Ever since, psychologists have been struggling to come up with a more nuanced view of learning. As we saw from Pinker’s selection in Chapter 6, Chomsky’s view has only become more plausible over time. Capacities such as the human gift for acquiring language do indeed seem to require much more than simple conditioning. And, in fact, there may be no such thing as a single general mechanism for learning; different kinds of learning may each depend on different mental mechanisms. In place of a one-size-fits-all view in which simple conditioning is the motor of learning, psychologists and animal ethologists are working toward a new view, presented in the selection from Marc Hauser’s *Wild Minds* (2000), in which each species has its own unique set of tools for learning.

**Conditioned Emotional Reactions**

*John B. Watson and Rosalie Rayner*

In recent literature various speculations have been entered into concerning the possibility of conditioning various types of emotional response, but direct experimental evidence in support of such a view has been lacking. If the theory advanced by Watson and Morgan to the effect that in infancy the original emotional reaction patterns are few, consisting so far as observed of fear, rage and love, then there must be some simple method by means of which the range of stimuli which can call out these emotions and their compounds is greatly increased. Otherwise, complexity in adult response could not be accounted for. These authors without adequate experimental evidence advanced the view that this range was increased by means of conditioned reflex factors. It was suggested there that the early home life of the child furnishes a laboratory situation for establishing conditioned emotional responses. The present authors have recently put the whole matter to an experimental test.

Experimental work had been done so far on only one child, Albert B. This infant was reared almost from birth in a hospital environment; his mother was a wet nurse in the Harriet Lane Home for Invalid Children. Albert’s life was normal: he was healthy from birth and one of the best developed youngsters ever brought to the hospital, weighing twenty-one pounds at nine months of age. He was on the whole stolid and unemotional. His stability was one of the principal reasons for using him as a subject in this test. We felt that we could do him relatively little harm by carrying out such experiments as those outlined below.

At approximately nine months of age we ran him through the emotional tests that have become a part of our regular routine in determining whether fear reactions can be called out by other stimuli than sharp noises and the sudden removal of support. Tests of this type have been described by the senior author in another place. In brief, the infant was confronted...
suddenly and for the first time successively with a white rat, a rabbit, a dog, a monkey, with masks with and without hair, cotton wool, burning newspapers, etc. A permanent record of Albert’s reactions to these objects and situations has been preserved in a motion picture study. Manipulation was the most usual reaction called out. *At no time did this infant ever show fear in any situation.* These experimental records were confirmed by the casual observations of the mother and hospital attendants. No one had ever seen him in a state of fear and rage. The infant practically never cried.

Up to approximately nine months of age we had not tested him with loud sounds. The test to determine whether a fear reaction could be called out by a loud sound was made when he was eight months, twenty-six days of age. The sound was that made by striking a hammer upon a suspended steel bar four feet in length and three-fourths of an inch in diameter. The laboratory notes are as follows:

One of the two experimenters caused the child to turn its head and fixate her moving hand; the other stationed back of the child, struck the steel bar a sharp blow. The child started violently, his breathing was checked and the arms were raised in a characteristic manner. On the second stimulation the same thing occurred, and in addition the lips began to pucker and tremble. On the third stimulation the child broke into a sudden crying fit. This is the first time an emotional situation in the laboratory has produced any fear or even crying in Albert.

We had expected just these results on account of our work with other infants brought up under similar conditions. It is worth while to call attention to the fact that removal of support (dropping and jerking the blanket upon which the infant was lying) was tried exhaustively upon this infant on the same occasion. It was not effective in producing the fear response. This stimulus is effective in younger children. At what age such stimuli lose their potency in producing fear is not known. Nor is it known whether less placid children ever lose their fear of them. This probably depends upon the training the child gets. It is well known that children eagerly run to be tossed into the air and caught. On the other hand it is equally well known that in the adult fear responses are called out quite clearly by the sudden removal of support, if the individual is walking across a bridge, walking out upon a beam, etc. There is a wide field of study here which is aside from our present point.

The sound stimulus, thus, at nine months of age, gives us the means of testing several important factors. I. Can we condition fear of an animal, e.g., a white rat, by visually presenting it and simultaneously striking a steel bar?
is thus seen that the two joint stimulations given the previous week were not without effect. He was tested with his blocks immediately afterwards to see if they shared in the process of conditioning. He began immediately to pick them up, dropping them, pounding them, etc. In the remainder of the tests the blocks were given frequently to quiet him and to test his general emotional state. They were always removed from sight when the process of conditioning was under way.

2. Joint stimulation with rat and sound. Started, then fell over immediately to right side. No crying.

3. Joint stimulation. Fell to right side and rested upon hands, with head turned away from rat. No crying.


5. Rat suddenly presented alone. Puckered face, whimpered and withdrew body sharply to the left.

6. Joint stimulation. Fell over immediately to right side and began to whimper.

7. Joint stimulation. Started violently and cried, but did not fall over.

8. Rat alone. The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over on left side, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before reaching the edge of the table.

This was as convincing a case of a completely conditioned fear response as could have been theoretically pictured. In all seven joint stimulations were given to bring about the complete reaction. It is not unlikely had the sound been of greater intensity or of a more complex clang character that the number of joint stimulations might have been materially reduced. Experiments designed to define the nature of the sounds that will serve best as emotional stimuli are under way.

II. When a conditioned emotional response has been established for one object, is there a transfer? Five days later Albert was again brought back into the laboratory and tested as follows:

11 Months 15 Days

1. Tested first with blocks. He reached readily for them, playing with them as usual. This shows that there has been no general transfer to the room, table, blocks, etc.

2. Rat alone. Whimpered immediately, withdrew right hand and turned head and trunk away.

3. Blocks again offered. Played readily with them, smiling and gurgling.

4. Rat alone. Leaned over to the left side as far away from the rat as possible, then fell over, getting up on all fours and scurrying away as rapidly as possible.

5. Blocks again offered. Reached immediately for them, smiling and laughing as before.

The above preliminary test shows that the conditioned response to the rat had carried over completely for the five days in which no tests were given. The question as to whether or not there is a transfer was next taken up.

6. Rabbit alone. The rabbit was suddenly placed on the mattress in front of him. The reaction was pronounced. Negative responses began at once. He leaned as far away from the animal as possible, whimpered, then burst into tears. When the rabbit was placed in contact with him he buried his face in the mattress, then got up on all fours and crawled away, crying as he went. This was a most convincing test.

7. The blocks were next given him, after an interval. He played with them as before. It was observed by four people that he played far more energetically with them than ever before. The blocks were raised high over his head and slammed down with a great deal of force.

8. Dog alone. The dog did not produce as violent a reaction as the rabbit. The moment fixation occurred the child shrank back and as the animal came nearer he attempted to get on all fours but did not cry at first. As soon as the dog passed out of his range of vision he became quiet. The dog was then made to approach the infant's head (he was lying down at the moment). Albert straightened up immediately, fell over to the opposite side and turned his head away. He then began to cry.

9. The blocks were again presented. He began immediately to play with them.

10. Fur coat (seal). Withdrew immediately to the left side and began to fret. Coat put close to him on the left side, he turned immediately, began to cry and tried to crawl away on all fours.

11. Cotton wool. The wool was presented in a paper package. At the end the cotton was not covered by the paper. It was placed first on his feet. He kicked it away but did not touch it with his hands. When his
hand was laid on the wool he immediately withdrew it but did not show the shock that the animals or fur coat produced in him. He then began to play with the paper, avoiding contact with the wool itself. He finally, under the impulse of the manipulative instinct, lost some of his negativism to the wool.

12. Just in play W. put his head down to see if Albert would play with his hair. Albert was completely negative. Two other observers did the same thing. He began immediately to play with their hair. W. then brought the Santa Claus mask and presented it to Albert. He was again pronouncedly negative.

11 Months 20 Days

1. Blocks alone. Played with them as usual.
2. Rat alone. Withdrawal of the whole body, bending over to left side, no crying. Fixation and following with eyes. The response was much less marked than on first presentation the previous week. It was thought best to freshen up the reaction by another joint stimulation.
3. Just as the rat was placed on his hand the rod was struck. Reaction violent.
4. Rat alone. Fell over at once to left side. Reaction practically as strong as on former occasion but no crying.
5. Rat alone. Fell over to left side, got up on all fours and started to crawl away. On this occasion there was no crying, but strange to say, as he started away he began to gurgle and coo, even while leaning far over to the left side to avoid the rat.
6. Rabbit alone. Leaned over to left side as far as possible. Did not fall over. Began to whimper but reaction not so violent as on former occasions.
7. Blocks again offered. He reached for them immediately and began to play.

All of these tests so far discussed were carried out upon a table supplied with a mattress, located in a small, well-lighted dark-room. We wished to test next whether conditioned fear responses so set up would appear if the situation were markedly altered. We thought it best before making this test to freshen the reaction both to the rabbit and to the dog by showing them at the moment the steel bar was struck. It will be recalled that this was the first time any effort had been made to directly condition response to the dog and rabbit. The experimental notes are as follows:

8. The rabbit at first was given alone. The reaction was exactly as given in test (6) above. When the rabbit was left on Albert's knees for a long time he began tentatively to reach out and manipulate its fur with forefingers. While doing this the steel rod was struck. A violent fear reaction resulted.
9. Rabbit alone. Reaction wholly similar to that on trial (6) above.
10. Rabbit alone. Started immediately to whimper, holding hands far up, but did not cry. Conflicting tendency to manipulate very evident.
11. Dog alone. Began to whimper, shaking head from side to side, holding hands as far away from the animal as possible.
12. Dog and sound. The rod was struck just as the animal touched him. A violent negative reaction appeared. He began to whimper, turned to one side, fell over and started to get up on all fours.

On this same day and immediately after the above experiment Albert was taken into the large well-lighted lecture room belonging to the laboratory. He was placed on a table in the center of the room immediately under the skylight. Four people were present. The situation was thus very different from that which obtained in the small dark room.

1. Rat alone. No sudden fear reaction appeared at first. The hands, however, were held up and away from the animal. No positive manipulatory reactions appeared.
2. Rabbit alone. Fear reaction slight. Turned to left and kept face away from the animal but the reaction was never pronounced.
3. Dog alone. Turned away but did not fall over. Cried. Hands moved as far away from the animal as possible. whimpered as long as the dog was present.
4. Rat alone. Slight negative reaction.
5. Rat and sound. It was thought best to freshen the reaction to the rat. The sound was given just as the rat was presented. Albert jumped violently but did not cry.
6. Rat alone. At first he did not show any negative reaction. When rat was placed nearer he began to show negative reaction by drawing back his body, raising his hands, whimpering, etc.
7. Blocks. Played with them immediately.
8. Rat alone. Pronounced withdrawal of body and whimpering.
9. Blocks. Played with them as before.
10. Rabbit alone. Pronounced reaction. Whimpered with arms held high, fell over backward and had to be caught.
11. Dog alone. At first the dog did not produce the pronounced reaction. The hands were held high over the head, breathing was checked, but there was no crying. Just at this moment the dog, which had not barked before, barked three times loudly when only about six inches from the baby's face. Albert immediately fell over and broke into a wail that continued until the dog was removed. The sudden barking of the hitherto quiet dog produced a marked fear response in the adult observers!

From the above results it would seem that emotional transfers do take place. Furthermore it would seem that the number of transfers resulting from an experimentally produced conditioned emotional reaction may be very large. In our observations we had no means of testing the complete number of transfers which may have resulted.

III. The effect of time upon conditioned emotional responses. We have already shown that the conditioned emotional response will continue for a period of one week. It was desired to make the time test longer. In view of the imminence of Albert's departure from the hospital we could not make the interval longer than one month. Accordingly no further emotional experimentation was entered into for thirty-one days after the above test. During the month, however, Albert was brought weekly to the laboratory for tests upon right and left-handedness, imitation, general development, etc. No emotional tests whatever were given and during the whole month his regular nursery routine was maintained in the Harriet Lane Home. The notes on the test given at the end of this period are as follows:

1 Year 21 Days

1. Santa Claus mask. Withdrawal, gurgling, then slapped at it without touching. When his hand was forced to touch it, he whimpered and cried. His hand was forced to touch it two more times. He whimpered and cried on both tests. He finally cried at the mere visual stimulus of the mask.
2. Fur coat. Wrinkled his nose and withdrew both hands, drew back his whole body and began to whimper as the coat was put nearer. Again there was the strife between withdrawal and the tendency to manipulate. Reached tentatively with left hand but drew back before contact had been made. In moving his body to one side his hand accidentally touched the coat. He began to cry at once, nodding his head in a very peculiar manner (this reaction was an entirely new one). Both hands were withdrawn as far as possible from the coat. The coat was then laid on his lap and he continued nodding his head and whimpering, withdrawing his body as far as possible, pushing the while at the coat with his feet but never touching it with his hands.
3. Fur coat. The coat was taken out of his sight and presented again at the end of a minute. He began immediately to fret, withdrawing his body and nodding his head as before.
4. Blocks. He began to play with them as usual.
5. The rat. He allowed the rat to crawl towards him without withdrawing. He sat very still and fixated it intently. Rat then touched his hand. Albert withdrew it immediately, then leaned back as far as possible but did not cry. When the rat was placed on his arm he withdrew his body and began to fret, nodding his head. The rat was then allowed to crawl against his chest. He first began to fret and then covered his eyes with both hands.
7. The rabbit. The animal was placed directly in front of him. It was very quiet. Albert showed no avoiding reactions at first. After a few seconds he puckered up his face, began to nod his head and to look intently at the experimenter. He next began to push the rabbit away with his feet, withdrawing his body at the same time. Then as the rabbit came nearer he began pulling his feet away, nodding his head, and wailing "da da". After about a minute he reached out tentatively and slowly touched the rabbit's ear with his right hand, finally manipulating it. The rabbit was again placed in his lap. Again he began to fret and withdrew his hands. He reached out tentatively with his left hand and touched the animal, shuddered and withdrew the whole body. The experimenter then took hold of his left hand and laid it on the rabbit's back. Albert immediately
withdrew his hand and began to suck his thumb. Again the rabbit was laid in his lap. He began to cry, covering his face with both hands.

