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Basic Behavioral Concepts (Chapter 1 from The Human Reflex)

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PART I

The Nature of Behavioral Psychology

1. Basic Behavioral Concepts

THIS CHAPTER examines the basic concepts and terminology used in behavioral psychology. Readers who have a working knowledge of the field may find much of the material familiar,[1] but for those who have not had prior exposure to behaviorism, this is a very important chapter.

The field of behavioral psychology has expanded greatly from its early beginnings at the turn of the century. Today, behavioral psychology can be viewed (1) as a body of knowledge; (2) as a method and philosophy of science; (3) as a systematic approach to the study of the psychological functioning of organisms; (4) as a set of principles useful for the analysis and understanding of observed behavior; (5) as a technology for application to practical human problems; and (6) as a philosophy of the underlying nature of our world and its significance.[2]

Broadly speaking, behavioral psychology takes a natural science approach to psychology. That is, it involves the study of natural phenomena through *the systematic study of observable events.*[3] In studying these events, behaviorists are interested in the response of the total organism rather than in the functioning of its various parts (as in biology), or the interactions between organisms (as in sociology).

Another important feature of behavioral psychology is its *functional* or *causal* approach to the study of behavior. This approach emphasizes "the relationship between stimuli, behavior and the consequences of this behavior in the environment."[4] Behaviorists use the term *environment* to denote a whole range of events that precede and follow behavior. Specifically, these events fall into four categories: physical, chemical, social, and organismic. Thus behavioral psychology explicitly recognizes that events within the organism may be thought of as comprising a part of its environment, and may exert controlling influence over its behavior.[5]

For our purposes, then, we may define behavioral psychology as *the systematic study of the functional relationships between the observable behavior of organisms (both human and animal) and other observable behaviors and events, as these organisms interact with themselves, with each other, and with the world around them.*

The Origins of Behavioral Psychology

The revolt against introspective analysis, which dominated the relatively new field of psychology at the turn of the century, was begun by John B. Watson.[6] Watson noted from his observations of animal research that introspection precluded contributions from the animal laboratory and he strongly rejected introspection as a suitable technique. Instead, he adopted a straightforward experimental objective: "Given the stimulus to be able to predict the response and given the response to be able to predict the antecedent stimulus."[7] He proposed the following research methods: (1) observation, with and without instrumental control; (2) conditioned reflex method; (3) verbal report method; and (4) testing methods.[8] Although the last two methods later fell into disrepute among behaviorists, Watson played a major role in the subsequent widespread adoption of the first two methods in psychological research in the United States.

By 1919, the *conditioned reflex* method had become one of Watson's chief research tools. He adapted this method from the work of Russian physiologist Ivan Pavlov.[9] While studying the salivary gland of dogs, Pavlov discovered that the dogs would begin to salivate in anticipation of food when their trainer simply entered the room in which they were kept. Intrigued, he followed up on this discovery with a series of experiments in which a bell was rung before presentation of the dogs' food. After a while, the dogs would salivate whenever the bell was rung. If food was no longer presented after the bell was rung, the salivation response would gradually become weaker and would eventually cease. This process came to be called *classical conditioning.*

Further work was done by E. L. Thorndike, a contemporary of Watson's, who developed the *law of effect* from his study of animal behavior in puzzle boxes. Thorndike observed that when first placed in the box, an animal would exhibit trial-and-error behav-

ior in its attempts to escape. Once it had successfully escaped from the box and been rewarded with food, the animal gradually became more effective in its escape attempts. From these observations, Thorndike postulated that effective behavior is learned, while behavior that is not effective is not learned. In his words, "[Acts] accompanied or closely followed by satisfaction . . . will be more likely to recur; those which are accompanied or closely followed by discomfort . . . will be less likely to occur."[10]

B. F. Skinner is generally credited with shaping the development of modern behavioral psychology. Although the roots of his approach can be seen in the conditioned reflex methodology of Pavlov and Watson, and especially in the problem-solving behavior observed by Thorndike, he departed from their thinking in a number of ways. First, Skinner adamantly objected to theorizing. He advocated a strictly empirical approach, in which there was no theory around which to organize the data. In this method, the relationship between behavior and events is described, but it is not interpreted in subjective terms such as pain, pleasure, and so on. In his early writings, Skinner's objections seem to be directed toward theory in general; in his later writings, however, his objections are against deductive theory in particular.[11]

A second departure from the work of his predecessors was Skinner's contention that the Pavlovian method of classical conditioning adopted by Watson was limited to a narrow range of behaviors, and that a special type of conditioning that he termed *operant conditioning* was more characteristic of everyday behavior.[12] Skinner also developed the *Skinner Box,* an experimental chamber for animal research; and the *cumulative record* and *cumulative recorder,* a technique and an instrument for recording behavior in the Skinner Box. These refinements of technique enabled Skinner to collect new types of data and to replace the number of trials or percentage of errors with a new primary measure, the *rate of behavior.* Much of Skinner's experimental work focused on the relationship between various reinforcement schedules and rates of performance of a bar press response in the Skinner Box.[13]

