Applied Behavior Analysis

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CHAPTER 1

Definition and Characteristics of Applied Behavior Analysis

Key Terms

applied behavior analysis (ABA)
behaviorism
determinism
empiricism
experiment
experimental analysis of behavior (EAB)
explanatory fiction
functional relation
hypothetical construct
mentalism
methodological behaviorism
parsimony
philosophic doubt
radical behaviorism
replication
science

Behavior Analyst Certification Board® BCBA® & BCABA® Behavior Analyst Task List©, Third Edition

Content Area 2: Definition and Characteristics	
2-1	Explain behavior in accordance with the philosophical assumptions of behavior analysis, such as the lawfulness of behavior, empiricism, experimental analysis, and parsimony.
2-2	Explain determinism as it relates to behavior analysis.
2-3	Distinguish between mentalistic and environmental explanations of behavior.
2-4	Distinguish among the experimental analysis of behavior, applied behavior analysis, and behavioral technologies.
2-5	Describe and explain behavior, including private events, in behavior analytic (nonmentalistic) terms.
2-6	Use the dimensions of applied behavior analysis (Baer, Wolf, & Risley 1968) for evaluating interventions to determine if they are behavior analytic.
Content Area 3: Principles, Processes, and Concepts	
3-10	Define and provide examples of functional relations.

Applied behavior analysis is a science devoted to the understanding and improvement of human behavior. But other fields have similar intent. What sets applied behavior analysis apart? The answer lies in its focus, goals, and methods. Applied behavior analysts focus on objectively defined behaviors of social significance; they intervene to improve the behaviors under study while demonstrating a reliable relationship between their interventions and the behavioral improvements; and they use the methods of scientific inquiry—objective description, quantification, and controlled experimentation. In short, applied behavior analysis, or ABA, is a scientific approach for discovering environmental variables that reliably influence socially significant behavior and for developing a technology of behavior change that takes practical advantage of those discoveries.

This chapter provides a brief outline of the history and development of behavior analysis, discusses the philosophy that underlies the science, and identifies the defining dimensions and characteristics of applied behavior analysis. Because applied behavior analysis is an applied science, we begin with an overview of some precepts fundamental to all scientific disciplines.

Some Basic Characteristics and a Definition of Science

Used properly, the word *science* refers to a systematic approach for seeking and organizing knowledge about the natural world. Before offering a definition of science, we discuss the purpose of science and the basic assumptions and attitudes that guide the work of all scientists, irrespective of their fields of study.

Purpose of Science

The overall goal of science is to achieve a thorough understanding of the phenomena under study—socially important behaviors, in the case of applied behavior analysis. Science differs from other sources of knowledge or ways we obtain knowledge about the world around us (e.g., contemplation, common sense, logic, authority figures, religious or spiritual beliefs, political campaigns, advertisements, testimonials). Science seeks to discover nature's truths. Although it is frequently misused, science is not a tool for validating the cherished or preferred versions of "the truth" held by any group, corporation, government, or institution. Therefore, scientific knowledge must be separated from any personal, political, economic, or other reasons for which it was sought.

Different types of scientific investigations yield knowledge that enables one or more of three levels of understanding: description, prediction, and control. Each level of understanding contributes to the scientific knowledge base of a given field.

Description

Systematic observation enhances the understanding of a given phenomenon by enabling scientists to describe it accurately. Descriptive knowledge consists of a collection of facts about the observed events that can be quantified, classified, and examined for possible relations with other known facts—a necessary and important activity for any scientific discipline. The knowledge obtained from descriptive studies often suggests possible hypotheses or questions for additional research.

For example, White (1975) reported the results of observing the "natural rates" of approval (verbal praise or encouragement) and disapproval (criticisms, reproach) by 104 classroom teachers in grades 1 to 12. Two major findings were that (a) the rates of teacher praise dropped with each grade level, and (b) in every grade after second, the rate at which teachers delivered statements of disapproval to students exceeded the rate of teacher approval. The results of this descriptive study helped to stimulate dozens of subsequent studies aimed at discovering the factors responsible for the disappointing findings or at increasing teachers' rates of praise (e.g., Alber, Heward, & Hippler, 1999; Martens, Hiralall, & Bradley, 1997; Sutherland, Wehby, & Yoder, 2002; Van Acker, Grant, & Henry, 1996).

