long as this cortical mapping accurately reflects the environment and produces appropriate responses, everything is fine. If, however, the environment is radically changed, the organism may find it difficult to change a dynamic stereotype. Pavlov (1955) put the matter as follows:

> The entire establishment and distribution in the cortex of excitatory and inhibitory states, taking place in a certain period under the action of external and internal stimuli, become more and more fixed under uniform, recurring conditions and are effected with ever-increasing ease and automatism. Thus, there appears a dynamic stereotype (systematization) in the cortex, the maintenance of which becomes an increasingly less difficult nervous task; but the stereotype becomes inert, little susceptible to change and resistant to new conditions and new stimulations. Any initial elaboration of a stereotype is, depending on the complexity of the system of stimuli, a difficult and often an extraordinary task [p. 259].

To summarize, certain environmental events tend to be followed by certain other environmental events, and as long as this continues to be true, the association between the two on the neural level continues to grow stronger. (Note the similarity here to Thorndike's early thinking concerning the effect of exercise on a neural bond.) If the environment abruptly changes, new neural paths must be formed, and that is no easy matter.

Irradiation and Concentration

Pavlov used the term "analyser" to describe the path from a sense receptor to a certain area of the brain. An analyser consists of sense receptors, the sensory tract in the spinal cord, and the area of the brain onto which the sensory activity is projected. Sensory information projected onto some area of the brain causes excitation in that area. Initially, this excitation spills over into neighboring brain areas; in other words, there is an **irradiation of excitation.** It is this process that Pavlov used to explain generalization. In our example of generalization described above, we noted that when an animal was conditioned to respond to a 2000 cps tone, it responded not only to that tone but to other related tones. The magnitude of the response was determined by the similarity between the tone being presented and the actual CS used during training. As the similarity increased, the CR's magnitude increased.

Pavlov's explanation for generalization was that neural impulses travelled from the sense receptors—in this case from the ears—to a specific area of the cortex that reacted to a 2000 cps tone. The activity caused by the 2000 cps tone irradiates from this location out into the neighboring regions. Pavlov assumed that tones closest to the 2000 cps tone would be represented in brain regions close to the area corresponding to the one for the 2000 cps tone. As tones become dissimilar, the brain regions representing them will be farther away from the area representing the 2000 cps tone. In addition, Pavlov assumed that excitation diminished with distance: it was strongest at the point corresponding to the CS and weaker farther away. Therefore an association was made not only between the CS and the UCS but with a number of stimuli related to the CS that had representation in neighboring brain regions. In addition to his hypothesis that excitation irradiated or spread to neighboring regions of the cortex, Pavlov found that inhibition also irradiated.

Pavlov also found that concentration, a process opposite to irradiation, can govern both excitation and inhibition. He found that under certain circumstances both excitation and inhibition can be concentrated at specific areas of the brain. As the process of irradiation is used to explain generalization, so is the process of concentration used to explain discrimination.

At first the organism has a generalized tendency to respond to a CS during conditioning. For example, if a signal is followed by a reinforcer, there is a learned tendency to respond to that and related signals. Likewise, if a signal is presented and is not followed by a reinforcer, there is a learned tendency not to respond to that and related signals. We say, therefore, that both excitation and inhibition have irradiated. With prolonged training, however, the tendencies to respond and not to respond become less general and increasingly specific to a narrow range of stimuli. In the latter case, we say the excitation and inhibition have been concentrated.

As we noted earlier in this chapter, discrimination, or the ability to respond differentially to related stimuli, can be brought about by prolonged training or differential reinforcement. If a large number of pairings are made between the CS and the UCS the excitation begins to concentrate. After such training, one would find that the organism tends to respond only to the CS or to stimuli very similar to the CS. In other words, because excitation has been concentrated, very little generalization would take place.

Summary of Pavlov's Views on Brain Functioning

Pavlov saw the brain as a mosaic of points of excitation and inhibition. Each point on the brain corresponded to an environmental event. Depending on what was being experienced at the moment, a different pattern of excitation and inhibition would occur in the brain and that pattern would determine behavior. Some connections in the brain are between unconditioned stimuli and their associated responses, and some are between conditioned stimuli and their associated responses. The former are permanent and the latter are temporary and change with varied environmental conditions.