Although Skinner's early work was conducted in the 1920s and 1930s, behavioral psychology remained an obscure academic discipline until the late 1950s and early 1960s, when it began to move from animal research to human application. One of the first steps

in this direction was the publication of *Personality and Psychotherapy* by J. Dollard and N. E. Miller in 1950.[14] Dollard and Miller reformulated Freud's psychoanalytic theory in learning theory (behavioral) terms, thus bringing together behavior theory and clinical practice. Skinner's book *Science and Human Behavior,* published in 1953,[15] further stimulated exploration of the application of behavior theory to human problems. In 1958, Joseph Wolpe published a book that argued that neuroses were learned and could be treated with behavioral learning techniques.[16] Further impetus was provided by Arnold Lazarus, who developed the technique of *systematic desensitization* as a method of eliminating phobias.[17] The mid-60s saw the publication of texts that discussed the use of behavioral techniques in the treatment of retardation, as well as in general education. At the same time, several journals devoted to the publication of behavioral research and theory appeared, and a professional society was founded to support continued research. Behavioral psychology was thus firmly established as an alternative to traditional introspective techniques.

Experimental Design

Behavioral research differs from that of the mainstream psychological theories in several ways: (1) search for "powerful effects"; (2) goal of experimental control; (3) eschewing statistics; (4) emphasis on basic research; and (5) use of individual-subject research designs.

Skinner and other behaviorists believed that they should begin their research by seeking behavioral effects that were so powerful as to be obvious in the absence of statistical analysis. Such powerful phenomena would be assumed to be basic and important. They believed that it was through such approaches that chemistry, physics, and other "hard" sciences had made their most important breakthroughs, and that psychology should follow a similar path.

Paralleling the emphasis on powerful effects was a search for experimental control, as opposed to mere prediction or statistical significance. Behaviorists believed that the objective of psychology should be to develop such a complete understanding that a given behavior could be produced whenever desired. With such a goal, mere statistical significance was not enough. What was needed was

the systematic study of individual organisms, in order to discover the conditions under which a particular behavior could be produced. Ideally, for example, it should be possible to produce a given pecking behavior in each pigeon tested.

To carry out such objectives, it was important not to obscure the effects of individual behavior by averaging groups; hence single-subject approaches were adopted. Simple descriptive statements took the place of standard descriptive and inferential statistics. Data were presented in the form of graphs and cumulative records, from which it was believed that strong effects should be apparent.

Another distinctive feature of the behavioral approach, at least in its early years, was a tendency to focus almost exclusively on basic rather than applied research. While much of Skinner's recent writing has emphasized practical application, his research has been largely in the animal laboratory. It was not until the 1960s that behavioral psychology began to have a widespread applied research emphasis.

The Nature of Theory

Before we explore the specific characteristics of behavior theory, it will be helpful to understand the general nature of theory. Essentially, any theory consists of three elements: assumptions, observations, and interpretations.

Assumptions are those ideas that are believed to be true from the outset, and for which no formal justification is required. Three assumptions that are basic to scientific research are (1) that the world exists; (2) that the world can be apprehended by human intellect; and (3) that the world operates in an orderly, predictable, or lawful fashion. *Observations* are the data used to support a theory. Data may be collected in a number of ways: questionnaires, surveys, self-report inventories, direct observation of behavior, use of measuring instruments, and so on. *Interpretations* are the explanations of the results of the observation process; that is, interpretation is the process of relating observations to assumptions.

Interpretations of scientific data are necessarily influenced by the assumptions with which the scientist began. Behavior theorists and other theorists differ primarily in terms of these assumptions, and hence in their interpretations of data. Because they make different

assumptions about the nature of reality and about the most productive methods to employ in seeking to understand the world, they also interpret data in different ways. The following account should help to clarify this point.

A certain psychologist (not a behaviorist) who was interested in measuring the effect of stress on judgment and psychological comfort decided to perform the following experiment. Three groups of thirty students each were tested in a judgment task, in which they were to report whether a test figure was the same as or different from a sample. Each student was given one hundred trials. To vary the amount of stress involved, the psychologist decided to use an electric shock. One group was told that the apparatus was defective and that they might experience an occasional minor shock, but that they should simply ignore it. This group experienced minor shocks following randomly selected responses and received shocks an average of once in each ten trials, for a total of ten shocks. The second group was given the same instructions as the first group, but no shocks were actually given. The third group received no shocks, nor were they told of the possibility.

At the end of the experiment, the experimenter told each student that he wanted to find out whether the mechanical failure that sometimes resulted in electric shock might have affected their performance on the judgment task. He asked each student to rate the degree to which electric shocks had affected performance on a 10-point scale, from "1—no effect on performance," to "10—completely disrupted performance." Judgment was measured by computing the percentage of correct responses on the comparison task.

After collecting and analyzing his data, the experimenter found that the group that had actually received the shocks made the most errors; the second group, which was warned of the shocks but did not receive any, made less errors; and the group that neither received shocks nor was warned of shocks made the fewest errors. Reports of the effect of shock were similar, and the differences between groups was significant. In summarizing these results, the experimenter concluded: "As stress increased, judgment deteriorated and psychological distress increased."