Prediction

A second level of scientific understanding occurs when repeated observations reveal that two events consistently covary with each other. That is, in the presence of one event (e.g., approaching winter) another event occurs (or fails to occur) with some specified probability (e.g., certain birds fly south). When systematic covariation between two events is found, this relationship—termed a *correlation*—can be used to predict the relative probability that one event will occur, based on the presence of the other event.

Because no variables are manipulated or controlled by the researcher, correlational studies cannot demonstrate whether any of the observed variables are responsible for the changes in the other variable(s), and no such relations should be inferred (Johnston & Pennypacker, 1993a). For example, although a strong correlation exists between hot weather and an increased incidence of drowning deaths, we should not assume that a hot and humid day causes anyone to drown. Hot weather also correlates with other factors, such as an increased number of people (both swimmers and nonswimmers) seeking relief in the water, and many instances of drowning have been found to be a function of factors such as the use of alcohol or drugs, the relative swimming skills of the victims, strong riptides, and the absence of supervision by lifeguards.

Results of correlational studies can, however, suggest the possibility of causal relations, which can then be explored in later studies. The most common type of correlational study reported in the applied behavior analysis literature compares the relative rates or conditional probabilities of two or more observed (but not manipulated) variables (e.g., Atwater & Morris, 1988; Symons, Hoch, Dahl, & McComas, 2003; Thompson & Iwata, 2001). For example, McKerchar and Thompson (2004) found correlations between problem behavior exhibited by 14 preschool children and the following consequent events: teacher attention (100% of the children), presentation of some material or item to the child (79% of the children), and escape from instructional tasks (33% of the children). The results of this study not only provide empirical validation for the social consequences typically used in clinical settings to analyze the variables maintaining children's problem behavior, but also increase confidence in the prediction that interventions based on the findings from such assessments will be relevant to the conditions that occur naturally in preschool classrooms (Iwata et al., 1994; see Chapter 24). In addition, by revealing the high probabilities with which teachers responded to problem behavior in ways that are likely to maintain and strengthen it, McKerchar and Thompson's findings also point to the need to train teachers in more effective ways to respond to problem behavior.

Control

The ability to predict with a certain degree of confidence is a valuable and useful result of science; prediction enables preparation. However, the greatest potential benefits from science can be derived from the third, and highest, level of scientific understanding—control. Evidence of the kinds of control that can been derived from scientific findings in the physical and biological sciences surrounds us in the everyday technologies we take for granted: pasteurized milk and the refrigerators we store it in; flu shots and the automobiles we drive to go get them; aspirin and the televisions that bombard us with news and advertisements about the drug.

Functional relations, the primary products of basic and applied behavior analytic research, provide the kind of scientific understanding that is most valuable and useful to the development of a technology for changing behavior. A **functional relation** exists when a well-controlled experiment reveals that a specific change in one event (the *dependent variable*) can reliably be produced by specific manipulations of another event (the *independent variable*), and that the change in the dependent variable was unlikely to be the result of other extraneous factors (*confounding variables*).

Johnston and Pennypacker (1980) described functional relations as "the ultimate product of a natural scientific investigation of the relation between behavior and its determining variables" (p. 16).

> Such a "co-relation" is expressed as $y = f(x)$, where x is the independent variable or argument of the function, and y is the dependent variable. In order to determine if an observed relation is truly functional, it is necessary to demonstrate the operation of the values of x in isolation and show that they are sufficient for the production of y. . . . [H]owever, a more powerful relation exists if necessity can be shown (that y occurs *only if* x occurs). The most complete and elegant form of empirical inquiry involves applying the experimental method to identifying functional relations. (Johnston & Pennypacker, 1993a, p. 239)

The understanding gained by the scientific discovery of functional relations is the basis of applied technologies in all fields. Almost all of the research studies cited in this text are experimental analyses that have demonstrated or discovered a functional relation between a target behavior and one or more environmental variables. However, it is important to understand that functional relations are also correlations (Cooper, 2005), and that:

> In fact, all we ever really know is that two events are related or "co-related" in some way. To say that one "causes" another is to say that one is solely the result of the other. To know this, it is necessary to know that no other factors are playing a contributing role. This is virtually impossible to know because it requires identifying all possible such factors and then showing that they are not relevant. (Johnston & Pennypacker, 1993a, p. 240)

Attitudes of Science

> Science is first of all a set of attitudes.
>
> —B. F. Skinner (1953, p. 12)

The definition of science lies not in test tubes, spectrometers, or electron accelerators, but in the behavior of scientists. To begin to understand any science, we need to look past the apparatus and instrumentation that are most readily apparent and examine what scientists do.[1] The

[1]Skinner (1953) noted, that although telescopes and cyclotrons give us a "dramatic picture of science in action" (p. 12), and science could not have advanced very far without them, such devices and apparatus are not science themselves. "Nor is science to be identified with precise measurement. We can measure and be mathematical without being scientific at all, just as we may be scientific with these aids" (p. 12). Scientific instruments bring scientists into greater contact with their subject matter and, with measurement and mathematics, enable a more precise description and control of key variables.

pursuit of knowledge can properly be called *science* when it is carried out according to general methodological precepts and expectations that define science. Although there is no "scientific method" in the sense of a prescribed set of steps or rules that must be followed, all scientists share a fundamental assumption about the nature of events that are amenable to investigation by science, general notions about basic strategy, and perspectives on how to view their findings. These attitudes of science—determinism, empiricism, experimentation, replication, parsimony, and philosophic doubt—constitute a set of overriding assumptions and values that guide the work of all scientists (Whaley & Surratt, 1968).

Determinism

Science is predicated on the assumption of **determinism.** Scientists presume that the universe, or at least that part of it they intend to probe with the methods of science, is a lawful and orderly place in which all phenomena occur as the result of other events. In other words, events do not just happen willy-nilly; they are related in systematic ways to other factors, which are themselves physical phenomena amenable to scientific investigation.

If the universe were governed by *accidentalism,* a philosophical position antithetical to determinism that holds that events occur by accident or without cause, or by *fatalism,* the belief that events are predetermined, the scientific discovery and technological use of functional relations to improve things would be impossible.

> If we are to use the methods of science in the field of human affairs, we must assume behavior is lawful and determined. We must expect to discover what a man does is the result of specifiable conditions and that once these conditions have been discovered, we can anticipate and to some extent determine his actions. (Skinner, 1953, p. 6)

Determinism plays a pivotal dual role in the conduct of scientific practice: It is at once a philosophical stance that does not lend itself to proof and the confirmation that is sought by each experiment. In other words, the scientist first assumes lawfulness and then proceeds to look for lawful relations (Delprato & Midgley, 1992).

Empiricism

Scientific knowledge is built on, above all, **empiricism**—the practice of objective observation of the phenomena of interest. Objectivity in this sense means "independent of the individual prejudices, tastes, and private opinions of the scientist. . . . Results of empirical methods are objective in that they are open to anyone's observation and do not depend on the subjective belief of the individual scientist" (Zuriff, 1985, p. 9).

In the prescientific era, as well as in nonscientific and pseudoscientific activities today, knowledge was (and is) the product of contemplation, speculation, personal opinion, authority, and the "obvious" logic of common sense. The scientist's empirical attitude, however, demands objective observation based on thorough description, systematic and repeated measurement, and precise quantification of the phenomena of interest.

As in every scientific field, empiricism is the foremost rule in the science of behavior. Every effort to understand, predict, and improve behavior hinges on the behavior analyst's ability to completely define, systematically observe, and accurately and reliably measure occurrences and nonoccurrences of the behavior of interest.

Experimentation

Experimentation is the basic strategy of most sciences. Whaley and Surratt (1968) used the following anecdote to introduce the need for conducting experiments.