When a temporary connection is first being formed in the brain, there is a tendency for a conditioned stimulus to have a very general effect in the brain. That is, the excitation caused by a conditioned stimulus irradiates over a relatively larger portion of the cortex. The same thing is true when an organism is learning not to respond to, or to avoid, a stimulus. The inhibitory effects of such a stimulus also irradiates over a fairly large portion of the brain in the early stages of learning. As learning proceeds, however, the excitation caused by a positive stimulus and the inhibition caused by a negative stimulus become concentrated in specific areas of the cortex. As the organism develops the connections between environmental events and brain processes that allow it to survive, a dynamic stereotype develops, which is a kind of neural mapping of the environment. The dynamic stereotype makes it easier to respond to a highly predictable environment but makes it difficult to adjust to a new environment.

Pavlov never explained how all these processes interact to produce the smooth, coordinated behavior we see from organisms, but he did express amazement that systematic behavior did result from such a large number of influences. Pavlov put the matter as follows (1955):

> Countless stimuli, different in nature and intensity, reach the cerebral hemispheres both from the external world and the internal medium of the organism itself. Whereas some of them are merely investigated (the orienting reflex), others evoke highly diverse conditioned and unconditioned effects. They all meet, come together, interact, and they must, finally, become systematized, equilibrated, and form, so to speak, a dynamic stereotype. What truly grandiose work [p. 454]!

The "orienting reflex" to which Pavlov refers is the tendency for organisms to attend to and explore novel stimuli that occur in their environment. The orienting reflex has been the topic of considerable research in recent years.

First and Second Signal Systems

Pavlov believed that human behavior was much more complex than that of other animals because humans utilize language, which Pavlov called a **second signal system.** The **first signal system** consists of the organism's reactions—both learned and unlearned—to environmental stimuli. Our discussion of learning up to this point has been concerned with the first signal system. Even though words are only symbols of reality, they too can have responses conditioned to them and, therefore, words can govern our behavior. For example, actual objects associated with previous pain or anxiety will be avoided but so will things labelled dangerous or harmful.

One example of how language complicates classical conditioning is found in the area of **semantic generalization** (sometimes called mediated generalization). Semantic generalization studies have shown that a response can be conditioned to the *meaning* of a stimulus rather than to the concrete stimulus itself. For example, if a response is conditioned to the number 4, human subjects will emit a conditioned response when they are confronted with such stimuli as $\sqrt{16}$; $2\overline{)8}$; 2×2; $10\overline{)40}$, etc. In other words, the number 4 elicits a conditioned response, but so will a variety of other stimuli that result in 4 after mental operations have been performed. The conclusion to be drawn is that for human subjects the true CS is the concept of "fourness." (See Razran, 1961, for additional examples of semantic conditioning.)

Semantic generalization also seems to vary as a function of age. In his work with children of different ages, Reiss (1946) found that after initial training which involved visually presenting a word such as "right" as a CS, children generalized by giving conditioned responses according to their level of language development. He found that eight-year-olds generalized to visually presented homophones (such as *rite*); eleven-year-olds generalized to antonyms (such as *wrong*); and fourteen-year-olds generalized to synonyms (such as *correct*).

Although the second signal system is clearly more complex than the first signal system, Pavlov felt that the same laws of conditioning govern both and therefore they both could be studied objectively. In other words, the process by which we develop a reaction to an environmental event is the same process by which we develop a reaction to a word or a thought.

A COMPARISON BETWEEN CLASSICAL AND INSTRUMENTAL CONDITIONING

The kind of conditioning that Thorndike studied is now called instrumental conditioning because the response being observed was instrumental in getting the animal something it wanted (reward). In the case of the cat in the puzzle box, the cat had to learn to perform a certain response which released it from the box and rewarded it with a piece of fish. If the appropriate response did not occur, the animal was not rewarded. To summarize, we can say that in instrumental conditioning, any response that leads to reward tends to be repeated, and a reward is something the animal wants.

Classical conditioning elicits a response from the animal, and instrumental conditioning depends on the animal's emitting the response. The former can be said to be involuntary and automatic; the latter to be voluntary and under the animal's control.