8. Dog. The dog was very active. Albert fixated it intensely for a few seconds, sitting very still. He began to cry but did not fall over backwards as on his last contact with the dog. When the dog was pushed closer to him he at first sat motionless, then began to cry, putting both hands over his face.

These experiments would seem to show conclusively that directly conditioned emotional responses as well as those conditioned by transfer persist, although with a certain loss in the intensity of the reaction, for a longer period than one month. Our view is that they persist and modify personality throughout life. It should be recalled again that Albert was of an extremely phlegmatic type. Had he been emotionally unstable probably both the directly conditioned response and those transferred would have persisted throughout the month unchanged in form.

IV. "Detachment" or removal of conditioned emotional responses. Unfortunately Albert was taken from the hospital the day the above tests were made. Hence the opportunity of building up an experimental technique by means of which we could remove the conditioned emotional responses was denied us. Our own view, expressed above, which is possibly not very well grounded, is that these responses in the home environment are likely to persist indefinitely, unless an accidental method for removing them is hit upon. The importance of establishing some method must be apparent to all. Had the opportunity been at hand we should have tried out several methods, some of which we may mention. (1) Constantly confronting the child with those stimuli which called out the responses in the hopes that habituation would come in corresponding to "fatigue" of reflex when differential reactions are to be set up. (2) By trying to "recondition" by showing objects calling out fear responses (visual) and simultaneously stimulating the erogenous zones (tactual). We should try first the lips, then the nipples and as a final resort the sex organs. (3) By trying to "recondition" by feeding the subject candy or other food just as the animal is shown. This method calls for the food control of the subject. (4) By building up "constructive" activities around the object by imitation and by putting the hand through the motions of manipulation. At this age imitation of overt motor activity is strong, as our present but unpublished experimentation has shown.

Incidental Observations

(a) Thumb sucking as a compensatory device for blocking fear and noxious stimuli. During the course of these experiments, especially in the final test, it was noticed that whenever Albert was on the verge of tears or emotionally upset generally he would continually thrust his thumb into his mouth. The moment the hand reached the mouth he became impervious to the stimuli producing fear. Again and again while the motion pictures were being made at the end of the thirty-day period, we had to remove the thumb from his mouth before the conditioned response could be obtained. This method of blocking noxious and emotional stimuli (fear and rage) through erogenous stimulation seems to persist from birth onward. Very often in our experiments upon the work adders with infants under ten days of age the same reaction appeared. When at work upon the adders both of the infants arms are under slight restraint. Often rage appears. They begin to cry, thrashing their arms and legs about. If the finger gets into the mouth crying ceases at once. The organism thus apparently from birth, when under the influence of love stimuli is blocked to all others. This resort to sex stimulation when under the influence of noxious and emotional situations, or when the individual is restless and idle, persists throughout adolescent and adult life. Albert, at any rate, did not resort to thumb sucking except in the presence of such stimuli. Thumb sucking could immediately be checked by offering him his blocks. These invariably called out active manipulation instincts. It is worth while here to call attention to the fact that Freud's conception of the stimulation of erogenous zones as being the expression of an original "pleasure" seeking principle may be turned about and possibly better described as a compensatory (and often conditioned) device for the blockage of noxious and fear and rage producing stimuli.

(b) Equal primacy of fear, love and possibly rage. While in general the results of our experiment offer no particular points of conflict with Freudian concepts, one fact out of harmony with them should be emphasized. According to proper Freudians sex (or in our terminology, love) is the principal emotion in which conditioned responses arise which later limit and distort personality. We wish to take sharp issue with this view on the basis of the experimental evidence we have gathered. Fear is as primal a factor as love in influencing personality. Fear does not gather its potency in any derived manner from love. It belongs to the original and inherited nature of
man. Probably the same may be true of rage although at present we are not so sure of this.

The Freudians twenty years from now, unless their hypotheses change, when they come to analyze Albert’s fear of a seal skin coat—assuming that he comes to analysis at that age—will probably tease from him the recital of a dream which upon their analysis will show that Albert at three years of age attempted to play with the pubic hair of the mother and was scolded violently for it. (We are by no means denying that this might in some other case condition it.) If the analyst has sufficiently prepared Albert to accept such a dream when found as an explanation of his avoiding tendencies, and if the analyst has the authority and personality to put it over, Albert may be fully convinced that the dream was a true revealer of the factors which brought about the fear.

It is probable that many of the phobias in psychopathology are true conditioned emotional reactions either of the direct or the transferred type. One may possibly have to believe that such persistence of early conditioned responses will be found only in persons who are constitutionally inferior. Our argument is meant to be constructive. Emotional disturbances in adults cannot be traced back to sex alone. They must be retraced along at least three collateral lines—to conditioned and transferred responses set up in infancy and early youth in all three of the fundamental human emotions.

A Review of B. F. Skinner’s Verbal Behavior

Noam Chomsky

I

A great many linguists and philosophers concerned with language have expressed the hope that their studies might ultimately be embedded in a framework provided by behaviorist psychology, and that refractory areas of investigation, particularly those in which meaning is involved, will in this way be opened up to fruitful exploration. Since this volume is the first large-scale attempt to incorporate the major aspects of linguistic behavior within a behaviorist framework, it merits and will undoubtedly receive careful attention. Skinner is noted for his contributions to the study of animal behavior. The book under review is the product of study of linguistic behavior extending over more than twenty years. Earlier versions of it have been fairly widely circulated, and there are quite a few references in the psychological literature to its major ideas.

The problem to which this book is addressed is that of giving a “functional analysis” of verbal behavior. By functional analysis, Skinner means identification of the variables that control this behavior and specification of how they interact to determine a particular verbal response. Furthermore, the controlling variables are to be described completely in terms of such notions as stimulus, reinforcement, deprivation, which have been given a reasonably clear meaning in animal experimentation. In other words, the goal of the book is to provide a way to predict and control verbal behavior by observing and manipulating the physical environment of the speaker.

Skinner feels that recent advances in the laboratory study of animal behavior permit us to approach this problem with a certain optimism, since “the basic processes and relations which give verbal behavior its special characteristics are now fairly well understood … the results [of this experimental
Classical Conditioning

17-2: What is classical conditioning, and how did Pavlov’s work influence behaviorism?

Although associative learning had long generated philosophical discussion, only in the early twentieth century did psychology’s most famous researcher verify it. For many people, the name Ivan Pavlov (1849–1936) rings a bell. His early twentieth-century experiments—now psychology’s most famous research—are classics, and the phenomenon he explored we justly call classical conditioning.

Pavlov’s work also laid the foundation for many of psychologist John B. Watson’s ideas, which influenced North American psychology during the first half of the twentieth century, in a movement called behaviorism. In searching for laws underlying learning, Watson (1913) urged his colleagues to discard reference to inner thoughts, feelings, and motives. The science of psychology should instead study how organisms respond to stimuli in their environments, said Watson: “Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods.” Simply said, psychology should be an objective science based on observable behavior.

Watson and Pavlov shared both a disdain for “mentalistic” concepts (such as consciousness) and a belief that the basic laws of learning were the same for all animals, whether dogs or humans. Few researchers today propose that psychology should ignore mental processes, but most now agree that classical conditioning is a basic form of learning by which all organisms adapt to their environment.

Pavlov’s Experiments

17-3: How does a neutral stimulus become a conditioned stimulus?

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

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

Pavlov and his assistants tried to imagine what the dog was thinking and feeling as it drooled in anticipation of the food. This only led them into fruitless debates. So, to explore the phenomenon more objectively, they experimented. To eliminate other possible influences, they isolated the dog in a small room, secured it in a harness, and attached a device to divert its saliva to a measuring instrument. From the next room, they presented food—first by sliding in a food bowl, later by blowing meat powder into the dog’s mouth at a precise moment. They then paired various neutral stimuli (NS)—events the dog could see or hear but didn’t associate with food—with food in the dog’s mouth. If a sight or sound regularly signaled the arrival of food, would the dog learn the link? If so, would it begin salivating in anticipation of the food?

The answers proved to be yes and yes. Just before placing food in the dog’s mouth to produce salivation, Pavlov sounded a tone. After several pairings of tone and food, the dog, anticipating the meat powder, began salivating to the tone alone.
In later experiments, a buzzer, a light, a touch on the leg, even the sight of a circle set off the drooling.1 (This procedure works with people, too. When hungry young Londoners viewed abstract figures before smelling peanut butter or vanilla, their brain soon responded in anticipation to the abstract images alone [Gottfried et al., 2003]).

Because salivation in response to food in the mouth was unlearned, Pavlov called it an unconditioned response (UR). Food in the mouth automatically, unconditionally, triggers a dog’s salivary reflex (FIGURE 17.1). Thus, Pavlov called the food stimulus an unconditioned stimulus (US).

Salivation in response to the tone was conditional upon the dog’s learning the association between the tone and the food. Today we call this learned response the conditioned response (CR). The previously neutral (in this context) tone stimulus that now triggered the conditional salivation we call the conditioned stimulus (CS).

Distinguishing these two kinds of stimuli and responses is easy: Conditioned = learned; unconditioned = unlearned.

Let’s check your understanding with a second example. An experimenter sounds a tone just before delivering an air puff to your blinking eye. After several repetitions, you blink to the tone alone. What is the NS? The US? The UR? The CS? The CR?2

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

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1The “buzzer” (English translation) was perhaps Pavlov’s supposed bell—a small electric bell (Tully, 2003).
2NS = tone before procedure; US = air puff; UR = blink to air puff; CS = tone after procedure; CR = blink to tone.
Acquisition

17-4: In classical conditioning, what are the processes of acquisition, extinction, spontaneous recovery, generalization, and discrimination?

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

What do you suppose would happen if the food (US) appeared before the tone (NS) rather than after? Would conditioning occur?

Not likely. With but a few exceptions, conditioning doesn’t happen when the NS follows the US. Remember, classical conditioning is biologically adaptive because it helps humans and other animals prepare for good or bad events. To Pavlov’s dogs, the originally neutral tone (NS) becomes a (CS) after signaling an important biological event—the arrival of food (US). To deer in the forest, the snapping of a twig (CS) may signal a predator’s approach (US). If the good or bad event had already occurred, the stimulus would not likely signal anything significant.

Michael Domjan (1992, 1994, 2005) showed how a CS can signal another important biological event, by conditioning the sexual arousal of male Japanese quail. Just before presenting an approachable female, the researchers turned on a red light. Over time, as the red light continued to herald the female’s arrival, the light caused the male quail to become excited. They developed a preference for their cage’s red-light district, and when a female appeared, they mated with her more quickly and released more semen and sperm (Matthews et al., 2007). All in all, the quail’s capacity for classical conditioning gives it a reproductive edge. Again we see the larger lesson: Conditioning helps an animal survive and reproduce—by responding to cues that help it gain food, avoid dangers, locate mates, and produce offspring (Hollis, 1997).

In humans, too, objects, smells, and sights associated with sexual pleasure—even a geometric figure in one experiment—can become conditioned stimuli for sexual arousal (Byrne, 1982). Psychologist Michael Tirrell (1990) recalled: “My first girl-friend loved onions, so I came to associate onion breath with kissing. Before long, onion breath sent tingles up and down my spine. Oh what a feeling!” (FIGURE 17.2).

Through higher-order conditioning, a new neutral stimulus can become a new conditioned stimulus. All that’s required is for it to become associated with a previously conditioned stimulus. If a tone regularly signals food and produces salivation, then a light that becomes associated with the tone may also begin to trigger salivation. Although this higher-order conditioning (also called second-order conditioning) tends to be weaker than first-stage conditioning, it influences our everyday lives.