A behaviorist would have evaluated these results quite differently. Indeed, a behaviorist probably would not have undertaken such an experiment in the first place, since neither its methods nor its

purpose are consistent with the behavioral approach.* Since behaviorists prefer to focus on behavior and events without reference to hypothetical constructs or intervening variables, a behavioral psychologist would object to references to judgment and psychological distress. Thus a behaviorist might state the interpretation in this way: "As threat of shock increased, errors increased and participants reported greater discomfort."

Notice the differences between these two interpretations. The first psychologist uses the term "judgment" to refer to internal process that are not directly observable. The behaviorist uses the objective term "errors," which recognizes only the overt behavior of the students. Similarly, the first psychologist's report of "psychological distress" is a subjective judgment of an unobservable condition, while the behaviorist's preference for the term "greater discomfort" merely reports the students' specific responses to the questionnaires.

Deduction and Induction

The two basic approaches to scientific investigation are *deduction* and *induction*. Deduction proceeds from a formally developed theory to the collection of data. Induction proceeds from the collection of data to the development of theory.

DEDUCTION

The deductive approach begins by making assumptions about how the world operates. These assumptions are stated as clearly as possible, and the practical implications are spelled out as hypotheses. Data is then collected and interpreted. If the data is consistent with the hypotheses, new data may be collected and interpreted.

For example, in the stress experiment described above, the psychologist began with the hypothesis that stress impairs judgment, and with a second hypothesis that stress increases subjective dis-

* It should be acknowledged that behaviorists have conducted similar research, using what is called the "match-to-sample" paradigm. However, both the procedures and the goals of the research are quite different. The behavioral emphasis is on learning how certain conditions or events affect behavior, rather than on developing support for a formal theoretical system. In addition, the behavioral psychologist would probably study neutral conditions and various levels of shock in the same students rather than in different groups of students.

tress. He varied both the shock and the warning about shock in the belief that these procedures would produce stress.

With respect to the effects of electric shock, the experimenter further *hypothesized* that threat of shock or actual shock would increase reported disruption of the judgment task. He *observed* that reported disruption was greater under threat of shock than in the neutral condition, and was still greater when shock was actually experienced. He *interpreted* his observations as confirming the hypothesis that threat of shock or actual shock would produce stress. Having demonstrated to his satisfaction that stress varied as a result of shock or threat of shock, the experimenter then evaluated the data on errors. He had *hypothesized* that stress would impair judgment. He *observed* that errors increased with shock threat and were greater still with actual shock. Thus his *interpretation* of this finding was that, "As stress increased, judgment deteriorated."

In the deductive method, the cycle of *hypothesis, observation,* and *interpretation* goes on indefinitely. Support for a theory is cumulative; the more data supporting a theory, the stronger the theory. A theory generally falls into disrepute only when a new theory is better able to explain the existing data, or when a new theory generates a body of data that is consistent with itself but inconsistent with the first theory.

INDUCTION

The inductive approach begins by making as few assumptions as possible. The inductive experimenter may begin with the question, "I wonder what would happen if. . . ?" The experiment is then tried, and the observations recorded. The inductive method can be said to consist of the following elements: assumptions, *observations, inductive generalizations,* and interpretations. While assumptions and interpretations are an inevitable part of the process, they are clearly deemphasized.

In this method, information is gradually accumulated through a series of experiments. When a particular relationship is repeatedly observed, the experimenter becomes more convinced of the importance of the relationship. Systematic exploration of variations in a given experiment (*systematic replication*) helps to establish the generality and limits of a given relationship.[18]

The inductive method can be illustrated by the following series of experiments. It is observed that a hungry pigeon, when placed in

a Skinner Box, will learn to peck a lighted disk if food is sometimes provided immediately after and contingent upon pecking. Subsequent experiments use a variety of organisms (e.g., dogs, children) and a variety of behaviors (e.g., stepping on a treadle, playing ping-pong). Similarities in the *observations* of the results of the series leads to the *inductive generalization* that food deprived (hungry) organisms will engage in a variety of behaviors if food is made contingent on these responses. When this method is applied to the stress experiment described above, the behaviorist would *observe* that the students reported that shock and threat of shock interfered with their performances, and would make the *inductive generalization* that "As threat of shock increased, errors increased and participants reported greater discomfort." Statements concerning nonobservable events such as "stress" and "judgment" do not enter into inductive reasoning.

Respondent and Operant Behavior

Behavioral psychologists divide all behavior into two broad classes: *respondent* and *operant.* Respondent behavior is primarily controlled by events that precede it, while operant behavior is primarily controlled by events that follow it.

Because respondent behavior was discovered first, early theorists assigned it a central role in accounting for behavior. Thus Watson, in his early twentieth-century writings, conceptualized respondent learning as the mode of acquiring all behavior. With the emerging prominence of Skinner in the late 1950s, operant behavior has come to be accorded a more central role. Respondent behavior is now thought to be less influential, especially in the behavior of such complex organisms as human beings. As we shall see, the range of possible respondent behavior is very narrowly determined by biological factors, while the range of possible operant behavior is less dependent on biological factors and hence wider.