The function of reinforcement (reward) is also quite different for classical and instrumental conditioning. With instrumental conditioning reward is presented to the animal *after* the response of interest has been made. With classical conditioning, however, the reward (UCS) is presented in order to *elicit* the response of interest. The two situations can be diagrammed as follows:

Instrumental Conditioning

Environmental situation	→	Effective behavior	→	Reward
(e.g., puzzle box)		(e.g., behavior which releases the animal from confinement)		(e.g., being released from confinement and/or receiving a piece of fish)

Association of interest (between environmental situation and effective behavior)

Classical Conditioning

Conditioned Stimulus	→	Reward	→	Unconditioned response
(e.g., a tone)		(Unconditioned stimulus, e.g., food)		(e.g., salivation)

Conditioned Stimulus → Conditioned response (salivation)

Association of Interest

Pavlov felt that he had discovered the physiological bases for the associations that philosophers and psychologists had been talking about for so many years. To him, conditioned reflexes could explain how the mind works. Pavlov placed himself squarely among the associationists with the following statement (1955):

> Are there any grounds . . . for distinguishing between that which the physiologist calls the temporary connection and that which the psychologist terms association? They are fully identical; they merge and absorb each other. Psychologists themselves seem to recognize this, since they (at least, some of them) have stated that the experiments with conditioned reflexes provide a solid foundation for associative psychology, i.e., psychology which regards association as the base of psychical activity [p. 251].

The two kinds of conditioning reflect basic differences in outlook between Pavlov and Thorndike. Pavlov was basically an experimental physiologist who was interested in learning how the brain functioned. Thorndike was an early functionalist who was strongly influenced by Darwin. Thorndike's main concern was how learning was involved in adapting to one's environment. He was more concerned with the *function* of learned behavior than was Pavlov. This may be why Thorndike did little more than acknowledge associative shifting, a kind of learning based strictly on contiguity between stimuli and response, whereas Pavlov developed a physiological model to explain this phenomena in detail.

Despite basic differences between the classical and instrumental conditioning paradigms, they have many similarities. Most importantly, both kinds of conditioning are dependent upon reward. In classical conditioning the UCS is the reward and if it is removed from the experimental arrangement, extinction occurs. In instrumental conditioning the reward is the "satisfying state of affairs" that *follows* an appropriate response. If reward no longer follows a certain response, the probability of that response goes back to the point where it was before reward was introduced. To summarize, classical and instrumental conditioning not only have in common the necessity of reward (extinction follows when it is removed), but also the phenomena of spontaneous recovery, generalization, discrimination, and secondary reinforcement.

It should also be pointed out that it is impossible to separate instrumental and classical conditioning completely. For example, every instrumental conditioning study that utilizes a primary reinforcer (such as food or water) will necessarily produce classical conditioning. That is, all of the stimuli that consistently occur prior to the primary reinforcer will, through the process of classical conditioning, become secondary reinforcers.

THE BIOLOGICAL BOUNDARIES OF LEARNING

Originally it was believed that any stimulus that an organism could detect would become a conditioned stimulus (CS) if it was presented in proper proximity to an unconditioned stimulus (UCS). The work of Egger and Miller (1962, 1963) challenged this contention by showing that only informative stimuli become CS's. That is, stimuli that reliably precede a reinforcer become CS's, and other stimuli, even if they are presented in accordance with the classical conditioning paradigm, do not. Recent evidence casts further doubt on the contention that conditioning will occur automatically if certain procedures are followed. As we saw in Chapter 5, there is growing recognition that the genetic endowment of an organism must be taken into consideration in any learning experiment. The Brelands' concept of instinctual drift demonstrated the importance of instinctive response tendencies in the operant conditioning situation. The importance of genetically determined tendencies has also been found in the classical conditioning situation. For example, Seligman (1970) maintains that some species learn associations more easily than other species do because they are biologically prepared to do so. Likewise, for some species an association may be difficult to learn because they are biologically contraprepared to learn them. Thus, where an association falls on the prepared-contraprepared continuum will determine how easily it will be learned.

A study by Wilcoxon, Dragoin, and Kral (1971) exemplifies Seligman's concept of preparedness. In their study, rats and quail were given blue, salty water which was treated to make them sick. After the experience of drinking the water and becoming ill, both species were offered a choice between blue water or salty walter. The rats avoided the salty water whereas the quail avoided the blue water. This finding reflects the fact that rats rely on taste in an eating (or drinking) situation and quail rely on visual cues. Thus each species formed an association in accordance with its genetic makeup. In other words, although the UCS (treated blue, salty water) and the UCR (illness) were the same for both species, each species selected a CS in accordance with its genetic endowment. For the rats, the taste of salt became the CS, whereas for the quail, the color blue was the CS. In Seligman's terms, the rats were more biologically prepared to make the salt-illness association than were the quail, but the quail were more prepared to make the blue-illness association.