Check yourself: If the aroma of cake baking sets your mouth to watering, what is the US? The CS? The CR? See inverted answer below.

Remember:
US = Unconditioned Stimulus
UR = Unconditioned Response
CS = Conditioned Stimulus
CR = Conditioned Response

unconditioned response (UR) in classical conditioning, the unlearned, naturally occurring response to the unconditioned stimulus (US), such as salivation when food is in the mouth.
unconditioned stimulus (US) in classical conditioning, a stimulus that unconditionally—naturally and automatically—triggers a response.
conditioned response (CR) in classical conditioning, the learned response to a previously neutral (but now conditioned) stimulus (CS).
conditioned stimulus (CS) in classical conditioning, a previously neutral stimulus that, after association with an unconditioned stimulus (US), comes to trigger a conditioned response.
acquisition in classical conditioning, the initial stage, when one links a neutral stimulus and an unconditioned stimulus so that the neutral stimulus begins triggering the conditioned response.
higher-order conditioning a procedure in which the conditioned stimulus in one conditioning experience is paired with a new neutral stimulus, creating a second (often weaker) conditioned stimulus. For example, an animal that has learned that a tone predicts food might then learn that a light predicts the tone and begin responding to the light alone. (Also called second-order conditioning.)

FIGURE 17.2 An unexpected CS Onion breath does not usually produce sexual arousal. But when repeatedly paired with a passionate kiss, it can become a CS and do just that.
extinction the diminishing of a conditioned response; occurs in classical conditioning when an unconditioned stimulus (US) does not follow a conditioned stimulus (CS).

spontaneous recovery the reappearance, after a pause, of an extinguished conditioned response.

generalization the tendency, once a response has been conditioned, for stimuli similar to the conditioned stimulus to elicit similar responses.

Imagine that something makes us very afraid (perhaps a guard dog associated with a previous dog bite). If something else, such as the sound of a barking dog, brings to mind that guard dog, the bark alone may make us feel a little afraid.

Extinction and Spontaneous Recovery

After conditioning, what happens if the CS occurs repeatedly without the US? Will the CS continue to elicit the CR? Pavlov discovered that when he sounded the tone again and again without presenting food, the dogs salivated less and less. Their declining salivation illustrates extinction, the diminished responding that occurs when the CS (tone) no longer signals an impending US (food).

Pavlov found, however, that if he allowed several hours to elapse before sounding the tone again, the salivation to the tone would reappear spontaneously (FIGURE 17.3). This spontaneous recovery—the reappearance of a (weakened) CR after a pause—suggested to Pavlov that extinction was suppressing the CR rather than eliminating it.

After breaking up with his fire-breathing heartthrob, Tirrell also experienced extinction and spontaneous recovery. He recalls that “the smell of onion breath (CS), no longer paired with the kissing (US), lost its ability to shiver my timbers. Occasionally, though, after not sensing the aroma for a long while, smelling onion breath awakens a small version of the emotional response I once felt.”

Generalization

Pavlov and his students noticed that a dog conditioned to the sound of one tone also responded somewhat to the sound of a different tone that had never been paired with food. Likewise, a dog conditioned to salivate when rubbed would also drool a bit when scratched (Windholz, 1989) or when touched on a different body part. This tendency to respond to stimuli similar to the CS is called generalization.

Generalization can be adaptive, as when toddlers taught to fear moving cars also become afraid of moving trucks and motorcycles. So automatic is generalization that one Argentine writer who underwent torture still recoils with fear when he sees black shoes—his first glimpse of his torturers as they approached his cell. Generalization of anxiety reactions has been demonstrated in laboratory studies comparing abused with nonabused children (FIGURE 17.4). Shown an angry face on a computer screen, abused children’s brain-wave responses are dramatically stronger and longer lasting (Pollak et al., 1998).

Because of generalization, stimuli similar to naturally disgusting or appealing objects will, by association, evoke some disgust or liking. Normally desirable foods,
such as fudge, are unappealing when shaped to resemble dog feces (Rozin et al., 1986). Adults with childlike facial features (round face, large forehead, small chin, large eyes) are perceived as having childlike warmth, submissiveness, and naiveté (Berry & McArthur, 1986). In both cases, people’s emotional reactions to one stimulus generalize to similar stimuli.

### Discrimination

Pavlov’s dogs also learned to respond to the sound of a particular tone and not to other tones. Discrimination is the learned ability to distinguish between a conditioned stimulus (which predicts the US) and other irrelevant stimuli. Being able to recognize differences is adaptive. Slightly different stimuli can be followed by vastly different consequences. Confronted by a guard dog, your heart may race; confronted by a guide dog, it probably will not.

### Extending Pavlov’s Understanding

**17-5: Do cognitive processes and biological constraints affect classical conditioning?**

In their dismissal of “mentalistic” concepts such as consciousness, Pavlov and Watson underestimated the importance of cognitive processes (thoughts, perceptions, expectations) and biological constraints on an organism’s learning capacity.

#### Cognitive Processes

The early behaviorists believed that rats’ and dogs’ learned behaviors could be reduced to mindless mechanisms, so there was no need to consider cognition. But Robert Rescorla and Allan Wagner (1972) explained why an animal can learn the predictability of an event. If a shock always is preceded by a tone, and then may also be preceded by a light that accompanies the tone, a rat will react with fear to the tone but not to the light. The tone is a better predictor, and the more predictable the association, the stronger the conditioned response. It’s as if the animal learns an expectancy, an awareness of how likely it is that the US will occur.

Such experiments help explain why classical conditioning treatments that ignore cognition often have limited success. For example, people receiving therapy for alcohol dependency may be given alcohol spiked with a nauseating drug. Will they then associate alcohol with sickness? If classical conditioning were merely a matter of “stamping in” stimulus associations, we might hope so, and to some extent this does occur. However, the awareness that the nausea is induced by the drug, not the alcohol, often weakens the association between drinking alcohol and feeling sick.

So, even in classical conditioning, it is (especially with humans) not simply the CS–US association but also the thought that counts.

#### Biological Predispositions

Ever since Charles Darwin, scientists have assumed that all animals share a common evolutionary history and thus commonalities in their makeup and functioning. Pavlov and Watson, for example, believed that the basic laws of learning were essentially similar in all animals. So it should make little difference whether one studied pigeons or people. Moreover, it seemed that any natural response could be conditioned to any neutral stimulus. As learning researcher Gregory Kimble proclaimed

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“All brains are, in essence, anticipation machines.”

—Daniel C. Dennett, *Consciousness Explained*, 1991

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**FIGURE 17.4 Child abuse leaves tracks in the brain** Seth Pollak (University of Wisconsin–Madison) reports that abused children’s sensitized brains react more strongly to angry faces. This generalized anxiety response may help explain why childhood abuse puts children at greater risk of psychological disorder.
“Once bitten, twice shy.”
—G. F. Northall, *Folk-Phrases*, 1894

“All animals are on a voyage through time, navigating toward futures that promote their survival and away from futures that threaten it. Pleasure and pain are the stars by which they steer.”

in 1956, “Just about any activity of which the organism is capable can be conditioned and . . . these responses can be conditioned to any stimulus that the organism can perceive” (p. 195).

Twenty-five years later, Kimble (1981) humbly acknowledged that “half a thousand” scientific reports had proven him wrong. More than the early behaviorists realized, an animal’s capacity for conditioning is constrained by its biology. Each species’ predispositions prepare it to learn the associations that enhance its survival. Environments are not the whole story.

John Garcia was among those who challenged the prevailing idea that all associations can be learned equally well. While researching the effects of radiation on laboratory animals, Garcia and Robert Koelling (1966) noticed that rats began to avoid drinking water from the plastic bottles in radiation chambers. Could classical conditioning be the culprit? Might the rats have linked the plastic-tasting water (a CS) to the sickness (UR) triggered by the radiation (US)?

To test their hunch, Garcia and Koelling gave the rats a particular taste, sight, or sound and later also gave them radiation or drugs (US) that led to nausea and vomiting (UR). Two startling findings emerged: First, even if sickened as late as several hours after tasting a particular novel flavor, the rats thereafter avoided that flavor. This appeared to violate the notion that for conditioning to occur, the US must immediately follow the CS.

Second, the sickened rats developed aversions to tastes but not to sights or sounds. This contradicted the behaviorists’ idea that any perceivable stimulus could serve as a CS. But it made adaptive sense, because for rats the easiest way to identify tainted food is to taste it. (If sickened after sampling a new food, they thereafter avoid the food—which makes it difficult to eradicate a population of “bait-shy” rats by poisoning.)

Humans, too, seem biologically prepared to learn some associations rather than others. If you become violently ill four hours after eating contaminated mussels, you will probably develop an aversion to the taste of mussels but not to the sight of the associated restaurant, its plates, the people you were with, or the music you heard there. In contrast, birds, which hunt by sight, appear biologically primed to develop aversions to the sight of tainted food (Nicolaus et al., 1983). Organisms are predisposed to learn associations that help them adapt.

Garcia and Koelling’s taste-aversion research is but one instance in which psychological experiments that began with the discomfort of some laboratory animals ended by enhancing the welfare of many others. In one well-known conditioned taste-aversion study, coyotes and wolves that were tempted into eating sheep carcasses laced with a sickening poison developed an aversion to sheep meat (Gustavson et al., 1974, 1976). Two wolves later penned with a live sheep seemed actually to fear it.

The study not only saved the sheep from their predators, but also saved the sheep-shunning coyotes and wolves from angry ranchers and farmers who had wanted to destroy them. Later applications of Garcia and Koelling’s findings have prevented baboons from raiding African gardens, raccoons from attacking chickens, and ravens and crows from feeding on crane eggs—all while preserving predators who occupy an important ecological niche (Garcia & Gustavson, 1997).

All these cases support Darwin’s principle that natural selection favors traits that aid survival. Our ancestors who readily learned taste aversions were unlikely to eat the same toxic food again and were more likely to survive and leave descendants. Nausea, like anxiety, pain, and other bad feelings, serves a good purpose. Like a low-oil warning on a car dashboard, each alerts the body to a threat (Neese, 1991).
The discovery of biological constraints affirms the value of the biopsychosocial approach, which considers different perspectives, including biological and cognitive influences (FIGURE 17.5), in seeking to understand phenomena such as learning. Responding to stimuli that announce significant events, such as food or pain, is adaptive. So is a genetic predisposition to associate a CS with a US that follows predictably and immediately: Causes often immediately precede effects. So once again, we see an important principle at work: Learning enables organisms to adapt to their environment.

This may help explain why we humans seem to be naturally disposed to learn associations between the color red and women’s sexuality, note Andrew Elliot and Daniela Niesta (2008). Female primates display red when nearing ovulation. In human females, enhanced bloodflow produces the red blush of flirtation and sexual excitation. Does the frequent pairing of red and sex—with Valentine’s hearts, red-light districts, and red lipstick—naturally enhance men’s attraction to women? Elliot and Niesta’s experiments consistently suggest that, without men’s awareness, it does (FIGURE 17.6).

**Pavlov’s Legacy**

17-6: Why is Pavlov’s work important?

What remains of Pavlov’s ideas? A great deal. Most psychologists agree that classical conditioning is a basic form of learning. Judged by today’s knowledge of cognitive processes and biological predispositions, Pavlov’s ideas were incomplete. But if we see further than Pavlov did, it is because we stand on his shoulders.

Why does Pavlov’s work remain so important? If he had merely taught us that old dogs can learn new tricks, his experiments would long ago have been forgotten. Why should we care that dogs can be conditioned to salivate at the sound of a tone? The importance lies first in this finding: Many other responses to many other stimuli can be classically conditioned in many other organisms—in fact, in every species tested, from earthworms to fish to dogs to monkeys to people (Schwartz, 1984). Thus, classical conditioning is one way that virtually all organisms learn to adapt to their environment.
“[Psychology’s] factual and theoretical developments in this century—which have changed the study of mind and behavior as radically as genetics changed the study of heredity—have all been the product of objective analysis—that is to say, behavioristic analysis.”

—Psychologist Donald Hebb (1980)

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

**Applications of Classical Conditioning**

17-7: What have been some applications of classical conditioning?

In countless areas of psychology, including consciousness, motivation, emotion, health, psychological disorders, and therapy, Pavlov’s principles of classical conditioning are now being used to improve human health and well-being. Two examples:

- Former drug users often feel a craving when they are again in the drug-using context—with people or in places they associate with previous highs. Thus, drug counselors advise addicts to steer clear of people and settings that may trigger these cravings (Siegel, 2005).

- Classical conditioning even works on the body’s disease-fighting immune system. When a particular taste accompanies a drug that influences immune responses, the taste by itself may come to produce an immune response (Ader & Cohen, 1985).