> A man who lived in a suburban dwelling area was surprised one evening to see his neighbor bow to the four winds, chant a strange melody, and dance around his front lawn beating a small drum. After witnessing the same ritual for over a month, the man became overwhelmed with curiosity and decided to look into the matter.
>
> "Why do you go through this same ritual each evening?" the man asked his neighbor.
>
> "It keeps my house safe from tigers," the neighbor replied.
>
> "Good grief!" the man said. "Don't you know there isn't a tiger within a thousand miles of here?"
>
> "Yeah," the neighbor smiled. "Sure works, doesn't it!" (pp. 23–2 to 23–3)

When events are observed to covary or occur in close temporal sequence, a functional relation may exist, but other factors may be responsible for the observed values of the dependent variable. To investigate the possible existence of a functional relation, an experiment (or better, a series of experiments) must be performed in which the factor(s) suspected of having causal status are systematically controlled and manipulated while the effects on the event under study are carefully observed. In discussing the meaning of the term *experimental,* Dinsmoor (2003) noted that

> two measures of behavior may be found to covary at a statistically significant level, but it is not thereby made clear which factor is the cause and which is the effect, or indeed whether the relations between the two is not the product of a third, confounded factor, with which both of them happened to covary. Suppose, for example, it is found that students with good grades have more dates than those with lower grades. Does this imply that high

> grades make people socially attractive? That dating is the royal road to academic success? That it pays to be smart? Or that financial security and free time contribute both to academic and to social success? (p. 152)

Reliably predicting and controlling any phenomena, including the presence of tigers in one's backyard, requires the identification and manipulation of the factors that cause those phenomena to act as they do. One way that the individual described previously could use the experimental method to evaluate the effectiveness of his ritual would be to first move to a neighborhood in which tigers are regularly observed and then systematically manipulate the use of his antitiger ritual (e.g., one week on, one week off, one week on) while observing and recording the presence of tigers under the ritual and no-ritual conditions.

> The experimental method is a method for isolating the relevant variables within a pattern of events. . . . [W]hen the experimental method is employed, it is possible to change one factor at a time (independent variable) while leaving all other aspects of the situation the same, and then to observe what effect this change has on the target behavior (dependent variable). Ideally, a functional relation may be obtained. Formal techniques of experimental control are designed to make sure that the conditions being compared are otherwise the same. Use of the experimental method serves as a necessary condition (sine quo non) to distinguish the experimental analysis of behavior from other methods of investigation. (Dinsmoor, 2003, p. 152)

Thus, an **experiment** is a carefully conducted comparison of some measure of the phenomenon of interest (the dependent variable) under two or more different conditions in which only one factor at a time (the independent variable) differs from one condition to another. Strategies and tactics for conducting experiments in applied behavior analysis are described in Chapters 7 through 10.

Replication

The results of a single experiment, no matter how well the study was designed and conducted and no matter how clear and impressive the findings, are never sufficient to earn an accepted place among the scientific knowledge base of any field. Although the data from a single experiment have value in their own right and cannot be discounted, only after an experiment has been replicated a number of times with the same basic pattern of results do scientists gradually become convinced of the findings.

Replication—the repeating of experiments (as well as repeating independent variable conditions within experiments)—"pervades every nook and cranny of the experimental method" (Johnston & Pennypacker, 1993a, p. 244). Replication is the primary method with which scientists determine the reliability and usefulness of their findings and discover their mistakes (Johnston & Pennypacker, 1980; 1993a; Sidman, 1960). Replication—not the infallibility or inherent honesty of scientists—is the primary reason science is a self-correcting enterprise that eventually gets it right (Skinner, 1953).

How many times must an experiment be repeated with the same results before the scientific community accepts the findings? There is no set number of replications required, but the greater the importance of the findings for either theory or practice, the greater the number of replications to be conducted. The role of replication in behavioral research and replication strategies used in applied behavior analysis are described in Chapters 7 through 10.