RESPONDENT BEHAVIOR

Respondent behavior is essentially involuntary: an event occurs, and a response follows. This happens automatically, in response to either an unconditioned stimulus or to a conditioned stimulus, so long as the organism is capable of responding. For example, when a light is flashed in a person's eyes, blinking occurs automatically.[19]

This is an *unconditioned response* to an *unconditioned stimulus,* and is biologically determined. If a tone that does not normally elicit a blinking response is repeatedly presented and immediately followed by a flashing light, the tone itself will eventually come to elicit eyeblinking. Eyeblinking has thus become a *conditioned response* to a *conditioned stimulus.* This process of pairing a neutral stimulus (the tone) with an unconditioned stimulus (the light) is called *respondent conditioning.* In respondent conditioning, a new stimulus acquires the capacity to elicit an existing response.

The ability of a conditioned stimulus to produce a given respondent may be weakened or eliminated by repeatedly presenting the conditioned stimulus in the absence of the unconditioned stimulus. For example, if the tone is sounded many times without being followed by the light flash, the tone will eventually stop eliciting the eyeblink response. This process is called *respondent extinction.*

The range of respondent behavior is limited for several reasons. First, because respondents are narrowly determined by biological factors, learning does not alter the response; learning simply brings respondents under control of new stimuli. Second, some respondents seem to be unconditionable. Third, conditioned stimuli lose their eliciting capacity very quickly. Fourth, most socially significant behaviors are not respondent in nature.

Although the scope of respondent behavior is limited, respondents interact with operant behavior in a number of important and complex ways. The stimuli that control operant behavior generally have simultaneous eliciting functions for respondent behavior as well. In addition, emotions, which are respondent behaviors, affect operant interactions in several important ways.

OPERANT BEHAVIOR

Respondent behavior is passive: the environment acts on the organism to produce a response. In operant behavior, however, the organism acts on the environment to produce a change, and this change is followed by a reinforcing stimulus. Thus, whereas the sequence of events in respondent behavior is stimulus-response, the sequence of events in operant behavior is response-reinforcing stimulus.*

* This definition is simplified to highlight the basic feature of operant behavior: the controlling role of stimulus consequences. It is possible for stimulus events that occur before an operant to acquire a controlling influence over operant performance.

Let us take the act of eating a piece of pie as an example. In this interaction, lifting fork to mouth is the *response,* and the pleasurable taste of the pie is the *reinforcing stimulus.* If the taste of the pie is unpleasant, the action of lifting it to the mouth will not be reinforced, and the person will be unlikely to continue eating pie.

Measuring Operants

To measure the base rate of a given response, we must choose a unit of measurement. For operants, several measures of *response strength* have been developed: (1) rate or frequency; (2) latency; (3) duration; and (4) intensity or amplitude. The particular measure of response strength used depends on which aspect of behavior is of most concern. Frequency has been found to be an extremely useful measure of response strength over a wide range of behaviors and situations, and is the most commonly used of the four.

To illustrate, we will take the example of a crying infant. *Rate* or *frequency* specifies how many times a given response occurs in a specified unit of time. We might measure frequency of crying by counting the number of crying episodes per hour. *Latency* refers to the amount of time between presentation of a given stimulus and the onset of a specific response. We could measure the latency for crying in terms of the number of seconds between the time we place the infant in bed and the onset of crying. *Duration* is the amount of time in which a given performance, in this case one crying episode, occurs. *Intensity* or *amplitude* is a measure of the strength or forcefulness of behavior. We could measure the amplitude of the infant's crying in terms of the number of decibels registered on a decibel meter.

Another concept related to measuring operants is *base rate,* the ongoing frequency of an operant before any specific contingencies have been introduced. Thus the base rate is the natural frequency of an operant. For example, the base rate of crying for a given child is the frequency with which it spontaneously cries when no special contingencies (such as punishment) are in effect.

Strengthening and Weakening Operants

The principal processes in operant conditioning involve the stimulus events that follow the response. These are the *consequences* or effects of the response. In general, any operant may result in the presentation or the removal of a stimulus; similarly,

stimuli may be classified into three groups: positive, negative, and neutral. The effect of a stimulus event on an operant will depend on the function of the stimulus for that organism, and on whether the stimulus is presented or removed.

Operants may be strengthened by two procedures: positive or negative reinforcement. When an operant is followed by the presentation of a stimulus, and an increase in the frequency of the operant is observed, the process is called *positive reinforcement.* For example, giving Mary a cookie after she runs an errand would be called positive reinforcement if her willingness to run errands were strengthened. When an operant is followed by the removal of a stimulus and an increase in the frequency of the response is observed, the process is called *negative reinforcement.* For example, putting on dark glasses in the bright sunlight results in reduced glare. If wearing dark glasses is thus encouraged, the reduced brightness would be negatively reinforcing. Thus *both positive reinforcement and negative reinforcement result in the increase in frequency of an operant.**

Weakening operants may also be accomplished in two ways. If a response decreases in frequency when it is followed by a particular stimulus, the process is called *punishment.* If slapping Peter's hand each time he touches a particular vase results in a decrease in the frequency of touching, this would be an example of punishment. A second procedure for weakening responses involves removing a stimulus following the response; the most common term for this process is *response cost.* Receiving a fine for speeding would be an example of response cost, provided it resulted in a reduced rate of speed for the driver. Note that *both punishment and response cost result in a decrease in the frequency of a performance.*

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* Reinforcement has been defined in terms of the effect of a stimulus on a response: in order to be termed a reinforcer, a stimulus must be shown to increase a response. Some question has been raised as to whether this is a circular definition.[20] Such concerns can be minimized if it is remembered that a reinforcer, in principle, should be capable of strengthening a wide range of performances. However, in order to assess whether a particular stimulus event is a reinforcer for a given individual, it must be tested on some performance. For example, before we can conclude that a cookie is a reinforcer for Mary, we must check to see that it will strengthen a performance, such as her willingness to run errands.