Pavlov’s work also provided a basis for John Watson’s (1913) idea that human emotions and behaviors, though biologically influenced, are mainly a bundle of conditioned responses. Working with an 11-month-old named Albert, Watson and Rosalie Rayner (1920; Harris, 1979) showed how specific fears might be conditioned. Like most infants, “Little Albert” feared loud noises but not white rats. Watson and Rayner presented a white rat and, as Little Albert reached to touch it, struck a hammer against a steel bar just behind his head. After seven repeats of seeing the rat and hearing the frightening noise, Albert burst into tears at the mere sight of the rat (an ethically troublesome study by today’s standards). What is more, five days later Albert showed generalization of his conditioned response by reacting with fear to a rabbit, a dog, and a sealskin coat, but not to dissimilar objects such as toys.

Although Little Albert’s fate is unknown, Watson’s is not. After losing his professorship at Johns Hopkins University over an affair with Rayner (whom he later married), he became the J. Walter Thompson advertising agency’s resident psychologist. There he used his knowledge of associative learning to conceive many successful campaigns, including one for Maxwell House that helped make the “coffee break” an American custom (Hunt, 1993).

Some psychologists, noting that Albert’s fear wasn’t learned quickly, had difficulty repeating Watson and Rayner’s findings with other children. Nevertheless, Little Albert’s case has had legendary significance for many psychologists. Some have wondered if each of us might not be a walking repository of conditioned emotions. Might extinction procedures or even new conditioning help us change our unwanted responses to emotion-arousing stimuli? One patient, who for 30 years had feared going into an elevator alone, did just that. Following his therapist’s advice, he forced himself to enter 20 elevators a day. Within 10 days, his fear had nearly vanished (Ellis & Becker, 1982). This dramatic turnaround is but one example of how psychologists use behavioral techniques to treat emotional disorders and promote personal growth.

In Watson and Rayner’s experiment, what was the US? The UR? The NS? The CS? The CR? See inverted answer below.

In Watson and Rayner’s experiment, what was the US? The CR? The NS? The CS? The UR? The CR? See inverted answer below.

John B. Watson

Watson (1924) admitted to “going beyond my facts” when offering his famous boast: “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 beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.”

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Classical Conditioning

Module Review

17-1: What distinguishes the basic forms of learning? Learning is a relatively permanent change in an organism’s behavior due to experience. In associative learning, we learn to associate two stimuli (as in classical conditioning) or a response and its consequences (as in operant conditioning). In observational learning, we learn by watching others’ experiences and examples.

17-2: What is classical conditioning, and how did Pavlov’s work influence behaviorism? Classical conditioning is a type of learning in which organisms come to associate one stimulus (such as lightning) with another stimulus (thunder). Pavlov’s work on classical conditioning laid the foundation for behaviorism, the view that psychology should be an objective science that studies behavior without reference to mental processes.

17-3: How does a neutral stimulus become a conditioned stimulus? In classical conditioning, a UR is an event that occurs naturally (such as salivation), in response to some stimulus. A US is something that naturally and automatically (without learning) triggers the unlearned response (as food in the mouth triggers salivation). An NS is a stimulus (such as a bell) that elicits no response before conditioning but, through learning, becomes a CS after being associated with some unlearned response (salivating). A CR is the learned response (salivating) to the originally irrelevant but now conditioned stimulus.

17-4: In classical conditioning, what are the processes of acquisition, extinction, spontaneous recovery, generalization, and discrimination? In classical conditioning, acquisition is associating an initial NS with the US. Acquisition transforms an NS into a CS most readily when the stimulus is presented just before (ideally, about a half-second before) a US, thus preparing the organism for the upcoming event. This finding supports the view that classical conditioning is biologically adaptive. In higher-order conditioning, the CS in one conditioning experience is paired with a new NS, creating a second (often weaker) CS. Extinction is diminished responding when the CS no longer signals an impending US. Spontaneous recovery is the reappearance of a formerly extinguished response, following a rest period. Generalization is the tendency to respond to stimuli that are similar to a CS. Discrimination is the learned ability to distinguish between a CS and other irrelevant stimuli.

17-5: Do cognitive processes and biological constraints affect classical conditioning? Despite early behaviorists’ views, research has shown that cognition and biological predispositions place some limits on conditioning. Organisms may learn when to expect a US and may be aware of the link between stimuli and responses. Because of biological predispositions, some associations are easier to learn than others. Learning is adaptive: Each species learns behaviors that aid its survival.

17-6: Why is Pavlov’s work important? Pavlov taught us that significant psychological phenomena can be studied objectively, and that classical conditioning is a basic form of learning that applies to all species.

17-7: What have been some applications of classical conditioning? Classical conditioning techniques have been used in drug-abuse treatment programs and in therapy for emotional disorders. The body’s immune system also appears to respond to classical conditioning.

Rehearse It!

1. Learning is defined as “a relatively permanent change in an organism’s behavior due to a. instinct.”
   b. mental processes.”
   c. experience.”
   d. formal education.”

2. Two forms of associative learning are classical conditioning, in which the organism associates ________, and operant conditioning, in which the organism associates ________.
   a. two responses; a response and a consequence
   b. two stimuli; two responses
   c. two stimuli; a response and a consequence
   d. two responses; two stimuli

3. In Pavlov’s experiments, dogs learned to salivate in response to a tone. The tone is therefore a(an)
   a. conditioned stimulus.
   b. unconditioned stimulus.
   c. neutral stimulus.
   d. unconditioned response.

4. Dogs can learn to respond (by salivating, for example) to one kind of stimulus (a circle, for example) and not to another (a square). This process is an example of a. generalization.
   b. discrimination.
   c. acquisition.
   d. spontaneous recovery.

5. Early behaviorists believed that for conditioning to occur, the unconditioned stimulus (US) must immediately follow the neutral stimulus (NS). ________ demonstrated this was not always so.
   a. The Little Albert experiment
   b. Pavlov’s experiments with dogs
   c. Watson’s behaviorism theory
   d. Garcia and Koelling’s taste-aversion studies

6. Taste-aversion research has shown that animals develop aversions to certain tastes but not to sights or sounds. This finding supports a. Pavlov’s demonstration of generalization.
   b. Darwin’s principle that natural selection favors traits that aid survival.
   c. Watson’s view that study should be limited to observable behavior.
   d. the early behaviorists’ view that organisms can be conditioned to any stimulus.

7. After Watson and Rayner classically conditioned a small child named Albert to fear a white rat, the child later showed fear in response to a rabbit, a dog, and a sealskin coat. Little Albert’s fear of objects resembling the rat illustrates a. extinction.
   b. generalization.
   c. spontaneous recovery.
   d. discrimination between two stimuli.

Answers: 1. a, b, c, d; 2. a; 3. b; 4. d; 5. d; 6. b; 7. a.
Terms and Concepts to Remember

associative learning, p. 239
classical conditioning, p. 239
behaviorism, p. 239
learning, p. 239
neutral stimulus (NS), p. 239
unconditioned response (UR), p. 240
unconditioned stimulus (US), p. 240
conditioned response (CR), p. 240
conditioned stimulus (CS), p. 240
acquisition, p. 241
higher-order conditioning, p. 241
extinction, p. 242
spontaneous recovery, p. 242
generalization, p. 242
discrimination, p. 243

Test For Success: Critical Thinking Exercise

1. “Sex sells!” is a common saying in advertising. Using classical conditioning terms, explain how sexual images in advertisements can condition your response to a product.

The Test for Success exercises offer you a chance to apply your critical thinking skills to aspects of the material you have just read. Suggestions for answering these questions can be found in Appendix D at the back of the book.
18-1: What is operant conditioning, and how does it differ from classical conditioning?

It’s one thing to classically condition a dog to salivate at the sound of a tone, or a child to fear moving cars. To teach an elephant to walk on its hind legs or a child to say *please*, we must turn to another type of learning—operant conditioning.

Classical conditioning and operant conditioning are both forms of *associative learning*, yet their difference is straightforward:

- **Classical conditioning** forms associations between stimuli (a CS and the US it signals). It also involves *respondent behavior*—actions that are automatic responses to a stimulus (such as salivating in response to meat powder and later in response to a tone).
- **In operant conditioning**, organisms associate their own actions with consequences. Actions followed by reinforcers increase; those followed by punishers decrease. Behavior that *operates* on the environment to *produce* rewarding or punishing stimuli is called *operant behavior*.

We can therefore distinguish classical from operant conditioning by asking: *Is the organism learning associations between events it does not control* (classical conditioning)? *Or is it learning associations between its behavior and resulting events* (operant conditioning)?

**Skinner’s Experiments**

B. F. Skinner (1904–1990) was a college English major and an aspiring writer who, seeking a new direction, entered graduate school in psychology. He went on to become modern behaviorism’s most influential and controversial figure. Skinner’s work elaborated what psychologist Edward L. Thorndike (1874–1949) called the *law of effect*: Rewarded behavior is likely to recur (*FIGURE 18.1*). Using Thorndike’s law of effect as a starting point, Skinner developed a *behavioral technology* that revealed principles of *behavior control*. These principles also enabled him to teach pigeons such unpigeonlike behaviors as walking in a figure 8, playing Ping-Pong, and keeping a missile on course by pecking at a screen target.
For his pioneering studies, Skinner designed an operant chamber, popularly known as a *Skinner box* (FIGURE 18.2). The box has a bar (a lever) that an animal presses—or a key (a disc) that an animal pecks—to release a reward of food or water, and a device that records these responses. Operant conditioning experiments have done far more than teach us how to pull habits out of a rat. They have explored the precise conditions that foster efficient and enduring learning.

**FIGURE 18.2 A Skinner box**

Inside the box, the rat presses a bar for a food reward. Outside, a measuring device (not shown here) records the animal’s accumulated responses.

**Shaping Behavior**

In his experiments, Skinner used shaping, a procedure in which *reinforcers*, such as food, gradually guide an animal’s actions toward a desired behavior. Imagine that you wanted to condition a hungry rat to press a bar. First, you would watch how the animal naturally behaves, so that you could build on its existing behaviors. You might give the rat a food reward each time it approaches the bar. Once the rat is approaching regularly, you would require it to move closer before rewarding it, then closer still. Finally, you would require it to touch the bar before you gave it the food.

With this method of *successive approximations*, you reward responses that are ever-closer to the final desired behavior, and you ignore all other responses. By making rewards contingent on desired behaviors, researchers and animal trainers gradually shape complex behaviors.

Shaping can also help us understand what nonverbal organisms perceive. Can a dog distinguish red and green? Can a baby hear the difference between lower- and higher-pitched tones? If we can shape them to respond to one stimulus and not to another, then we know they can perceive the difference. Such experiments have even shown that some animals can form concepts. If an experimenter reinforces a pigeon for pecking after seeing a human face, but not after seeing other images, the pigeon learns to recognize human faces (Herrnstein & Loveland, 1964). In this experiment, a face is a *discriminative stimulus*; like a green traffic light, it signals that a response will be reinforced. After being trained to discriminate among flowers, people, cars, and chairs, pigeons can usually identify the category in which a new pictured object belongs (Bhatt et al., 1988; Wasserman, 1993). They have even been trained to discriminate between Bach’s music and Stravinsky’s (Porter & Neuringer, 1984).

**A discriminating creature**

University of Windsor psychologist Dale Woodyard uses a food reward to train this manatee to discriminate between objects of different shapes, colors, and sizes. Manatees remember such responses for a year or more.

Shaping rats to save lives A Gambian giant pouched rat, having been shaped to sniff out land mines, receives a bite of banana after successfully locating a mine during training in Mozambique.
In everyday life, we continually reward and shape others’ behavior, said Skinner, but we often do so unintentionally. Billy’s whining, for example, annoys his mystified parents, but look how they typically deal with Billy:

**Billy:** Could you tie my shoes?

**Father:** (Continues reading paper.)

**Billy:** Dad, I need my shoes tied.

**Father:** Uh, yeah, just a minute.

**Billy:** DAAAAD! TIE MY SHOES!

**Father:** How many times have I told you not to whine? Now, which shoe do we do first?

Billy’s whining is reinforced, because he gets something desirable—his dad’s attention. Dad’s response is reinforced because it gets rid of something aversive—Billy’s whining.

Or consider a teacher who pastes gold stars on a wall chart after the names of children scoring 100 percent on spelling tests. As everyone can then see, some children consistently do perfect work. The others, who take the same test and may have worked harder than the academic all-stars, get no rewards. The teacher would be better advised to apply the principles of operant conditioning—to reinforce all spellers for gradual improvements (successive approximations toward perfect spelling of words they find challenging).