Parsimony

One dictionary definition of *parsimony* is great frugality, and in a special way this connotation accurately describes the behavior of scientists. As an attitude of science, **parsimony** requires that all simple, logical explanations for the phenomenon under investigation be ruled out, experimentally or conceptually, before more complex or abstract explanations are considered. Parsimonious interpretations help scientists fit their findings within the field's existing knowledge base. A fully parsimonious interpretation consists only of those elements that are necessary and sufficient to explain the phenomenon at hand. The attitude of parsimony is so critical to scientific explanations that it is sometimes referred to as the Law of Parsimony (Whaley & Surratt, 1968), a "law" derived from *Occam's Razor,* credited to William of Occam (1285–1349), who stated: "One should not increase, beyond what is necessary, the number of entities required to explain anything" (Mole, 2003). In other words, given a choice between two competing and compelling explanations for the same phenomenon, one should shave off extraneous variables and choose the simplest explanation, the one that requires the fewest assumptions.

Philosophic Doubt

The attitude of **philosophic doubt** requires the scientist to continually question the truthfulness of what is regarded as fact. Scientific knowledge must always be viewed as tentative. Scientists must constantly be willing to set aside their most cherished beliefs and findings and replace them with the knowledge derived from new discoveries.

Good scientists maintain a healthy level of skepticism. Although being skeptical of others' research may be easy, a more difficult but critical characteristic of scientists is that they remain open to the possibility—as well as look for evidence—that their own findings or interpretations are wrong. As Oliver Cromwell (1650) stated in another context: "I beseech you . . . think it possible you may be mistaken." For the true scientist, "new findings are not problems; they are opportunities for further investigation and expanded understanding" (Todd & Morris, 1993, p. 1159).

Practitioners should be as skeptical as researchers. The skeptical practitioner not only requires scientific evidence before implementing a new practice, but also evaluates continually its effectiveness once the practice has been implemented. Practitioners must be particularly skeptical of extraordinary claims made for the effectiveness of new theories, therapies, or treatments (Jacobson, Foxx, & Mulick, 2005; Maurice, 2006).

> Claims that sound too good to be true are usually just that. . . . Extraordinary claims require extraordinary evidence. (Sagan, 1996; Shermer, 1997)
>
> What constitutes extraordinary evidence? In the strictest sense, and the sense that should be employed when evaluating claims of educational effectiveness, evidence is the outcome of the application of the scientific method to test the effectiveness of a claim, a theory, or a practice. The more rigorously the test is conducted, the more often the test is replicated, the more extensively the test is corroborated, the more extraordinary the evidence. Evidence becomes extraordinary when it is extraordinarily well tested. (Heward & Silvestri, 2005, p. 209)

We end our discussion of philosophic doubt with two pieces of advice, one from Carl Sagan, the other from B. F. Skinner: "The question is not whether we *like* the conclusion that emerges out of a train of reasoning, but whether the conclusion *follows* from the premise or starting point and whether that premise is true" (Sagan, 1996, p. 210). "Regard no practice as immutable. Change and be ready to change again. Accept no eternal verity. Experiment" (Skinner, 1979, p. 346).

Other Important Attitudes and Values

The six attitudes of science that we have examined are necessary features of science and provide an important context for understanding applied behavior analysis. However, the behavior of most productive and successful scientists is also characterized by qualities such as thoroughness, curiosity, perseverance, diligence, ethics, and honesty. Good scientists acquire these traits because behaving in such ways has proven beneficial to the progress of science.

A Definition of Science

There is no universally accepted, standard definition of science. We offer the following definition as one that encompasses the previously discussed purposes and attitudes of science, irrespective of the subject matter. **Science** is a systematic approach to the understanding of natural phenomena—as evidenced by description, prediction, and control—that relies on determinism as its fundamental assumption, empiricism as its prime directive, experimentation as its basic strategy, replication as its necessary requirement for believability, parsimony as its conservative value, and philosophic doubt as its guiding conscience.

A Brief History of the Development of Behavior Analysis

Behavior analysis consists of three major branches. **Behaviorism** is the philosophy of the science of behavior, basic research is the province of the experimental analysis of behavior (EAB), and developing a technology for improving behavior is the concern of applied behavior analysis (ABA). Applied behavior analysis can be fully understood only in the context of the philosophy and basic research traditions and findings from which it evolved and remains connected today. This section provides an elementary description of the basic tenets of behaviorism and outlines some of the major events that have marked the development of behavior analysis.[2] Table 1.1 lists major books, journals, and professional organizations that have contributed to the advancement of behavior analysis since the 1930s.