A series of experiments run by Garcia and his colleagues also give credence to the contention that genetic endowment influences what associations are made by an organism. Whereas the research of Wilcoxon , Dragoin, and Kral (1971) demonstrates that different associations will be optimal for different species, Garcia's research indicates that within a species certain associations will be easier to form than others because of the genetic endowment of that species. For example, Garcia and Koelling (1966) offered thirsty rats the opportunity to drink under four conditions. One group was offered bright, noisy water, and drinking it was immediately followed by an electric shock to the feet. The bright, noisy water was created by attaching an electrode to the drinking tube in a way that set off flashing lights and loud clicking sounds when the organism touched the water. A second group was offered the bright, noisy water, but instead of being shocked for drinking they were injected with lithium chloride, which induces nausea. A third group was given water without the flashing lights and clicking sounds but with the taste of saccharin; these animals, like those in group one, were shocked through the feet immediately after drinking the saccharin solution. A fourth group was given the saccharin solution and then was made ill by an injection of lithium chloride.

Garcia and Koelling (1966) found that animals in group one developed an aversion to bright, noisy water, whereas animals in group two did not. In addition, animals in group three did not develop an aversion to saccharin flavored water, whereas animals in group four did develop an aversion to the water. The experimental design and the results of the experiment can be summarized as follows:

Group One: Bright, noisy water→shock: Developed an aversion to the water
Group Two: Bright, noisy water→nausea: No aversion to the water
Group Three: Saccharin Solution→shock: No aversion to saccharin
Group Four: Saccharin Solution→nausea: Developed an aversion to saccharin

It can be seen that bright, noisy water became an effective CS when paired with shock, but not when it was paired with nausea. Likewise, the taste of saccharin was an effective CS when paired with nausea, but not when it was paired with shock. Garcia and Koelling (1966) explained their results by saying that there was a natural relationship between external events and the pain that the animals experienced. In other words, the pain was coming from "out there" and therefore the animals searched for an external predictor of that pain, which in this case was the lights and noise associated with drinking. On the other hand, nausea comes from something which is ingested and not experienced externally. Therefore, the animals associated the taste of saccharin (which is internal) and not the bright, noisy water (which is external) with nausea. To use Seligman's terminology, we can say that the rats were biologically prepared to form an association between bright, noisy water and pain, but not prepared to form an association between bright, noisy water and nausea. Likewise, the animals were biologically prepared to form an association between the taste of saccharin and nausea, but they were not biologically prepared to form an association between the taste of saccharin and pain.

Although the Garcia and Koelling experiment seems to follow classical conditioning procedures, it presents a few problems when the results are interpreted as classical conditioning phenomena. First, the time delay between the CS (the taste of saccharin) and the UCS (nausea) greatly exceeds the time interval considered necessary for classical conditioning. The interval between the time an animal tastes a substance and then experiences illness can be several hours. Second, it is repeatedly found that a strong taste aversion can develop after only a few (sometimes only one) pairings of a substance and nausea. Ordinarily it takes many pairings between a CS and a UCS to produce a conditioned response (CR). Sometimes when strong punishment is used, conditioning has been found to take place in one trial, but never when the interval between the CS and the UCS is as long as it typically is in taste aversion studies. Third, although taste aversions develop after long time delays and, in some cases in just one trial, they are extremely resistant to extinction. Usually, resistance to extinction goes up as the number of pairings between the CS and the UCS goes up, but taste aversions seem to violate this principle.

Thus, taste aversions are formed rapidly and they last a long time, and these facts seem directly related to an organism's survival. It seems that if an organism is biologically prepared to form any associations, they would be those conducive to survival and that appears to be the case with the development of taste aversions. The formation of taste aversions has so many unique features that the phenomenon has been given a name (Bolles, 1979):

> The remarkable facility with which rats (and a number of other animals) learn about the relationship between the taste of a particular food substance and a subsequent illness we shall call the "Garcia effect" [p. 167].

Does the **Garcia effect** have any practical implications? The answer seems to be yes. Wild coyotes have long been a problem in the Western United States because they prey on lambs and other livestock. This has led to a debate between farmers and ranchers who often want to kill the coyotes and environmentalists who want to save the coyotes for ecological reasons. Gustavson, Garcia, Hankins, and Rusiniak (1974) have shown that the Garcia effect can be used to control the eating habits of coyotes. In their study, three coyotes were fed lamb flesh treated with lithium chloride and three were fed rabbit flesh treated with the same substance. After only one or two experiences with the treated flesh the coyotes avoided attacking the kind of animals whose flesh had made them ill but showed no avoidance of the other type of flesh. That is, those coyotes that ate treated lamb flesh avoided sheep but ate rabbits, and those coyotes that ate treated rabbit flesh avoided rabbits but ate sheep. Thus, it appears that we have a straightforward way of controlling the eating habits of predators that satisfies the wishes of both ranchers and farmers and the environmentalists.