---

**Types of Reinforcers**

**18-2:** What are the basic types of reinforcers?

People often refer rather loosely to the power of “rewards.” This idea gains a more precise meaning in Skinner’s concept of a **reinforcer**: any event that strengthens (increases the frequency of) a preceding response. A reinforcer may be a tangible reward, such as food or money. It may be praise or attention—even being yelled at, for a child hungry for attention. Or it may be an activity—borrowing the family car after doing the dishes, or taking a break after an hour of study.

Although anything that serves to increase behavior is a reinforcer, reinforcers vary with circumstances. What’s reinforcing to one person (rock concert tickets) may not be to another. What’s reinforcing in one situation (food when hungry) may not be in another.

Up to now, we’ve really been discussing **positive reinforcement**, which strengthens a response by presenting a typically pleasurable stimulus after a response. But there are **two** basic kinds of reinforcement (TABLE 18.1 on the next page). **Negative reinforcement** strengthens a response by reducing or removing something undesirable or unpleasant, as when an organism escapes an aversive situation. Taking aspirin may relieve your headache, and pushing the snooze button will silence your annoying alarm. These welcome results (end of pain, end of alarm) provide negative reinforcement and increase the odds that you will repeat these behaviors. For drug addicts, the negative reinforcement of ending withdrawal pangs can be a compelling reason to resume using (Baker et al., 2004).
Note that contrary to popular usage, negative reinforcement is not punishment. (Advice: Repeat the last five words in your mind, because this is one of psychology’s most often misunderstood concepts.) Rather, negative reinforcement removes a punishing (aversive) event.

Sometimes negative and positive reinforcement coincide. Imagine a worried student who, after goofing off and getting a bad exam grade, studies harder for the next exam. This increased effort may be negatively reinforced by reducing anxiety, and positively reinforced by receiving a better grade. Whether it works by reducing something aversive, or by giving something desirable, reinforcement is any consequence that strengthens behavior.

Primary and Conditioned Reinforcers

Primary reinforcers—getting food when hungry or having a painful headache go away—are unlearned. They are innately satisfying. Conditioned reinforcers, also called secondary reinforcers, get their power through learned association with primary reinforcers. If a rat in a Skinner box learns that a light reliably signals that food is coming, the rat will work to turn on the light. The light has become a conditioned reinforcer associated with food. Our lives are filled with conditioned reinforcers—money, good grades, a pleasant tone of voice—each of which has been linked with more basic rewards. If money is a conditioned reinforcer—if people’s desire for money is derived from their desire for food—then hunger should also make people more money-hungry, reasoned one European research team (Briers et al., 2006). Indeed, in their experiments, people were less likely to donate to charity when food deprived, and less likely to share money with fellow participants when in a room with hunger-arousing aromas.

Immediate and Delayed Reinforcers

Let’s return to the imaginary shaping experiment in which you were conditioning a rat to press a bar. Before performing this “wanted” behavior, the hungry rat will engage in a sequence of “unwanted” behaviors—scratching, sniffing, and moving around. If you present food immediately after any one of these behaviors, the rat will likely repeat that rewarded behavior. But what if the rat presses the bar while you are distracted, and you delay giving the reinforcer? If the delay lasts longer than 30 seconds, the rat will not learn to press the bar. You will have reinforced other incidental behaviors—more sniffing and moving—that intervened after the bar press.

Unlike rats, humans do respond to delayed reinforcers: the paycheck at the end of the week, the good grade at the end of the semester, the trophy at the end of the season. Indeed, to function effectively we must learn to delay gratification. In laboratory testing, some 4-year-olds show this ability. In choosing a candy, they prefer having a big reward tomorrow to munching on a small one right now. Learning to control our impulses in order to achieve more valued rewards is a big step toward maturity (Logue, 1998a,b). No wonder children who make such choices have tended to become socially competent and high-achieving adults (Mischel et al., 1989).

But to our detriment, small but immediate consequences (the enjoyment of watching late-night TV, for example) are sometimes more alluring than big but delayed consequences (feeling alert tomorrow). For many teens, the immediate gratification of risky, unprotected sex in passionate moments prevails over the delayed gratifications of safe sex or saved sex (Loewenstein & Furstenberg, 1991). And for

<table>
<thead>
<tr>
<th>Operant Conditioning Term</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive reinforcement</td>
<td>Add a desirable stimulus</td>
<td>Getting a hug; receiving a paycheck</td>
</tr>
<tr>
<td>Negative reinforcement</td>
<td>Remove an aversive stimulus</td>
<td>Fastening seatbelt to turn off beeping</td>
</tr>
</tbody>
</table>

Remember whining Billy? In that example, whose behavior was positively reinforced and whose was negatively reinforced? See inverted answer below.

Billy’s whining was positively reinforced, because Billy got something desirable—his father’s attention. His dad’s response to the whining (doing what Billy wanted) was negatively reinforced, because Billy got something undesirable—his dad’s attention. The light comes on, I press the bar—they write me a check. How about you?”
too many of us, the immediate rewards of today’s gas-guzzling vehicles, air travel, and air conditioning have prevailed over the bigger future consequences of global climate change, rising seas, and extreme weather.

**Reinforcement Schedules**

**18-3: How do different reinforcement schedules affect behavior?**

So far, most of our examples have assumed continuous reinforcement: Reinforcing the desired response every time it occurs. Under such conditions, learning occurs rapidly, which makes continuous reinforcement preferable until a behavior is mastered. But extinction also occurs rapidly. When reinforcement stops—when we stop delivering food after the rat presses the bar—the behavior soon stops. If a normally dependable candy machine fails to deliver a chocolate bar twice in a row, we stop putting money into it (although a week later we may exhibit spontaneous recovery by trying again).

Real life rarely provides continuous reinforcement. Salespeople do not make a sale with every pitch, nor do anglers get a bite with every cast. But they persist because their efforts are occasionally rewarded. This persistence is typical with partial (intermittent) reinforcement schedules, in which responses are sometimes reinforced, sometimes not. Although initial learning is slower, intermittent reinforcement produces greater resistance to extinction than is found with continuous reinforcement. Imagine a pigeon that has learned to peck a key to obtain food. When the experimenter gradually phases out the delivery of food until it occurs only rarely and unpredictably, pigeons may peck 150,000 times without a reward (Skinner, 1953). Slot machines reward gamblers in much the same way—occasionally and unpredictably. And like pigeons, slot players keep trying, time and time again. With intermittent reinforcement, hope springs eternal.

*Lesson for parents:* Partial reinforcement also works with children. Occasionally giving in to children’s tantrums for the sake of peace and quiet intermittently reinforces the tantrums. This is the very best procedure for making a behavior persist.

Skinner (1961) and his collaborators compared four schedules of partial reinforcement. Some are rigidly fixed, some unpredictably variable.

**Fixed-ratio schedules** reinforce behavior after a set number of responses. Just as coffee shops reward us with a free drink after every 10 purchased, laboratory animals may be reinforced on a fixed ratio of, say, one reinforcer for every 30 responses. Once conditioned, the animal will pause only briefly after a reinforcer and will then return to a high rate of responding (FIGURE 18.3).

![FIGURE 18.3 Intermittent reinforcement schedules](image-url) Skinner’s laboratory pigeons produced these response patterns to each of four reinforcement schedules. (Reinforcers are indicated by diagonal marks.) For people, as for pigeons, reinforcement linked to number of responses (a ratio schedule) produces a higher response rate than reinforcement linked to amount of time elapsed (an interval schedule). But the predictability of the reward also matters. An unpredictable (variable) schedule produces more consistent responding than does a predictable (fixed) schedule.
Variable-ratio schedules provide reinforcers after an unpredictable number of responses. This is what slot-machine players and fly-casting anglers experience—unpredictable reinforcement—and what makes gambling and fly fishing so hard to extinguish even when both are getting nothing for something. Like the fixed-ratio schedule, the variable-ratio schedule produces high rates of responding, because reinforcers increase as the number of responses increases.

**Fixed-interval schedules** reinforce the first response after a fixed time period. Like people checking more frequently for the mail as the delivery time approaches, or checking to see if the Jell-O has set, pigeons on a fixed-interval schedule peck a key more frequently as the anticipated time for reward draws near, producing a choppy stop-start pattern (see Figure 18.3) rather than a steady rate of response.

**Variable-interval schedules** reinforce the first response after varying time intervals. Like the “You’ve got mail” that finally rewards persistence in rechecking for e-mail, variable-interval schedules tend to produce slow, steady responding. This makes sense, because there is no knowing when the waiting will be over (TABLE 18.2).

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**TABLE 18.2 Schedules of Reinforcement**

<table>
<thead>
<tr>
<th>Fixed Ratio</th>
<th>Variable Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every so many: reinforcement after every nth behavior, such as buy 10 coffees, get 1 free, or pay per product unit produced.</td>
<td>After an unpredictable number: reinforcement after a random number of behaviors, as when playing slot machines or fly-casting.</td>
</tr>
<tr>
<td>Every so often: reinforcement for behavior after a fixed time, such as Tuesday discount prices.</td>
<td>Unpredictably often: reinforcement for behavior after a random amount of time, as in checking for texts.</td>
</tr>
</tbody>
</table>

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Animal behaviors differ, yet Skinner (1956) contended that the reinforcement principles of operant conditioning are universal. It matters little, he said, what response, what reinforcer, or what species you use. The effect of a given reinforcement schedule is pretty much the same: “Pigeon, rat, monkey, which is which? It doesn’t matter. . . . Behavior shows astonishingly similar properties.”

**Punishment**

18-4: How does punishment affect behavior?

Reinforcement increases a behavior; **punishment** does the opposite. A **punisher** is any consequence that decreases the frequency of a preceding behavior (see TABLE 18.3).

Swift and sure punishers can powerfully restrain unwanted behavior. The rat that is shocked after touching a forbidden object and the child who loses a treat after running into the street will learn not to repeat the behavior. Some punishments, though unintentional, are nevertheless quite effective: A dog that has learned to come running at the sound of an electric can opener will stop coming if its owner starts running the machine to attract the dog and banish it to the basement.

---

**TABLE 18.3 Ways to Decrease Behavior**

<table>
<thead>
<tr>
<th>Type of Punisher</th>
<th>Description</th>
<th>Possible Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive punishment</strong></td>
<td>Administer an aversive stimulus</td>
<td>Spanking; receiving a parking ticket</td>
</tr>
<tr>
<td><strong>Negative punishment</strong></td>
<td>Withdraw a desirable stimulus</td>
<td>Time-out from privileges (such as time with friends); revoked driver’s license</td>
</tr>
</tbody>
</table>

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The charm of fishing is that it is the pursuit of what is elusive but attainable, a perpetual series of occasions for hope.”
—Scottish author John Buchan (1875–1940)
So, how should we interpret the punishment studies in relation to parenting practices? Many psychologists and supporters of nonviolent parenting note four drawbacks of physically punishing children (Gershoff, 2002; Marshall, 2002).

1. *Punished behavior is suppressed, not forgotten.* This suppression, though temporary, may (negatively) reinforce parents’ punishing behavior. The child swears, the parent swats, the parent hears no more swearing and feels the punishment successfully stopped the behavior. No wonder spanking is a hit with so many U.S. parents of 3- and 4-year-olds—more than 9 in 10 of whom have acknowledged spanking their children (Kazdin & Benjet, 2003).

2. *Punishment teaches discrimination.* Was the punishment effective in putting an end to the swearing? Or did the child simply learn that it’s not okay to swear around the house, but it is okay to swear elsewhere?

3. *Punishment can teach fear.* The child may generalize what has been learned, associating fear not only with the undesirable behavior but also with the person delivering the punishment or the place it occurred. Thus, children may learn to fear a punishing teacher and try to avoid school. For such reasons, most European countries have banned hitting children in schools and childcare institutions (Leach, 1993, 1994). Eleven countries, including those in Scandinavia, have further outlawed hitting by parents, giving children the same legal protection given to spouses (EPOCH, 2000).

4. *Physical punishment may increase aggressiveness by modeling aggression as a way to cope with problems.* Many aggressive delinquents and abusive parents come from abusive families (Straus & Gelles, 1980; Straus et al., 1997). Some researchers dispute this drawback. They agree that spanked children are at increased risk for aggression. Likewise, they say, people who have undergone psychotherapy are more likely to suffer depression—because they had preexisting problems that triggered the treatments (Larzelere, 2000, 2004). Which is the chicken and which is the egg? The correlations don’t hand us an answer.

If one adjusts for preexisting antisocial behavior, then an occasional single swat or two to misbehaving 2- to 6-year-olds looks more effective (Baumrind et al., 2002; Larzelere & Kuhn, 2005). That is especially so if the swat is used only as a backup when milder disciplinary tactics (such as a time-out, removing them from reinforcing surroundings) fail, and when the swat is combined with a generous dose of reasoning and reinforcing. Remember: *Punishment tells you what not to do; reinforcement tells you what to do.* This dual approach can be effective. When children with self-destructive behaviors bite themselves or bang their heads, they may be mildly punished (say, with a squirt of water in the face), but they may also be rewarded (with positive attention and food) when they behave well. In high school classrooms, teachers can give feedback on papers by saying, “No, but try this . . .” and “Yes, that’s it!” Such responses reduce unwanted behavior while reinforcing more desirable alternatives.