Stimulus–Response Behaviorism of Watson

Psychology in the early 1900s was dominated by the study of states of consciousness, images, and other mental processes. Introspection, the act of carefully observing one's own conscious thoughts and feelings, was a primary method of investigation. Although the authors of several texts in the first decade of the 20th century defined psychology as the science of behavior (see Kazdin, 1978), John B. Watson is widely recognized as the spokesman for a new direction in the field of psychology.

[2] Informative and interesting descriptions of the history of behavior analysis can be found in Hackenberg (1995), Kazdin (1978), Michael (2004), Pierce and Epling (1999), Risley (1997, 2005), Sidman (2002), Skinner (1956, 1979), Stokes (2003), and in a special section of articles in the fall 2003 issue of *The Behavior Analyst.*

Table 1.1 Representative Selection of Books, Journals, and Organizations That Have Played a Major Role in the Development and Dissemination of Behavior Analysis

Decade	Books	Journals	Organizations
1930s	*The Behavior of Organisms*—Skinner (1938)		
1940s	*Walden Two*—Skinner (1948)		
1950s	*Principles of Psychology*—Keller & Schoenfeld (1950) *Science and Human Behavior*—Skinner (1953) *Schedules of Reinforcement*—Ferster & Skinner (1957) *Verbal Behavior*—Skinner (1957)	*Journal of the Experimental Analysis of Behavior* (1958)	Society for the Experimental Analysis of Behavior (SEAB) (1957)
1960s	*Tactics for Scientific Research*—Sidman (1960) *Child Development, Vols. I & II*—Bijou & Baer (1961, 1965) *The Analysis of Behavior*—Holland & Skinner (1961) *Research in Behavior Modification*—Krasner & Ullmann (1965) *Operant Behavior: Areas of Research and Application*—Honig (1966) *The Analysis of Human Operant Behavior*—Reese (1966) *Contingencies of Reinforcement: A Theoretical Analysis*—Skinner (1969)	*Journal of Applied Behavior Analysis* (1968)	American Psychological Association - Division 25 Experimental Analysis of Behavior (1964) Experimental Analysis of Behaviour Group (UK) (1965)
1970s	*Beyond Freedom and Dignity*—Skinner (1971) *Elementary Principles of Behavior*—Whaley & Malott (1971) *Contingency Management in Education and Other Equally Exciting Places*—Malott (1974) *About Behaviorism*—Skinner (1974) *Applying Behavior-Analysis Procedures with Children and Youth*—Sulzer-Azaroff & Mayer (1977) *Learning*—Catania (1979)	*Behaviorism* (1972) (became *Behavior and Philosophy* in 1990) *Revista Mexicana de Analisis de la Conducta* (1975) *Behavior Modification* (1977) *Journal of Organizational Behavior Management* (1977) *Education & Treatment of Children* (1977) *The Behavior Analyst* (1978)	Norwegian Association for Behavior Analysis (1973) Midwestern Association for Behavior Analysis (MABA) (1974) Mexican Society of Behavior Analysis (1975) Association for Behavior Analysis (formerly MABA) (1978)
1980s	*Strategies and Tactics for Human Behavioral Research*—Johnston & Pennypacker (1980) *Behaviorism: A Conceptual Reconstruction*—Zuriff (1985) *Recent Issues in the Analysis of Behavior*—Skinner (1989)	*Journal of Precision Teaching and Celeration* (originally, *Journal of Precision Teaching*) (1980) *Journal of Organizational Behavior Management* (1977) *Analysis of Verbal Behavior* (1982) *Japanese Journal of Behavior Analysis* (1986) *Behavior Analysis Digest* (1989)	Society for the Advancement of Behavior Analysis (1980) Cambridge Center for Behavioral Studies (1981) Japanese Association for Behavior Analysis (1983)