Stimulus Function

Positive reinforcement, negative reinforcement, punishment, and response cost are examples of *stimulus functions;* other examples are discussed below. The concept of a stimulus function is important because it distinguishes between stimuli that affect behavior and stimuli that do not. Neutral stimuli, those which have no stimulus function, are more abundant than might at first be supposed. Most operants produce a variety of changes in the environment that have little or no effect on the ongoing operant. For example, speaking produces movement of the air near the body. Since such movement generally has no effect on behavior, it would be termed a neutral stimulus.

Operant Reinforcement

Reinforcers may be broadly grouped into two classes: primary reinforcers and conditioned (secondary) reinforcers. Primary reinforcers include those stimulus events that have reinforcing capacity without any specific learning experiences. In general, *primary reinforcers* are biologically based (e.g., food, water, air temperature, physical comfort, sex, avoidance of pain, and so on). *Conditioned reinforcers* are stimuli that have acquired their reinforcing capabilities by means of specific learning experiences. Basically, this involves their being associated with primary reinforcers. When a previously neutral stimulus is used to signal the availability of positive reinforcement following a given response, the stimulus will acquire a conditioned reinforcing function. For example, when a child receives stars for completed school assignments and is then permitted to trade stars for candy, stars acquire a conditioned reinforcing function.

Operant Extinction

Termination of reinforcement is referred to as *operant extinction.* When reinforcement is presented following a performance, the response rate increases to a level that is above the base rate. When reinforcement is terminated, the operant returns to the original base rate. Although no comparable technical term has been developed, it should be noted that there is a parallel for responses that have been punished. When a response is followed by

an effective punishment or response cost, the rate of the response is reduced; terminating punishment will result in a recovery of the base rate.

In operant interactions, reinforcement need not follow each operant. Mother may give Mary a cookie after she has run an errand on Monday, and not give her a cookie following Tuesday's errand. When the stimulus event follows each response, it is called *continuous reinforcement;* a situation in which the stimulus does not always follow the response is called *intermittent reinforcement.* There are a number of ways by which intermittent reinforcement may be scheduled to occur; these are called *schedules of reinforcement.*

Many factors enter into defining schedules of reinforcement. Schedules that are determined mainly by the passage of time are *interval schedules.* Reinforcement schedules that are influnced by the number of responses are called *ratio schedules.* When the unit or number of responses is consistent, they are termed *fixed interval* or *fixed ratio* schedules. When the time interval varies, or when the number of responses changes from time to time, the schedules are called *variable interval* or *variable ratio* schedules.*

Operant Stimulus Control

Given controlling consequences, it is possible for stimulus events that occur before an operant to acquire a controlling influence over an operant performance. An operant performance that has come under control of an antecedent stimulus is called a *discriminated operant.*

A discriminated operant occurs at a higher (or lower) frequency in the presence of a particular stimulus event. For example, when a child learns to say "Daddy" when told, "Say Daddy," or in the presence of the male parent, the child's use of the word "Daddy" is a discriminated operant. The tendency for operants to come under

* While the basic types of schedules are simple and straightforward, the potential complexities are enormous. The units of time or ratio may be varied over wide ranges; two or more schedules may be used in sequence or simultaneously; and so on. Psychologists C. B. Ferster and B. F. Skinner have compiled an entire book cataloguing some of the characteristic response patterns generated by a number of different schedules of reinforcement,[22] and numerous articles have been published on this topic.

control of events that precede them, and thus to become discriminated operants, is a natural and common occurrence. It would be unusual for any given performance to be followed by a reinforcing consequence whenever and wherever it occurs. The child's use of the word "Daddy" quickly becomes discriminated, since the parental response to this expression is different in the presence of another person, such as the child's mother. When no one is present, saying "Daddy" also goes unreinforced.

The stimulus that comes to control a discriminated operant (e.g., the presence of the male parent) is called a *discriminative stimulus;* and the process of coming under control of a discriminative stimulus (e.g., being reinforced for saying "Daddy" in his presence and not reinforced in his absence) is called *operant stimulus discrimination.* It is important to remember that the basic controlling influence in an operant performance is the consequence of the performance, the stimulus event that follows. In our example, the social consequence of the parent saying "good boy" and giving the child a hug is the major controlling event; however, when a hug and the words "good boy" occur only in the presence of Daddy, Daddy's presence comes to exert discriminative stimulus control over the performance.