Parents of delinquent youth are often unaware of how to achieve desirable behaviors without screaming or hitting their children (Patterson et al., 1982, 2005). Training programs can help reframe contingencies from dire threats to positive incentives—turning “You clean up your room this minute or no dinner!” to “You’re welcome at the dinner table after you get your room cleaned up.” When you stop to think about it, many threats of punishment are just as forceful, and perhaps more effective, if rephrased positively. Thus, “If you don’t get your homework done, there’ll be no car” would better be phrased as . . .

What punishment often teaches, said Skinner, is how to avoid it. Most psychologists now favor an emphasis on reinforcement: Catch people behaving well and affirm them for it.
Extending Skinner’s Understanding

18-5: Do cognitive processes and biological constraints affect operant conditioning?

Skinner granted the existence of private thought processes and the biological underpinnings of behavior. Nevertheless, many psychologists criticized him for discounting the importance of these influences.

Cognition and Operant Conditioning

A mere eight days before dying of leukemia, Skinner (1990) stood before the American Psychological Association convention for one final critique of “cognitive science,” which he viewed as a throwback to early twentieth-century introspectionism. Skinner died resisting the growing belief that cognitive processes—thoughts, perceptions, expectations—have a necessary place in the science of psychology and even in our understanding of conditioning. (He regarded thoughts and emotions as behaviors that follow the same laws as other behaviors.) Yet we have seen several hints that cognitive processes might be at work in operant learning. For example, animals on a fixed-interval reinforcement schedule respond more and more frequently as the time approaches when a response will produce a reinforcer. Although a strict behaviorist would object to talk of “expectations,” the animals behave as if they expected that repeating the response would soon produce the reward.

Evidence of cognitive processes has also come from studying rats in mazes. Rats exploring a maze, with no obvious reward, are like people sightseeing in a new town. They seem to develop a cognitive map, a mental representation of the maze. When an experimenter then places food in the maze’s goal box, the rats very soon run the maze as quickly as rats that have been reinforced with food for running the maze.

During their explorations, the rats have seemingly experienced latent learning—learning that becomes apparent only when there is some incentive to demonstrate it. Children, too, may learn from watching a parent but demonstrate the learning only much later, as needed. The point to remember: There is more to learning than associating a response with a consequence; there is also cognition. Psychologists have presented some striking evidence of animals’ cognitive abilities in solving problems and in using aspects of language.

Biological Predispositions

As with classical conditioning, an animal’s natural predispositions constrain its capacity for operant conditioning. Using food as a reinforcer, you can easily condition a hamster to dig or to rear up because these actions are among the animal’s natural food-searching behaviors. But you won’t be so successful if you use food as a reinforcer to shape other hamster behaviors, such as face washing, that aren’t normally associated with food or hunger (Shettleworth, 1973). Similarly, you could easily teach pigeons to flap their wings to avoid being shocked, and to peck to obtain food, because fleeing with their wings and eating with their beaks are natural pigeon behaviors. However, they would have a hard time learning to peck to avoid a shock, or to flap their wings to obtain food (Foree & LoLordo, 1973). The principle: Biological constraints predispose organisms to learn associations that are naturally adaptive.

After witnessing the power of operant learning, Skinner’s students Keller Breland and Marian Breland (1961; Bailey & Gillaspy, 2005) began training dogs, cats, chickens, parakeets, turkeys, pigs, ducks, and hamsters, and they eventually left...
their graduate studies to form an animal training company. Over the ensuing 47 years they trained more than 15,000 animals from 140 species for movies, traveling shows, corporations, amusement parks, and the government. They also trained animal trainers, including Sea World’s first director of training.

At first, the Brelsands presumed that operant principles would work on almost any response an animal could make. But along the way, they confronted the constraints of biological predispositions. In one act, pigs trained to pick up large wooden “dollars” and deposit them in a piggy bank began to drift back to their natural ways. They would drop the coin, push it with their snouts as pigs are prone to do, pick it up again, and then repeat the sequence—delaying their food reinforcer. This **instinctive drift** occurred as the animals reverted to their biologically predisposed patterns. Operant training works best when it builds on an animal’s natural behavior tendencies.

**Skinner’s Legacy**

B. F. Skinner was one of the most controversial intellectual figures of the late twentieth century. He stirred a hornet’s nest with his outspoken beliefs. He repeatedly insisted that external influences (not internal thoughts and feelings) shape behavior. And he urged people to use operant principles to influence others’ behavior at school, work, and home. Knowing that behavior is shaped by its results, he said we should use rewards to evoke more desirable behavior.

Skinner’s critics objected, saying that he dehumanized people by neglecting their personal freedom and by seeking to control their actions. Skinner’s reply: External consequences already haphazardly control people’s behavior. Why not administer those consequences toward human betterment? Wouldn’t reinforcers be more humane than the punishments used in homes, schools, and prisons? And if it is humbling to think that our history has shaped us, doesn’t this very idea also give us hope that we can shape our future?

**Applications of Operant Conditioning**

18-6: How might operant conditioning principles be applied at school, in sports, at work, and at home?

Psychologists are applying operant conditioning principles to help people with a variety of challenges, from moderating high blood pressure to gaining social skills. Reinforcement technologies are also at work in schools, sports, workplaces, and homes (Flora, 2004).

**Natural athletes** Animals can most easily learn and retain behaviors that draw on their biological predispositions, such as cats’ inborn tendency to leap high and land on their feet.

*For more information on animal behavior, see books by (I am not making this up) Robin Fox and Lionel Tiger.*

“Never try to teach a pig to sing. It wastes your time and annoys the pig.”
—Mark Twain (1835–1910)

B. F. Skinner “I am sometimes asked, ‘Do you think of yourself as you think of the organisms you study?’ The answer is yes. So far as I know, my behavior at any given moment has been nothing more than the product of my genetic endowment, my personal history, and the current setting” (1983).
At School

A generation ago, Skinner and others worked toward a day when teaching machines and textbooks would shape learning in small steps, immediately reinforcing correct responses. Such machines and texts, they said, would revolutionize education and free teachers to focus on each student’s special needs.

Stand in Skinner’s shoes for a moment and imagine two math teachers, each with a class of students ranging from whiz kids to slow learners. Teacher A gives the whole class the same lesson, knowing that the bright kids will breeze through the math concepts, and the slower ones will be frustrated and fail. With so many different children, how could one teacher guide them individually? Teacher B, faced with a similar class, paces the material according to each student’s rate of learning and provides prompt feedback, with positive reinforcement, to both the slow and the fast learners. Thinking as Skinner did, how might you achieve the individualized instruction of Teacher B?

Computers were Skinner’s final hope. “Good instruction demands two things,” he said. “Students must be told immediately whether what they do is right or wrong and, when right, they must be directed to the step to be taken next.” Thus, the computer could be Teacher B—pacing math drills to the student’s rate of learning, quizzing the student to find gaps in understanding, giving immediate feedback, and keeping flawless records. To the end of his life, Skinner (1986, 1988, 1989) believed his ideal was achievable. Although the predicted education revolution has not occurred, today’s interactive student software, Web-based learning, and online testing bring us closer than ever before to achieving his ideal.

In Sports

Reinforcement principles can enhance athletic performance as well. Again, the key is to shape behavior, by first reinforcing small successes and then gradually increasing the challenge. Thomas Simek and Richard O’Brien (1981, 1988) applied these principles to teaching golf and baseball by starting with easily reinforced responses. Golf students learn putting by starting with very short putts. As they build mastery, they eventually step back farther and farther. Likewise, novice batters begin with half swings at an oversized ball pitched from 10 feet away, giving them the immediate pleasure of smacking the ball. As the hitters’ confidence builds with their success and they achieve mastery at each level, the pitcher gradually moves back—to 15, then 22, 30, and 40.5 feet—and eventually introduces a standard baseball. Compared with children taught by conventional methods, those trained by this behavioral method show, in both testing and game situations, faster skill improvement.

At Work

Skinner’s ideas have also shown up in the workplace. Knowing that reinforcers influence productivity, many organizations have invited employees to share the risks and rewards of company ownership. Others focus on reinforcing a job well done. Rewards are most likely to increase productivity if the desired performance has been well-defined and is achievable. The message for managers? Reward specific, achievable behaviors, not vaguely defined “merit.” Even criticism triggers the least resentment and the greatest performance boost when specific and considerate (Baron, 1988).

Operant conditioning also reminds us that reinforcement should be immediate. IBM legend Thomas Watson understood. When he observed an achievement, he wrote the employee a check on the spot (Peters & Waterman, 1982). But rewards need not be material, or lavish. An effective manager may simply walk the floor and sincerely affirm people for good work, or write notes of appreciation for a completed project. As Skinner said, “How much richer would the whole world be if the reinforcers in daily life were more effectively contingent on productive work?”
At Home

As we have seen, parents can apply operant conditioning practices. Parent-training researchers remind us that parents who say “Get ready for bed” but cave in to protests or defiance reinforce whining and arguing (Wierson & Forehand, 1994). Exasperated, they may then yell or gesture menacingly. When the child, now frightened, obeys, that in turn reinforces the parents’ angry behavior. Over time, a destructive parent-child relationship develops.

To disrupt this cycle, parents should remember the basic rule of shaping: Notice people doing something right and affirm them for it. Give children attention and other reinforcers when they are behaving well (Wierson & Forehand, 1994). Target a specific behavior, reward it, and watch it increase. When children misbehave or are defiant, don’t yell at them or hit them. Simply explain the misbehavior and give them a time-out.

Finally, we can use operant conditioning in our own lives (see Close-Up: Training Our Partners). To reinforce your own desired behaviors and extinguish the undesired ones, psychologists suggest taking these steps:

1. **State your goal**—to stop smoking, eat less, or study or exercise more—in measurable terms, and announce it. You might, for example, aim to boost your study time by an hour a day and share that goal with some close friends.

2. **Monitor how often you engage in your desired behavior.** You might log your current study time, noting under what conditions you do and don’t study. (When I began writing textbooks, I logged how I spent my time each day and was amazed to discover how much time I was wasting.)

3. **Reinforce the desired behavior.** To increase your study time, give yourself a reward (a snack or some activity you enjoy) only after you finish your extra hour of study. Agree with your friends that you will join them for weekend activities only if you have met your realistic weekly studying goal.

4. **Reduce the rewards gradually.** As your new behaviors become more habitual, give yourself a mental pat on the back instead of a cookie.

**Close-Up:**

**Training Our Partners**

By Amy Sutherland

For a book I was writing about a school for exotic animal trainers, I started commuting from Maine to California, where I spent my days watching students do the seemingly impossible: teaching hyenas to pirouette on command, cougars to offer their paws for a nail clipping, and baboons to skateboard.

I listened, rapt, as professional trainers explained how they taught dolphins to flip and elephants to paint. Eventually it hit me that the same techniques might work on that stubborn but lovable species, the American husband.

The central lesson I learned from exotic animal trainers is that I should reward behavior I like and ignore behavior I don’t. After all, you don’t get a sea lion to balance a ball on the end of its nose by nagging. The same goes for the American husband.

Back in Maine, I began thanking Scott if he threw one dirty shirt into the hamper. If he threw in two, I’d kiss him. Meanwhile, I would step over any soiled clothes on the floor without one sharp word, though I did sometimes kick them under the bed. But as he basked in my appreciation, the piles became smaller.

I was using what trainers call “approximations,” rewarding the small steps toward learning a whole new behavior. . . . Once I started thinking this way, I couldn’t stop. At the school in California, I’d be scribbling notes on how to walk an emu or have a wolf accept you as a pack member, but I’d be thinking, “I can’t wait to try this on Scott. . . .”

After two years of exotic animal training, my marriage is far smoother, my husband much easier to love. I used to take his faults personally; his dirty clothes on the floor were an affront, a symbol of how he didn’t care enough about me. But thinking of my husband as an exotic species gave me the distance I needed to consider our differences more objectively.

Contrasting Classical and Operant Conditioning

Both classical and operant conditioning are forms of associative learning, and both involve acquisition, extinction, spontaneous recovery, generalization, and discrimination. The similarities are sufficient to make some researchers wonder if a single stimulus-response learning process might explain them both (Donahoe & Vegas, 2004). Their procedural difference is this: Through classical (Pavlovian) conditioning, an organism associates different stimuli that it does not control and responds automatically (respondent behaviors) (TABLE 18.4). Through operant conditioning, an organism associates its operant behaviors—those that act on its environment to produce rewarding or punishing stimuli—with their consequences. Cognitive processes and biological predispositions influence both classical and operant conditioning.