Table 1.1 *(continued)*

Decade	Books	Journals	Organizations
1990s	*Concepts and Principles of Behavior Analysis*—Michael (1993)	*Behavior and Social Issues* (1991)	Accreditation of Training Programs in Behavior Analysis (Association for Behavior Analysis) (1993)
	Radical Behaviorism: The Philosophy and the Science—Chiesa (1994)	*Journal of Behavioral Education* (1991)	Behavior Analyst Certification Board (BACB) (1998)
	Equivalence Relations and Behavior—Sidman (1994)	*Behavioral Interventions* (1986)	Council of Directors of Graduate Programs in Behavior Analysis (Association for Behavior Analysis) (1999)
	Functional Analysis of Problem Behavior—Repp & Horner (1999)	*Journal of Positive Behavior Interventions* (1999)	
		The Behavior Analyst Today (1999)	
2000s		*European Journal of Behavior Analysis* (2000)	First Board Certified Behavior Analysts (BCBA) and Board Certified Associate Behavior Analysts (BCABA) credentialed by the BACB (2000)
		Behavioral Technology Today (2001)	
		Behavioral Development Bulletin (2002)	European Association for Behaviour Analysis (2002)
		Journal of Early and Intensive Behavior Intervention (2004)	
		Brazilian Journal of Behavior Analysis (2005)	
		International Journal of Behavioral Consultation and Therapy (2005)	

In his influential article, "Psychology as the Behaviorist Views It," Watson (1913) wrote:

> Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. (p. 158)

Watson argued that the proper subject matter for psychology was not states of mind or mental processes but observable behavior. Further, the objective study of behavior as a natural science should consist of direct observation of the relationships between environmental stimuli (S) and the responses (R) they evoke. Watsonian behaviorism thus became known as stimulus–response (S–R) psychology. Although there was insufficient scientific evidence to support S–R psychology as a workable explanation for most behavior, Watson was confident that his new behaviorism would indeed lead to the prediction and control of human behavior and that it would allow practitioners to improve performance in areas such as education, business, and law. Watson (1924) made bold claims concerning human behavior, as illustrated in this famous quotation:

> 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. I am going beyond my facts and I admit it, but so have the advocates of the contrary and they have been doing it for many thousands of years. (p. 104)

It is unfortunate that such extraordinary claims were made, exaggerating the ability to predict and control human behavior beyond the scientific knowledge available. The quotation just cited has been used to discredit Watson and continues to be used to discredit behaviorism in general, even though the behaviorism that underlies contemporary behavior analysis is fundamentally different from the S–R paradigm. Nevertheless, Watson's contributions were of great significance: He made a strong

B. F. Skinner *(left)* in his Indiana University lab circa 1945 and *(right)* circa 1967.

case for the study of behavior as a natural science on a par with the physical and biological sciences.[3]

Experimental Analysis of Behavior

The experimental branch of behavior analysis formally began in 1938 with the publication of B. F. Skinner's *The Behavior of Organisms* (1938/1966). The book summarized Skinner's laboratory research conducted from 1930 to 1937 and brought into perspective two kinds of behavior: respondent and operant.

Respondent behavior is reflexive behavior as in the tradition of Ivan Pavlov (1927/1960). Respondents are elicited, or "brought out," by stimuli that immediately precede them. The antecedent stimulus (e.g., bright light) and the response it elicits (e.g., pupil constriction) form a functional unit called a *reflex.* Respondent behaviors are essentially involuntary and occur whenever the eliciting stimulus is presented.

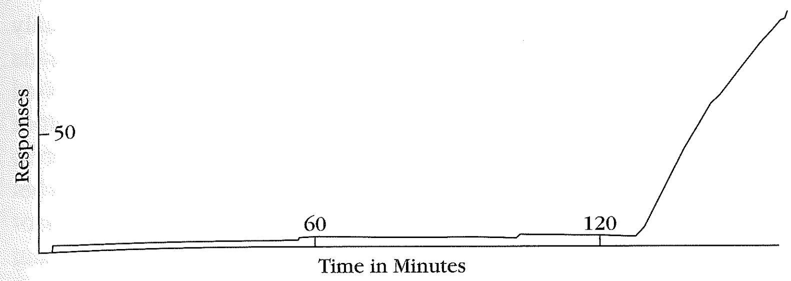
Skinner was "interested in giving a scientific account of all behavior, including that which Descartes had set aside as 'willed' and outside the reach of science" (Glenn, Ellis, & Greenspoon, 1992, p. 1330). But, like other psychologists of the time, Skinner found that the S–R paradigm could not explain a great deal of behavior, particularly behaviors for which there were no apparent antecedent causes in the environment. Compared to reflexive behavior with its clear eliciting events, much of the behavior of organisms appeared spontaneous or "voluntary." In an attempt to explain the mechanisms responsible for "voluntary" behavior, other psychologists postulated mediating variables inside the organism in the form of hypothetical constructs such as cognitive processes, drives, and free will. Skinner took a different tack. Instead of creating **hypothetical constructs,** presumed but unobserved entities that could not be manipulated in an experiment, Skinner continued to look in the environment for the determinants of behavior that did not have apparent antecedent causes (Kimball, 2002; Palmer, 1998).