When a performance is consistently reinforced in the presence of a particular discriminative stimulus, other stimuli—to the degree that they are similar to the discriminative stimulus—will come to have a similar controlling function over the performance. This phenomenon is called *stimulus generalization.* The more similar a stimulus is to the training stimulus, the greater is its capacity to produce the response whose probability is increased in the presence of the training stimulus. A child who learns to say "dog" in the presence of the family pet will generally say "dog" in the presence of similar animals (e.g., cats). This same effect may be observed with cows and horses, but their differences in size would account for a lower probability that the child would call them "dog." Eventually, of course, the child learns to say "dog" only when a dog is present, and to name other animals accurately. The process involved requires repeated reinforcement of saying "dog" in the presence of dogs, and extinction (or punishment) for saying "dog" in the presence of other animals.

Developing New Operants

To this point, operants have been referred to as responses. Henceforth the term *performances* will be used, in order to make an important distinction. We noted earlier that respondents are biologically determined. The basic operant response units are also inherited, as psychologists Sidney W. Bijou and Donald M. Baer note.[22] Pigs don't fly; biological factors preclude this response. Unlike respondents, however, operants may be linked together into complex sequences. Because of this important distinction between the innate response units and the complex response sequences developed through operant conditioning, operants will now be referred to as performances. A *performance* is a sequence of relatively discrete operant responses linked together into a precisely coordinated sequence that is carried out as a functional unit.

The distinction between operant responses and operant performances is basic. Operant responses are biologically given. By contrast, operant performances involve coordinated sequences of operant responses that are developed through learning. For example, movement of the fingers, hands, and arms are innate biological capabilities; playing the piano is a complex operant performance that links together these foundational response units into an integrated functional performance. A performance is a functional unit because there are no explicit stimulus consequences that control the individual components. Rather, the reinforcement maintains the overall performance.

Before a response can be strengthened by reinforcement, it must first occur. For example, until a child begins to vocalize, there is little the parent can do to influence the process of learning to speak. Once vocalization begins, however, operant procedures may play an important role in the further development of speech. Some specialized techniques are needed to develop new operants: these techniques are called *shaping* and *successive approximation of a performance.*

The basic problem in developing new performances is that of linking together the right sequence of existing response units for the first time. Teaching a one-year-old child to say "Daddy" involves getting him to link together the syllables "da" and "dee" in the proper sequence. Typically, the child will spontaneously say

"da da da" and "dee dee dee," but not "da dee." To shape the child to say "Daddy," the parent would begin by reinforcing any occurrences of the sequence "da dee," even if it were part of a longer sequence such as "da da da da dee. . . ." Typically, the parent would hug the child and exclaim, "Good boy, you said 'Daddy.' " Assuming this parental response is a reinforcer, the "da dee" sequence will be strengthened and will become more frequent. Over a period of time, the child will gradually come to say "da dee" more often; it will be easier to reinforce it, and if the parent is careful not to reinforce the child's other babblings, it will become more clear and precise. Eventually, the child will also learn to say "Daddy" when prompted or when his father is present.

A basic principle, and one that is central to the process of shaping new performances, is *response induction* (sometimes called response generalization). This is the tendency for similar performances to increase in frequency if a given performance is reinforced. Since each performance is to some extent unique, this tendency is extremely important. In addition, it plays a role in developing new performances. In the shaping process, performances that are moderately low in frequency (such as the "da da da dee" sequence) are initially strengthened. The result is that similar performances—ones that are more like the desired performance—also become more probable. We can then gradually shift the criterion for reinforcement in the direction of performances that are more and more like the desired performance; when the desired performance begins to occur with some frequency, it can be strengthened and undesired performances can be progressively weakened. In our example, the parent would now reinforce only clear expressions of "Daddy" that are not immediately preceded or followed by other vocalizations.

Establishing Complex Performances

In general, pure shaping procedures are used mostly with simple performances and in persons or other organisms that have rather limited ranges of existing behavior. For example, once the child has developed a moderate vocabulary and a number of other discriminated performances, more sophisticated methods may be used to establish new performances or to bring existing performances under stimulus control. These methods include instructions, modeling and imitation, and chaining.

Instructions. From a behavioral perspective, we may think of instructions as a class of discriminative stimuli. Functionally, instructions specify the response that will be reinforced in their presence in much the same way that discriminative stimuli identify the circumstances under which a particular performance will be followed by particular stimulus consequences. In the example presented earlier, no amount of instructions to the infant to "say Daddy" would have been effective. For instructions to be effective, the required responses must already be available in the repertory of the individual, and they must be under stimulus control of the instructional stimuli.

In developing complex performances, instructions may be used initially, then gradually eliminated as the performance begins to come under the control of other stimulus events that are more intrinsic to the performance. For example, in learning to kick a soccer ball, the child is instructed to watch the ball, step next to it with his left foot, swing the right foot back, and then kick "through" the ball. As the child's soccer skills improve, the sight of the approaching ball controls his stepping into position, drawing back his foot, kicking, and watching the ball fly away. A younger child might learn to kick the ball effectively over a longer period of time through a pure shaping process, in which the movement of the ball (and any social responses) are the reinforcers for successively approximating effective kicking style.