**TABLE 18.4 Comparison of Classical and Operant Conditioning**

<table>
<thead>
<tr>
<th></th>
<th>Classical Conditioning</th>
<th>Operant Conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic idea</strong></td>
<td>Organism learns associations between events it doesn’t control.</td>
<td>Organism learns associations between its behavior and resulting events.</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>Involuntary, automatic.</td>
<td>Voluntary, operates on environment.</td>
</tr>
<tr>
<td><strong>Acquisition</strong></td>
<td>Associating events; NS is paired with US and becomes CS.</td>
<td>Associating response with a consequence (reinforcer or punisher).</td>
</tr>
<tr>
<td><strong>Extinction</strong></td>
<td>CR decreases when CS is repeatedly presented alone.</td>
<td>Responding decreases when reinforcement stops.</td>
</tr>
<tr>
<td><strong>Spontaneous recovery</strong></td>
<td>The reappearance, after a rest period, of an extinguished CR.</td>
<td>The reappearance, after a rest period, of an extinguished response.</td>
</tr>
<tr>
<td><strong>Generalization</strong></td>
<td>The tendency to respond to stimuli similar to the CS.</td>
<td>Organism’s response to similar stimuli is also reinforced.</td>
</tr>
<tr>
<td><strong>Discrimination</strong></td>
<td>The learned ability to distinguish between a CS and other stimuli that do not signal a US.</td>
<td>Organism learns that certain responses, but not others, will be reinforced.</td>
</tr>
<tr>
<td><strong>Cognitive processes</strong></td>
<td>Organisms develop expectation that CS signals the arrival of US.</td>
<td>Organisms develop expectation that a response will be reinforced or punished; they also exhibit latent learning, without reinforcement.</td>
</tr>
<tr>
<td><strong>Biological predispositions</strong></td>
<td>Natural predispositions constrain what stimuli and responses can easily be associated.</td>
<td>Organisms best learn behaviors similar to their natural behaviors; unnatural behaviors instinctively drift back toward natural ones.</td>
</tr>
</tbody>
</table>

“O! This learning, what a thing it is.”
—William Shakespeare, *The Taming of the Shrew*, 1597

Operant Conditioning

**Module Review**

**18-1:** What is operant conditioning, and how does it differ from classical conditioning? In operant conditioning, an organism learns associations between its own behavior and resulting events; this form of associative learning involves operant behavior (behavior that operates on the environment, producing consequences). In classical conditioning, the organism forms associations between stimuli—behaviors it does not control; this learning involves respondent behavior (automatic responses to some stimulus).

Expanding on Thorndike’s law of effect, Skinner and others found that the behavior of rats or pigeons placed in an operant chamber (Skinner box) can be shaped by reinforcing closer and closer approximations of the desired behavior.

**18-2:** What are the basic types of reinforcers? A reinforcer is anything that strengthens the behavior it follows. Positive reinforcement adds something desirable to increase the frequency of a behavior. Negative reinforcement removes something undesirable to increase the frequency of a behavior. Primary reinforcers (receiving food when hungry, or having a headache go away) are innately satisfying—no learning is required. Conditioned (or secondary) reinforcers (such as cash) are satisfying because we have learned to associate them with more basic rewards (such as the food or medicine we buy with them). Immediate reinforcers (watching late-night TV) offer immediate payback; delayed reinforcers (feeling rested tomorrow) require the ability to delay gratification.
18-3: How do different reinforcement schedules affect behavior? In continuous reinforcement (reinforcing desired responses every time they occur), learning is rapid, but so is extinction if rewards cease. In partial (intermittent) reinforcement, initial learning is slower, but resistance to extinction is greater. Fixed-ratio schedules offer rewards after a set number of responses; variable-ratio schedules, after an unpredictable number. Fixed-interval schedules offer rewards after set time periods; variable-interval schedules, after unpredictable time periods.

18-4: How does punishment affect behavior? Punishment attempts to decrease the frequency of a behavior (a child’s disobedience) by administering an undesirable consequence (spanking) or withdrawing something desirable (taking away a favorite toy). Undesirable side effects of physical punishment can include suppressing rather than changing unwanted behaviors, encouraging discrimination (the undesirable behavior appears when the punisher is not present), generalizing fear, and teaching aggression.

18-5: Do cognitive processes and biological constraints affect operant conditioning? Skinner underestimated the limits that cognitive and biological constraints place on conditioning. Research on cognitive maps and latent learning demonstrate the importance of cognitive processes in learning. And when training attempts to override biological constraints, instinctive drift occurs as animals revert to predisposed patterns.

18-6: How might operant conditioning principles be applied at school, in sports, at work, and at home? In school, teachers can use shaping techniques to guide students’ behaviors, and they can use interactive software and Web sites to provide immediate feedback. In sports, coaches can build players’ skills and self-confidence by rewarding small improvements. At work, managers can boost productivity and morale by rewarding well-defined and achievable behaviors. At home, parents can reward desirable behaviors, but not undesirable ones. We can shape our own behaviors by stating our goals, monitoring the frequency of desired behaviors, reinforcing desired behaviors, and gradually reducing incentives as the desired behaviors become habitual.

Rehearse It!

1. Salivating in response to a tone paired with food is a (an) ________, pressing a bar to obtain food is a (an) ________.
   a. primary reinforcer; conditioned reinforcer
   b. conditioned reinforcer; primary reinforcer
   c. operant behavior; respondent behavior
   d. respondent behavior; operant behavior

2. Thorndike’s law of effect became the basis for operant conditioning and the “behavioral technology” developed by
   a. Ivan Pavlov.
   b. John Garcia.
   c. B. F. Skinner.

3. One way to change behavior is to reward natural behaviors in small steps, as they get closer and closer to the desired behavior. This process is called
   a. shaping.
   b. punishment.
   c. taste aversion.
   d. classical conditioning.

4. Your dog is barking so loudly that it’s making your ears ring. You clap your hands, the dog stops barking, your ears stop ringing, and you think to yourself, “I’ll have to do that when he barks again.” The end of the barking was for you a
   a. positive reinforcer.
   b. negative reinforcer.
   c. punishment.
   d. primary reinforcer.

5. The partial reinforcement schedule that reinforces a response at unpredictable times is a
   a. fixed-interval schedule.
   b. variable-interval schedule.
   c. fixed-ratio schedule.
   d. variable-ratio schedule.

6. A medieval proverb notes that “a burnt child dreads the fire.” In operant conditioning, the burning would be an example of a
   a. primary reinforcer.
   b. negative reinforcer.
   c. punisher.
   d. positive reinforcer.

7. We now know that cognitive processes (thoughts, perceptions, and expectations) play an important role in learning. Evidence comes from studies in which rats
   a. spontaneously recover previously learned behavior.
   b. develop cognitive maps.
   c. exhibit respondent behavior.
   d. generalize responses.

8. Rats carried passively through a maze and given no reward later ran the maze as well as rats that had received food rewards for running the maze. The rats that had learned without reinforcement demonstrate
   a. modeling.
   b. biological predisposition.
   c. shaping.
   d. latent learning.

Answers: 1. d, 2. c, 3. a, 4. b, 5. b, 6. d, 7. b, 8. d.
### Terms and Concepts to Remember

<table>
<thead>
<tr>
<th>Learning</th>
<th>Reinforcer</th>
<th>Fixed-Ratio Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>Reinforcer, p. 251</td>
<td>Fixed-Ratio Schedule, p. 253</td>
</tr>
<tr>
<td>Associative Learning</td>
<td>Positive Reinforcement, p. 251</td>
<td>Variable-Ratio Schedule, p. 254</td>
</tr>
<tr>
<td>Respondent Behavior</td>
<td>Negative Reinforcement, p. 251</td>
<td>Fixed-Interval Schedule, p. 254</td>
</tr>
<tr>
<td>Operant Conditioning</td>
<td>Primary Reinforcer, p. 252</td>
<td>Variable-Interval Schedule, p. 254</td>
</tr>
<tr>
<td>Operant Behavior</td>
<td>Conditioned Reinforcer, p. 252</td>
<td>Punishment, p. 254</td>
</tr>
<tr>
<td>Law of Effect</td>
<td>Continuous Reinforcement, p. 253</td>
<td>Cognitive Map, p. 256</td>
</tr>
<tr>
<td>Operant Chamber</td>
<td>Partial (Intermittent) Reinforcement, p. 253</td>
<td>Latent Learning, p. 256</td>
</tr>
<tr>
<td>Shaping</td>
<td></td>
<td></td>
</tr>
</tbody>
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### Test For Success: Critical Thinking Exercises

1. Ethan constantly misbehaves at preschool even though his teacher scolds him several times each day. Why does his misbehavior continue, and what can his teacher do to stop it?

2. How could your psychology instructor use negative reinforcement to encourage your attentive behavior during class?

*The Test for Success exercises offer you a chance to apply your critical thinking skills to aspects of the material you have just read. Suggestions for answering these questions can be found in Appendix D at the back of the book.*
man. Probably the same may be true of rage although at present we are not so sure of this.

The Freudians twenty years from now, unless their hypotheses change, when they come to analyze Albert’s fear of a seal skin coat—assuming that he comes to analysis at that age—will probably tease from him the recital of a dream which upon their analysis will show that Albert at three years of age attempted to play with the pubic hair of the mother and was scolded violently for it. (We are by no means denying that this might in some other case condition it.) If the analyst has sufficiently prepared Albert to accept such a dream when found as an explanation of his avoiding tendencies, and if the analyst has the authority and personality to put it over, Albert may be fully convinced that the dream was a true revealer of the factors which brought about the fear.

It is probable that many of the phobias in psychopathology are true conditioned emotional reactions either of the direct or the transferred type. One may possibly have to believe that such persistence of early conditioned responses will be found only in persons who are constitutionally inferior. Our argument is meant to be constructive. Emotional disturbances in adults cannot be traced back to sex alone. They must be retraced along at least three collateral lines—to conditioned and transferred responses set up in infancy and early youth in all three of the fundamental human emotions.

A Review of B. F. Skinner’s Verbal Behavior

Noam Chomsky

I

A great many linguists and philosophers concerned with language have expressed the hope that their studies might ultimately be embedded in a framework provided by behaviorist psychology, and that refractory areas of investigation, particularly those in which meaning is involved, will in this way be opened up to fruitful exploration. Since this volume is the first large-scale attempt to incorporate the major aspects of linguistic behavior within a behaviorist framework, it merits and will undoubtedly receive careful attention. Skinner is noted for his contributions to the study of animal behavior. The book under review is the product of study of linguistic behavior extending over more than twenty years. Earlier versions of it have been fairly widely circulated, and there are quite a few references in the psychological literature to its major ideas.

The problem to which this book is addressed is that of giving a “functional analysis” of verbal behavior. By functional analysis, Skinner means identification of the variables that control this behavior and specification of how they interact to determine a particular verbal response. Furthermore, the controlling variables are to be described completely in terms of such notions as stimulus, reinforcement, deprivation, which have been given a reasonably clear meaning in animal experimentation. In other words, the goal of the book is to provide a way to predict and control verbal behavior by observing and manipulating the physical environment of the speaker.

Skinner feels that recent advances in the laboratory study of animal behavior permit us to approach this problem with a certain optimism, since “the basic processes and relations which give verbal behavior its special characteristics are now fairly well understood … the results [of this experimental
work] have been surprisingly free of species restrictions. Recent work has shown that the methods can be extended to human behavior without serious modification.

It is important to see clearly just what it is in Skinner's program and claims that makes them appear so bold and remarkable. It is not primarily the fact that he has set functional analysis as his problem, or that he limits himself to study of observables, i.e., input-output relations. What is so surprising is the particular limitations he has imposed on the way in which the observables of behavior are to be studied, and, above all, the particularly simple nature of the function which, he claims, describes the causation of behavior. One would naturally expect that prediction of the behavior of a complex organism (or machine) would require, in addition to information about external stimulation, knowledge of the internal structure of the organism, the ways in which it processes input information and organizes its own behavior. These characteristics of the organism are in general a complicated product of inborn structure, the genetically determined course of maturation, and past experience. Insofar as independent neurophysiological evidence is not available, it is obvious that inferences concerning the structure of the organism are based on observation of behavior and outside events.

Nevertheless, one's estimate of the relative importance of external factors and internal structure in the determination of behavior will have an important effect on the direction of research on linguistic (or any other) behavior, and on the kinds of analogies from animal behavior studies that will be considered relevant or suggestive.

Putting it differently, anyone who sets himself the problem of analyzing the causation of behavior will (in the absence of independent neurophysiological evidence) concern himself with the only data available, namely the record of inputs to the organism and the organism's present response, and will try to describe the function specifying the response in terms of the history of inputs. This is nothing more than the definition of his problem. There are no possible grounds for argument here, if one accepts the problem as legitimate, though Skinner has often advanced and defended this definition of a problem as if it were a thesis which other investigators reject. The differences that arise between those who affirm and those who deny the importance of the specific "contribution of the organism" to learning and performance concern the particular character and complexity of this function, and the kinds of observations and research necessary for arriving at a precise specification of it. If the contribution of the organism is complex, the only hope of predicting behavior even in a gross way will be through a very indirect program of research that begins by studying the detailed character of the behavior itself and the particular capacities of the organism involved.