The findings of instinctual drift, autoshaping, and the preparedness continuum are currently causing learning theorists to recognize that genetically determined response tendencies are powerful determinants of behavior and, therefore, must be taken into consideration when attempting to modify behavior using either instrumental or classical conditional principles.

PSYCHOTHERAPY

Pavlov's work has influenced almost every aspect of psychology and psychotherapy is no exception. Classical conditioning procedures have been used to treat a wide array of psychological disorders. For example, Mount, Payton, Ellis, and Barnes (1976) injected anectine into the arm of alcoholic clients immediately after they drank a glass of their favorite alcoholic beverage. Anectine produces a paralyzing effect on the respiratory system which most people report as a frightening experience. After such treatment, only one of the nine individuals involved in this study started drinking again.

One of the most thorough attempts to apply classical conditioning principles to psychotherapy was undertaken by Joseph Wolpe (1958) who developed a therapeutic technique referred to as **systematic desensitization.** Wolpe's technique, which is used primarily for treating clients with phobias, involves three phases. The first phase consists of developing an anxiety hierarchy, which is done by taking a sequence of related anxiety-provoking events and ordering them from those that produce the greatest amount of anxiety to those that produce the least amount. Let us say that a person has an extreme fear of flying in an airplane. Such a person's anxiety hierarchy may look something like this:

1. Flying in an airplane
2. Sitting in an airplane while it is on the ground with its engines running
3. Sitting in an airplane while it is on the ground with its engines turned off
4. Being in close proximity of an airplane
5. Seeing an airplane at a distance
6. Being in an airport
7. Hearing the sound of airplane engines
8. Talking about being on an airplane
9. Planning a trip without airplanes involved
10. Hearing others plan a trip without airplanes involved

In the second phase of his procedure, Wolpe teaches his clients to relax. He teaches them how to reduce muscle tension and, in general, how it feels when one is not experiencing anxiety. In phase three, the client first experiences deep relaxation and then is asked to imagine the weakest item on the anxiety hierarchy. While experiencing this item the client is again asked to induce relaxation. When this is accomplished, the client is asked to ponder the next item on the list, and so forth through the entire list. It is assumed by Wolpe that if each time an item on the list is experienced along with relaxation (the absence of anxiety) a little bit of the phobic response associated with the terminal item on the list extinguishes. This procedure allows the client to gradually approximate the situation that he or she was too frightened to ponder previously. Such an anxiety-provoking experience must be approached gradually and with a great deal of care; otherwise the client will be unable to ponder the feared item, and therefore fear of it will never extinguish. One problem that a person with a phobia has is that he or she avoids the very experiences that will eliminate the phobia. In other words a person with a flying phobia typically avoids flying and all related experiences; the person with sex phobia avoids sexual and related experiences; and so on. If a phobia is ever going to extinguish, the feared item must be experienced in the absence of anxiety.

After this cognitive extinction has occurred it is hoped that the person will be able to repeat the steps in the real world. After systematic desensitization, the client should be able to deal with his or her fear (or previous fear) more rationally, and hopefully, in this case, fly in an airplane without experiencing dishabilitating anxiety.

Efforts such as Wolpe's to apply principles of learning to the treatment of psychological disorders have been referred to as behavior therapy. Behavior therapy involves either the application of operant principles, as in the case of the Skinnerians, or of classical conditioning principles, as in the case of Wolpe. We will compare Wolpe's technique of systematic desensitization with other techniques of treating phobias in Chapter 13.

JOHN B. WATSON

One cannot conclude a discussion of Pavlov without reviewing briefly the work of **John Broadus Watson** (1878–1958), upon whom Pavlov had a great influence. We noted earlier that psychologists were becoming increasingly dissatisfied with the study of consciousness. Structuralism, with its search for the elements of thought through the use of introspection, was abandoned and the new school of functionalism took its place. The functionalist studied both behavior and consciousness to discover how the organism adapted to the environment. Gradually psychologists developed the idea that there was no need to study consciousness at all, that in order to be completely objective, psychology had to make behavior its only subject matter. Watson embraced this idea enthusiastically and founded the school of **behaviorism.**

In order to be a science, psychology had to have a subject matter that could be measured reliably. That subject matter, said Watson, was behavior. Explanations of behavior that involved mental processes were not admitted in the science of behaviorism since such processes were unobservable and therefore unmeasurable. Thorndike's "pleasurable state of affairs" and "annoying state of affairs" were also mentalistic and therefore had no place in the new psychology. No more introspection, no more talk of instinctive behavior, and no more attempts to study the human conscious or unconscious mind. Behavior is what we can see and therefore behavior is what we study. According to Watson (1913):

> Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods,

John Broadus Watson

Murchison, Co., ed., *Psychologies of 1925,* Worcester, Mass.: Clark University, 1926.

> nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. The behaviorist, in his efforts to get a unitary scheme of animal response, recognizes no dividing line between man and brute. The behavior of man, with all its refinement and complexity, forms only a part of the behaviorist's total scheme of investigation . . . [p. 158]. (Copyright © 1913 by the Amer. Psych. Assoc. Reprinted by perm.)

Elsewhere Watson said (1929):

> . . . The behaviorist cannot find consciousness in the test tube of his science. He finds no evidence anywhere for a stream of consciousness, not even for one so convincing as that described by William James. He does, however, find convincing proof of an ever-widening stream of behavior [p. 26].

Personality was, to Watson, a collection of conditioned reflexes. Human emotion was a product of both heredity and experience. According to Watson, we inherit three emotions—fear, rage, and love. Through the conditioning process, these three basic emotions become attached to different things for different people. Speech was behavior that resulted from the movement of the muscles in the throat. Thinking was implicit or subvocal speech. During overt speech, the vocal apparatus responded with vigor; during thinking, the same apparatus is involved but its movements are minute. Speech could indeed be studied but it had to be studied as behavior and not as a tool used to investigate "inner experience."

Watson was an extreme environmental determinist. He held the position that all we come equipped with at birth is a few reflexes and a few basic emotions, and through classical conditioning, these reflexes become paired with a variety of stimuli. He emphatically denied that we are born with any mental abilities or predispositions. In this, Watson's thinking followed that of John Locke, who said that the mind was a blank slate at birth. The extreme to which Watson was willing to carry this position is exemplified by his following famous (or infamous) statement (1926):

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant, chief, and yes, even beggarman and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors [p. 10].

Experiment with Albert

To demonstrate how inborn emotional reflexes become conditioned to neutral stimuli, Watson and Rosalie Rayner (1920) performed an experiment on an eleven-month-old infant named Albert. In addition to Albert, the other ingredients in the experiment were a white rat, a steel bar, and a hammer. At the onset of the study, Albert showed no fear of the rat. In fact, he reached out and tried to touch it. During the initial part of the experiment, when Albert saw the rat and reached for it, the experimenter took the hammer and struck the steel bar behind the infant, making a loud noise. In response to the noise, Albert "jumped violently and fell forward." Again Albert saw the rat and reached for it, and again, just as his hand touched the rat, the bar was struck making a loud noise. Again Albert jumped violently and began to whimper. Because of Albert's emotional state, the experiment was suspended for one week so Albert would not become too disturbed.

After a week, the rat was again presented to Albert. This time Albert was very cautious of the animal and watched it very carefully. At one point, when the rat came into contact with his hand, Albert withdrew his hand immediately. There were several more pairings between the rat and the sound and eventually Albert developed a strong fear of the rat. Now when the rat was presented to Albert again, he began to cry and "almost instantly he turned sharply to the left, fell over, raised himself on all fours and began to crawl away . . . rapidly" [1920, p. 5].

It was also shown that Albert's fear generalized to a variety of objects that were not feared at the onset of the experiment: a rabbit, a dog, a fur coat, cotton, and a Santa Claus mask. Thus, Watson showed that our emotional reactions can be rearranged through classical conditioning. In the experiment above, the loud noise was the UCS, fear produced by the noise was the UCR, the rat was the CS, and the fear of the rat was the CR. Albert's fear of all white and furry objects showed that generalization also took place.

Watson was enthusiastic about his work and its implications. He saw behaviorism as a means of stripping ignorance and superstition from human existence, thereby paving the way for a more rational, meaningful life. Understanding the principles of behavior, he thought, was the first step toward that kind of life. He said (1925):

> I think behaviorism does lay a foundation for saner living. It ought to be a science that prepares men and women for understanding the first principles of their own behavior. It ought to make men and women eager to rearrange their own lives, and especially eager to prepare themselves to bring up their own children in a healthy way. I wish I had time more fully to describe this, to picture to you the kind of rich and wonderful individual we should make of every healthy child; if only we could let it shape itself properly and then provide for it a universe unshackled by legendary folk lore of happenings thousands of years ago; unhampered by disgraceful political history; free of foolish customs and conventions which have no significance in themselves, yet which hem the individual in like taut steel bands [p. 248].