Technically, instructions and the use of other supportive discriminitive stimuli in developing a given performance are called *prompts*. Once the behavior is developed, the prompts may be gradually removed so that the performance comes under control of the natural stimulus events; this process is called *fading*. In the soccer example, the instructions were prompts, and eliminating them over time would be fading.

Modeling and Imitation. From a behavioral perspective, the performance of the model may be viewed as a complex discriminative stimulus in which each element of the model's performance controls a corresponding element in the performance of the person who imitates it. The behavior of a model thus may be viewed as similar to instructions. This implies that if the individual response elements are lacking, or they are not under control of the corre-

sponding behavior of the model, imitation will either fail to occur or will be imperfect. A typical third grade child can readily imitate the phrase "ten times ten equals one hundred," since each of these words is already in the child's repertory and under stimulus control. But the same child would probably have trouble saying "monoamine oxidase," even though it has fewer syllables, because this particular sequence is not in the child's repertory and under stimulus control.

Chaining. Performances are complex sequences of response that are linked together as a functional whole. Many performances could be fractionated into two or more elements, and each element brought under stimulus and reinforcement control. A more common practice, however, is to link two or more performances into a more complex sequence. For convenience and clarity these sequences have come to be called response chains. *Response chains,* then, are sequences of two or more performances that have been linked together into a new functional unit. Saying "ten times ten equals one hundred" might be termed an operant response chain, since we normally think of individual words as a functional response unit.

Setting Events

A *setting event* is a stimulus-response interaction that, by its very occurrence, will affect a wide variety of subsequent stimulus-response interactions. The most commonly described setting event in the behavioral literature is food deprivation. When an organism has gone without food for an extended period of time, a number of changes in ongoing stimulus-response interactions result. A wide range of responses that have previously been successful in obtaining food will be increased in frequency (e.g., saying "I'm hungry"). Conversely, a host of other responses will be reduced in frequency (e.g., play, work, sleep). Food deprivation will also affect emotional behavior, resulting in an increased tendency to become angry or impatient, and a reduced tendency to show pleasant emotional reactions.

A second major class of setting events is emotional behavior. Other examples of setting events include being ill, going without sleep for a long period, and experiencing the death of a loved one.

All the consequences of operant behavior affect both emotional behavior and other setting events. There is an intimate interplay between setting events, which affect dispositions to respond in a given situation, and the consequences of responding, which in turn affect the setting conditions of the organism and thus interact with dispositions to respond on subsequent occasions. For example, when Mother gives Mary a cookie for running an errand, Mary has a pleasant emotional response; this may affect all of her interactions with Mother for a time. Eating the cookie will also temporarily reduce the effectiveness of food as a reinforcer.

Internal Events

Physical events within the body (e.g., temperature and pain sensations, kinesthetic sensations, gastric secretions, pulsing of the heart muscle) are termed *internal events*. These are conceptualized as response or stimulus events, and may come to have the same interrelationships as overt behavior and external events. Internal events may interact with each other as well as with external events.

One example of the role played by internal events is illustrated by the responses set in motion by a headache. In the presence of this event, which functions as a discriminative stimulus, taking an aspirin is reinforced by the termination of the pain. In this interaction, we observe the process of negative reinforecment; that is, the response of taking an aspirin is strengthened by the removal of a stimulus, the headache. This is also an example of a discriminated operant performance, since the headache marked an occasion when taking medication would be reinforced.

Operant and Respondent Interactions

Before examining interactions between operant and respondent behavior, it may be helpful to briefly review the basic characteristics of each type of behavior. Respondents are controlled by events that precede them, and they generally occur whenever a functional eliciting stimulus is presented. By contrast, operants are controlled primarily by stimulus events that follow them. Because reinforcement need not follow each operant response, it is said that reinforcement follows with some *probability*. Further, operants may come under control of discriminitive stimuli that mark the occasion

on which a particular operant is likely to be followed by a particular consequence.

It is widely believed that behavioral psychology is concerned only with the most basic forms of behavior, and is interested only in simple stimulus-response/response-stimulus terms. With the rapid advances in behavioral research over the past two decades, however, such a view has become increasingly misrepresentative. In reality, the behavioral spectum is quite complex.

For example, in the life of Michael, a college student, a broad class of responses may be treated together as "academic responses." These responses may be followed by a number of consequences; for simplicity, these will be classed as reinforcing and punishing consequences. *Reinforcing consequences* (e.g., good grades, praise from his teachers) will tend to strengthen Michael's academic responses. Conversely, *punishing consequences* (e.g., his father's remark that Michael should "forget about college and go into the family business," a low mark on a math test) will tend to weaken Michael's academic responses.