Skinner's thesis is that external factors consisting of present stimulation and the history of reinforcement (in particular, the frequency, arrangement, and withholding of reinforcing stimuli) are of overwhelming importance, and that the general principles revealed in laboratory studies of these phenomena provide the basis for understanding the complexities of verbal behavior. He confidently and repeatedly voices his claim to have demonstrated that the contribution of the speaker is quite trivial and elementary, and that precise prediction of verbal behavior involves only specification of the few external factors that he has isolated experimentally with lower organisms.

Careful study of this book (and of the research on which it draws) reveals, however, that these astonishing claims are far from justified. It indicates, furthermore, that the insights that have been achieved in the laboratories of the reinforcement theorist, though quite genuine, can be applied to complex human behavior only in the most gross and superficial way, and that speculative attempts to discuss linguistic behavior in these terms alone omit from consideration factors of fundamental importance that are, no doubt, amenable to scientific study, although their specific character cannot at present be precisely formulated. Since Skinner's work is the most extensive attempt to accommodate human behavior involving higher mental faculties within a strict behaviorist schema of the type that has attracted many linguists and philosophers, as well as psychologists, a detailed documentation is of independent interest. The magnitude of the failure of this attempt to account for verbal behavior serves as a kind of measure of the importance of the factors omitted from consideration, and an indication of how little is really known about this remarkably complex phenomenon.

Consider first Skinner's use of the notions stimulus and response. In Behavior of Organisms (9) he commits himself to the narrow definitions for these terms: A part of the environment and a part of behavior are called stimulus (eliciting, discriminated, or reinforcing) and response, respectively, only if
they are lawfully related; that is, if the *dynamic laws* relating them show smooth and reproducible curves. Evidently, stimuli and responses, so defined, have not been shown to figure very widely in ordinary human behavior. We can, in the face of presently available evidence, continue to maintain the lawfulness of the relation between stimulus and response only by depriving them of their objective character. A typical example of *stimulus control* for Skinner would be the response to a piece of music with the utterance *Mozart* or to a painting with the response *Dutch*. These responses are asserted to be “under the control of extremely subtle properties” of the physical object or event (108). Suppose instead of saying *Dutch* we had said *Clashes with the wallpaper, I thought you liked abstract work, Never saw it before, Tilted, Hanging too low, Beautiful, Hideous, Remember our camping trip last summer?,* or whatever else might come into our minds when looking at a picture (in Skinnerian translation, whatever other responses exist in sufficient strength). Skinner could only say that each of these responses is under the control of some other stimulus property of the physical object. If we look at a red chair and say *red*, the response is under the control of the stimulus *redness*; if we say *chair*, it is under the control of the collection of properties (for Skinner, the object) *chairness* (110), and similarly for any other response. This device is as simple as it is empty. Since properties are free for the asking (we have as many of them as we have nonsynonymous descriptive expressions in our language, whatever this means exactly), we can account for a wide class of responses in terms of Skinnerian functional analysis by identifying the controlling *stimuli*. But the word *stimulus* has lost all objectivity in this usage. Stimuli are no longer part of the outside physical world; they are driven back into the organism. We identify the stimulus when we hear the response. It is clear from such examples, which abound, that the talk of *stimulus control* simply disguises a complete retreat to mentalistic psychology. We cannot predict verbal behavior in terms of the stimuli in the speaker’s environment, since we do not know what the current stimuli are until he responds. Furthermore, since we cannot control the property of a physical object to which an individual will respond, except in highly artificial cases, Skinner’s claim that his system, as opposed to the traditional one, permits the practical control of verbal behavior is quite false.

Other examples of *stimulus control* merely add to the general mystification. Thus, a proper noun is held to be a response “under the control of a specific person or thing” (as controlling stimulus, 113). I have often used the words *Eisenhower* and *Moscow*, which I presume are proper nouns if anything is, but have never been *stimulated* by the corresponding objects. How can this fact be made compatible with this definition? Suppose that I use the name of a friend who is not present. Is this an instance of a proper noun under the control of the friend as stimulus? Elsewhere it is asserted that a stimulus controls a response in the sense that presence of the stimulus increases the probability of the response. But it is obviously untrue that the probability that a speaker will produce a full name is increased when its bearer faces the speaker. Furthermore, how can one’s own name be a proper noun in this sense?

A multitude of similar questions arise immediately. It appears that the word *control* here is merely a misleading paraphrase for the traditional *denote* or *refer*. The assertion (115) that so far as the speaker is concerned, the relation of reference is “simply the probability that the speaker will emit a response of a given form in the presence of a stimulus having specified properties” is surely incorrect if we take the words *presence*, *stimulus*, and *probability* in their literal sense. That they are not intended to be taken literally is indicated by many examples, as when a response is said to be “controlled” by a situation or state of affairs as “stimulus.” Thus, the expression *a needle in a haystack* “may be controlled as a unit by a particular type of situation” (116); the words in a single part of speech, e.g., all adjectives, are under the control of a single set of subtle properties of stimuli (121); “the sentence *The boy runs a store* is under the control of an extremely complex stimulus situation” (333); “*He is not at all well* may function as a standard response under the control of a state of affairs which might also control *He is ailing*” (325); when an envoy observes events in a foreign country and reports upon his return, his report is under “remote stimulus control” (416); the statement *This is war* may be a response to a “confusing international situation” (441); the suffix *-ed* is controlled by that “subtle property of stimuli which we speak of as action-in-the-past” (121) just as the *-s* in *The boy runs* is under the control of such specific features of the situation as its “currency” (332). No characterization of the notion *stimulus control* that is remotely related to the bar-pressing experiment (or that preserves the faintest objectivity) can be made to cover a set of examples like these, in which, for example, the controlling stimulus need not even impinge on the responding organism.

Consider now Skinner’s use of the notion *response*. The problem of identifying units in verbal behavior has of course been a primary concern of...
linguists, and it seems very likely that experimental psychologists should be able to provide much-needed assistance in clearing up the many remaining difficulties in systematic identification. Skinner recognizes (20) the fundamental character of the problem of identification of a unit of verbal behavior, but is satisfied with an answer so vague and subjective that it does not really contribute to its solution. The unit of verbal behavior—the verbal operant—is defined as a class of responses of identifiable form functionally related to one or more controlling variables. No method is suggested for determining in a particular instance what are the controlling variables, how many such units have occurred, or where their boundaries are in the total response. Nor is any attempt made to specify how much or what kind of similarity in form or control is required for two physical events to be considered instances of the same operant. In short, no answers are suggested for the most elementary questions that must be asked of anyone proposing a method for description of behavior. Skinner is content with what he calls an extrapolation of the concept of operant developed in the laboratory to the verbal field. In the typical Skinnerian experiment, the problem of identifying the unit of behavior is not too crucial. It is defined, by fiat, as a recorded peck or bar-press, and systematic variations in the rate of this operant and its resistance to extinction are studied as a function of deprivation and scheduling of reinforcement (pellets). The operant is thus defined with respect to a particular experimental procedure. This is perfectly reasonable and has led to many interesting results. It is, however, completely meaningless to speak of extrapolating this concept of operant to ordinary verbal behavior. Such “extrapolation” leaves us with no way of justifying one or another decision about the units in the “verbal repertoire.”

The behavior of the speaker, listener, and learner of language constitutes, of course, the actual data for any study of language. The construction of a grammar which enumerates sentences in such a way that a meaningful structural description can be determined for each sentence does not in itself provide an account of this actual behavior. It merely characterizes abstractly the ability of one who has mastered the language to distinguish sentences from nonsentences, to understand new sentences (in part), to note certain ambiguities, etc. These are very remarkable abilities. We constantly read and hear new sequences of words, recognize them as sentences, and understand them. It is easy to show that the new events that we accept and understand as sentences are not related to those with which we are familiar by any simple notion of formal (or semantic or statistical) similarity or identity of grammatical frame. Talk of generalization in this case is entirely pointless and empty. It appears that we recognize a new item as a sentence not because matches some familiar item in any simple way, but because it is generated by the grammar that each individual has somehow and in some form internalized. And we understand a new sentence, in part, because we are somehow capable of determining the process by which this sentence is derived in this grammar.

Suppose that we manage to construct grammars having the properties outlined above. We can then attempt to describe and study the achievement of the speaker, listener, and learner. The speaker and the listener, we must assume, have already acquired the capacities characterized abstractly by the grammar. The speaker’s task is to select a particular compatible set of optional rules. If we know, from grammatical study, what choices are available and what conditions of compatibility the choices must meet, we can proceed meaningfully to investigate the factors that lead him to make one or another choice. The listener (or reader) must determine, from an exhibited utterance, what optional rules were chosen in the construction of the utterance. It must be admitted that the ability of a human being to do this far surpasses our present understanding. The child who learns a language has in some sense constructed the grammar for himself on the basis of his observation of sentences and nonsentences (i.e., corrections by the verbal community). Study of the actual observed ability of a speaker to distinguish sentences from nonsentences, detect ambiguities, etc., apparently forces us to the conclusion that this grammar is of an extremely complex and abstract character, and that the young child has succeeded in carrying out what from the formal point of view, at least, seems to be a remarkable type of theory construction. Furthermore, this task is accomplished in an astonishingly short time, to a large extent independently of intelligence, and in a comparable way by all children. Any theory of learning must cope with these facts.

It is not easy to accept the view that a child is capable of constructing an extremely complex mechanism for generating a set of sentences, some of which he has heard, or that an adult can instantaneously determine whether
(and if so, how) a particular item is generated by this mechanism, which has many of the properties of an abstract deductive theory. Yet this appears to be a fair description of the performance of the speaker, listener, and learner. If this is correct, we can predict that a direct attempt to account for the actual behavior of speaker, listener, and learner, not based on a prior understanding of the structure of grammars, will achieve very limited success. The grammar must be regarded as a component in the behavior of the speaker and listener which can only be inferred, as Lashley has put it, from the resulting physical acts. The fact that all normal children acquire essentially comparable grammars of great complexity with remarkable rapidity suggests that human beings are somehow specially designed to do this, with data-handling or “hypothesis-formulating” ability of unknown character and complexity. The study of linguistic structure may ultimately lead to some significant insights into this matter. At the moment the question cannot be seriously posed, but in principle it may be possible to study the problem of determining what the built-in structure of an information-processing (hypothesis-forming) system must be to enable it to arrive at the grammar of a language from the available data in the available time. At any rate, just as the attempt to eliminate the contribution of the speaker leads to a “mentalistic” descriptive system that succeeds only in blurring important traditional distinctions, a refusal to study the contribution of the child to language learning permits only a superficial account of language acquisition, with a vast and unanalyzed contribution attributed to a step called generalization which in fact includes just about everything of interest in this process. If the study of language is limited in these ways, it seems inevitable that major aspects of verbal behavior will remain a mystery.

From Wild Minds: What Animals Really Think

Marc D. Hauser

A female Japanese macaque drops a heap of wheat and sand into the ocean, and then skims the wheat off the surface once the sand has settled to the bottom. Although this technique is now a tradition in the population of monkeys living on the Japanese island of Koshima, it was invented by a highly creative female and then acquired by other members of the population. Naïve blue tits, watching skilled birds remove foil from a milk bottle and then drink the rich cream from the top, will then operate the foil in the same way. Human infants, only one hour old, stick out their tongues after an adult has performed the same display. An unmated female guppy will copy the mating preferences of another female if she watches the model’s selection of males. These observations, all well documented, suggest that in group living animals, an individual’s actions are highly influenced by social interactions. But how do these social interactions help in solving the problems of extracting food, choosing a mate, or finding safe refuge from predators?

Assume you observed a Japanese macaque pick up a heap of wheat and sand, walk over to the water, drop the mixture in and then, as the sand drops down, skim the wheat off the surface and eat it. How did this monkey, or any of the others in the population, acquire the wheat-washing technique? One possibility is that a naïve individual walks over to the water without any group members in sight. Some wheat is floating in the water. She skims it off and eats it. All of a sudden she is struck by insight, and deduces the answer to this foraging problem. Like a contestant playing Jeopardy, she has been given the solution and must work out the question. The answer is, “The wheat floats, the sand sinks.” The question is, “What happens when you bring wheat and sand over to the water and drop the mixture in?” In this scenario, deduction, not social learning, drives skill acquisition and thus knowledge. Here’s a second, similarly asocial method of discovery: the animal walks over to the water for a drink and happens to have some sand and wheat on her hands. As she