Clearly, Watson was a rebel. He took the various objective approaches to the study of psychology that were appearing here and there, and through his forceful writing and speaking, organized them into a new school of psychology. Unfortunately, Watson's career as a professional psychologist was cut short when he was asked to leave the Johns Hopkins University because of marital troubles leading to divorce. The same year he left the Johns Hopkins University he married Rosalie Rayner, with whom he did the study with Albert, and went into the advertising business. From that point on, instead of writing in professional journals, Watson published his ideas in *McCall's*, *Harper's*, and *Collier's* magazines.

Watson never wavered from his behaviorist outlook, and in 1936 he had the following to say about the position he took in 1912 (1936):

> I still believe as firmly as ever in the general behavioristic position I took overtly in 1912. I think it has influenced psychology. Strangely enough, I think it has temporarily slowed down psychology because the older in-

structors would not accept it wholeheartedly, and consequently they failed to present it convincingly to their classes. The youngsters did not get a fair presentation, hence they are not embarking wholeheartedly upon a behavioristic career, and yet they will no longer accept the teachings of James, Titchener, and Angell. I honestly think that psychology has been sterile for several years. We need younger instructors who will teach objective psychology with no reference to the mythology most of us present-day psychologists have been brought up upon. When this day comes, psychology will have a renaissance greater than that which occurred in science in the Middle Ages. I believe as firmly as ever in the future of behaviorism—behaviorism as a companion of zoology, physiology, psychiatry, and physical chemistry [p. 231].

DISCUSSION QUESTIONS

1. Design a cigarette commercial utilizing the principles of classical conditioning. How would this commercial differ from one based upon the principles of instrumental conditioning?
2. Differentiate between classical conditioning and Thorndike's notion of associative shifting.
3. Give a few examples of your own conditioned reflexes.
4. Give a few examples of how classical conditioning might operate in a classroom situation.
5. Can you think of where a knowledge of classical conditioning would be useful in child rearing? Give examples.
6. Briefly describe the following: acquisition of a conditioned response, extinction, spontaneous recovery, generalization, discrimination, and higher order conditioning.
7. Briefly describe Pavlov's physiological explanation of conditioning, generalization, and discrimination.
8. According to Pavlov, what determines how we respond to the environment at any given time?
9. Discuss the major differences and similarities between instrumental and classical conditioning.
10. How is classical conditioning related to survival?
11. Describe the conditions necessary for a stimulus to become a secondary reinforcer. How can one tell if a stimulus has become a secondary reinforcer?
12. What is the Garcia effect?
13. Summarize the problems involved in trying to explain the development of taste aversions as a classical conditioning phenomenon.
14. How can the Garcia effect be used to change the eating habits of predators?

15. Explain Seligman's concepts of preparedness and contrapreparedness.
16. Summarize Wolpe's therapeutic technique of systematic desensitization.
17. Explain emotional development from J. B. Watson's point of view.
18. If the Garcia effect exists on the human level, why do you suppose so many individuals continue to smoke or consume alcohol even though their initial experience with smoking or drinking alcohol made them extremely ill?

CHAPTER HIGHLIGHTS

Anxiety hierarchy. The initial stage of Wolpe's therapeutic technique of systematic desensitization which involves taking a series of related anxiety experiences and ordering them from the experience that causes the greatest amount of anxiety to the experience that causes the least amount of anxiety.

Backward conditioning. An experimental arrangement in which the conditioned stimulus is presented to the organism after the unconditioned stimulus is presented.

Behaviorism. The school of psychology started by J. B. Watson. The behaviorist believes that the proper subject matter for psychology is behavior, not mental events.

Conditioned response (CR) (also called conditioned reflex). A response that is made to a stimulus not originally associated with the response. For example, salivation to the sound of a tone is a conditioned response because an organism would not ordinarily salivate to the sound of a tone.

Conditioned stimulus (CS). A stimulus that, before conditioning, does not cause an organism to respond in any particular way. Before conditioning, the stimulus is a neutral stimulus. After conditioning, however, the conditioned stimulus elicits a conditioned response.

Contrapreparedness. The condition in which an organism's genetic endowment makes it difficult for certain associations to be formed.

Cortical mosaic. The pattern of excitation and inhibition that constitutes the activity of the cortex at any given moment.