In addition to affecting academic responses, which are operant in nature, reinforcement and punishment for academic responses will also have an affect on Michael's respondent behaviors. The reinforcing stimuli of good grades, for example, will also elicit emotional responses such as pleasure, confidence and self-satisfaction. The punishment of his father's remarks will elicit anxiety and self-doubt. To state this relationship in general terms, *stimulus events that follow operant responses generally have two functions: (1) a reinforcing or punishing function for the operant that precedes them; and (2) an eliciting function for emotional respondents that follow them.*

Another class of events is also produced by these interactions: *setting event functions.* Although the emotional effects of the reinforcing or punishing consequences for academic responses are a part of the overall interaction that affects Michael's probability of engaging in future academic responses, their effects are not limited to this area. The emotions generated—self-confidence, fear, anxiety, and so on—will also affect virtually all other ongoing interactions between Michael and his environment. Stated more generally, *the emotional effects of the reinforcing and punishing consequences that follow an operant will affect the ongoing operant*

*interaction and virtually all other ongoing organism-environment interactions at that time.**

To add further complexity to the situation, any number of other stimulus events may exert an influence on Michael simultaneously with the negative and positive academic responses. For example, while he is trying to study, he may be distracted by a phone call from a friend, nagging hunger sensations, or the appeal of a nap. The prevailing consequences for each of these responses enters into the picture in determining which response will actually occur at any given moment.[23] Thus it can be seen that, *though conceptually simple, operant and respondent behaviors interact in intricate and complex ways.*

NOTES

1. Readers who want to explore basic behavioral concepts may wish to consult one or more of the following: James A. Dinsmoor, *Operant Conditioning: An Experimental Analysis of Behavior* (Dubuque, Iowa: Wm. C. Brown Company, 1970); C. B. Ferster, Stuart Culbertson, and Mary C. P. Boren, *Behavior Principles,* 2d ed. (Englewood Cliffs, N.J.: Prentice-Hall, 1975); F. S. Keller, *Learning; Reinforcement Theory,* rev. ed. (New York: Random House, 1969); Richard B. Powers and J. Grayson Osborne, *Fundamentals of Behavior* (St. Paul, Minn.: West, 1976); and G. S. Reynolds, *A Primer of Operant Conditioning,* rev. ed. (Glenview, Ill: Scott, Foresman and Company, 1975). Keller's Book is written especially for the layperson.
2. Ferster, Culbertson, and Boren, *Behavior Principles,* pp. 2–3. Cf. Rodger K. Bufford, "God and Behavior Mod II: Some Reflections on Vos's Response," *Journal of Psychology and Theology* 6 (1978): 215–218; and Mary Stewart Van Leeuwen, "The Behaviorist Bandwagon and the Body of Christ," *Journal of the American Scientific Affiliation* 31 (1979): 3–9, 89–91, 129–138.
3. Sidney W. Bijou and Donald M. Baer, *Child Development I: A Systematic and Empirical Theory* (New York: Appleton-Century-Crofts, 1961), p. 4.
4. Ferster, Culbertson, and Boren, *Behavior Principles,* p. 3.
5. Bijou and Baer, *Child Development I,* p. 17.
6. John B. Watson's writings include: *Behavior: An Introduction to Comparative Psychology* (New York: Holt, 1914); *Psychology from the Standpoint of a Behaviorist* (Philadelphia: Lippincott, 1919); and *Behaviorism,* rev. ed. (New York: Norton, 1930).
7. J. P. Chaplin and T. S. Krawiec, *Systems and Theories of Psychology* (New York: Holt, Rinehart, and Winston, 1960), p. 50.
8. Ibid.

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* The effects of the emotional behaviors elicited may extend over a substantial period of time. For example, an Olympic gymnast who falls in the middle of a balance beam routine may be depressed for weeks or even months as a result of the emotional responses elicited by his inept behavior.

9. Ibid., p. 200.
10. Ibid., p. 187.
11. B. F. Skinner, "Are Theories of Learning Necessary?" *Psychological Review* 57 (1950): 193–216.
12. B. F. Skinner, *Science and Human Behavior* (New York: Macmillan Co., 1953), pp. 59 ff. Cf. Sidney W. Bijou and Dona'd M. Baer, *Child Development II: Universal Stage of Infancy* (New York: Appleton-Century-Crofts, 1965), pp. 79–82.
13. C. B. Ferster and B. F. Skinner, *Schedules of Reinforcement* (New York: Appleton-Century-Crofts, 1957).
14. John Dollard and Neil E. Miller, *Personality and Psychotherapy* (New York: McGraw-Hill Publishing Co., 1950).
15. Skinner, *Science and Human Behavior.*
16. Joseph Wolpe, *Psychotherapy by Reciprocal Inhibition* (Stanford, Cal: Stanford University Press, 1958).
17. Arnold A. Lazarus, "The Results of Behavior Therapy in 126 Cases of Severe Neurosis," *Behavior Research and Therapy* 1 (1963): 69–79.
18. Murray Sidman, *Tactics of Scientific Research* (New York: Basic Books, 1960).
19. Bijou and Baer, *Child Development I,* pp. 26–31.
20. See R. L. Burgess and R. L. Akers, "Are Operant Principles Tautological?" *The Psychological Record* 16 (1966): 305–312; and J. R. Millenson, *Principles of Behavioral Analysis* (New York: Macmillan Co., 1967), pp. 76–77.
21. Ferster and Skinner, *Schedules of Reinforcement.*
22. Bijou and Baer, *Child Development I,* pp. 42–43; Sidney W. Bijou and Donald M. Baer, *Child Development II: Universal Stage of Infancy* (New York: Appleton-Century-Crofts, 1965), pp. 82–85.
23. For another example of a complex set of behavioral interactions, see Bijou and Baer, *Child Development I,* pp. 65–70.