Discrimination. Learning to respond to one stimulus but not to other stimuli although they may be related to the first. For example, through discrimination training a tone of 500 cps elicits a conditioned response, whereas a tone of 490 cps does not.

Dynamic stereotype. A cortical mapping of events consistently occurring in the environment. A stable environment comes to have neurological representation on the cortex.

Excitation. An increase in brain activity. A stimulus that causes excitation is called a positive stimulus.

Extinction. The procedure whereby a conditioned stimulus is presented but is not followed by reinforcement. Under these circumstances, the magnitude of the conditioned response gradually becomes smaller. When a conditioned response is no longer elicited by a conditioned stimulus, the conditioned response is said to have been extinguished.

First signal system. Physical events in the environment and the responses they produce.

Garcia effect. The name given to the observation that animals form taste aversions easily and in apparent contradiction to several principles of classical conditioning.

Generalization. The tendency for an organism to respond not only to the specific stimulus it was trained on, but also to other related stimuli. For example, if an organism was trained with a 500 cps tone as a conditioned stimulus, such tones as 600, 550, and 490 cps will also tend to elicit conditioned responses.

Higher order conditioning. After classical conditioning has taken place, a second conditioned stimulus is paired with the first conditioned stimulus. After a number of such pairings, the second conditioned stimulus can also elicit a conditioned response. This is called second order conditioning. Once the second conditioned stimulus has the power to elicit a conditioned response, it can be paired with a third conditioned stimulus to produce third order conditioning.

Information value of a stimulus. The ability of a stimulus to act as a signal to an organism that a significant event is about to occur. For example, a stimulus that signals the occurrence of food for a hungry animal has information value.

Inhibition. A decrease in brain activity. A stimulus that causes inhibition is called a negative stimulus.

Irradiation. The tendency for excitation or inhibition in a specific area of the brain to spill over into neighboring brain regions.

Orienting reflex. The tendency for an organism to attend to and explore a novel stimulus as it occurs in its environment.

Preparedness. The condition in which an organism's genetic endowment makes it easy for certain associations to be formed.

Primary reinforcer. Something related to survival such as food, water, or sex. All conditioning ultimately depends upon primary reinforcement. In classical conditioning, the primary reinforcer is the unconditioned stimulus.

Secondary reinforcer. A previously neutral stimulus that takes on reinforcing properties through its close association with primary reward. After conditioning has taken place, a conditioned stimulus must necessarily be a secondary reinforcer.

Second signal system. Language. The symbols humans use in communication. Since responses can be conditioned to symbols, they can influence human behavior. The second signal system, which is peculiarly human, makes human behavior much more complex than the behavior of other animals.

Semantic generalization. Generalization to symbols that have a meaning similar to the meaning of the conditioned stimulus used during training, although the physical characteristics of symbols may be totally dissimilar to those of the conditioned stimulus. For example, if human subjects are taught to salivate when they see the number 10, they will also salivate when they see $8\overline{)80}$ or $\sqrt{100}$. In semantic generalization, it is meaning that determines how much generalization occurs rather than the physical similarity between stimuli.

Spontaneous recovery. When a conditioned response is no longer elicited by a conditioned stimulus, extinction is said to have taken place. Following a delay after extinction, the conditioned stimulus again elicits conditioned responses, although there were no further pairings between the conditioned stimulus and the unconditioned stimulus. The reappearance of the conditioned response after extinction has taken place is called spontaneous recovery.

Systematic desensitization. A therapeutic technique developed by Wolpe whereby a phobia is extinguished by having a client approach the feared experience one small step at a time while relaxing after each step.

Unconditioned response (UCR). The natural and automatic response that is elicited when an unconditioned stimulus is presented to an organism. Withdrawing when stuck by a pin, salivating when food or acid is placed in the mouth, and the constriction of the pupil of the eye when light is shone into it, are all examples of unconditioned responses.

Unconditioned stimulus (UCS). A stimulus that causes a natural and automatic response from the organism. An object that causes pain to a certain part of the body will cause the organism to automatically withdraw from the source of pain. Pain, therefore, is an unconditioned stimulus. Shining a light into the pupil of the eye will cause the pupil to automatically constrict; the light, therefore, is an unconditioned stimulus.

Watson, J. B. The founder of the school of behaviorism. Watson relied heavily on Pavlov's theory of learning in his explanation of human behavior. Watson believed that, except for a few basic emotions, human behavior was learned. Therefore, he believed that by controlling the learning process it is possible to control human personality. For this reason, Watson was considered an extreme environmental determinist.