> He did not deny that physiological variables played a role in determining behavior. He merely felt that this was the domain of other disciplines, and for his part, remained committed to assessing the causal role of the environment. This decision meant looking elsewhere in time. Through painstaking research, Skinner accumulated significant, if counterintuitive, evidence that behavior is changed less by the stimuli that precede it (though context is important) and more by the consequences that immediately follow it (i.e., consequences that are contingent upon it). The essential formulation for this notion is S–R–S, otherwise known as the three–term contingency. It did not replace the S–R model—we still salivate, for instance, if we smell food cooking when we are hungry. It did, however, account for how the environment "selects" the great part of learned behavior.
>
> With the three-term contingency Skinner gave us a new paradigm. He achieved something no less profound for the study of behavior and learning than Bohr's model of the atom or Mendel's model of the gene. (Kimball, 2002, p. 71)

Skinner called the second type of behavior *operant behavior.*[4] Operant behaviors are not elicited by preceding stimuli but instead are influenced by stimulus changes that have followed the behavior in the past. Skinner's

[3]For an interesting biography and scholarly examination of J. B. Watson's contributions, see Todd and Morris (1994).

[4]In *The Behavior of Organisms,* Skinner called the conditioning of respondent behavior Type S conditioning and the conditioning of operant behavior Type R conditioning, but these terms were soon dropped. Respondent and operant conditioning and the three-term contingency are further defined and discussed in Chapter 2.



Original Conditioning
All responses to the lever were reinforced. The first three reinforcements were apparently ineffective. The fourth is followed by a rapid increase in rate.

Figure 1.1 The first data set presented in B. F. Skinner's *The Behavior of Organisms: An Experimental Analysis* (1938).
From *The Behavior of Organisms: An Experimental Analysis* by B. F. Skinner, p. 67. Original copyright 1938 by Appleton-Century. Copyright 1991 by B. F. Skinner Foundation, Cambridge, MA. Used by permission.

most powerful and fundamental contribution to our understanding of behavior was his discovery and experimental analyses of the effects of consequences on behavior. The operant three-term contingency as the primary unit of analysis was a revolutionary conceptual breakthrough (Glenn, Ellis, & Greenspoon, 1992).

Skinner (1938/1966) argued that the analysis of operant behavior "with its unique relation to the environment presents a separate important field of investigation" (p. 438). He named this new science the **experimental analysis of behavior** and outlined the methodology for its practice. Simply put, Skinner recorded the rate at which a single subject (he initially used rats and later, pigeons) emitted a given behavior in a controlled and standardized experimental chamber.

The first set of data Skinner presented in *The Behavior of Organisms* was a graph that "gives a record of the resulting change in behavior" (p. 67) when a food pellet was delivered immediately after a rat pressed a lever (see Figure 1.1). Skinner noted that the first three times that food followed a response "had no observable effect" but that "the fourth response was followed by an appreciable increase in rate showing a swift acceleration to a maximum" (pp. 67–68).

Skinner's investigative procedures evolved into an elegant experimental approach that enabled clear and powerful demonstrations of orderly and reliable functional relations between behavior and various types of environmental events.[5] By systematically manipulating the arrangement and scheduling of stimuli that preceded and followed behavior in literally thousands of laboratory experiments from the 1930s through the 1950s, Skinner and his colleagues and students discovered and verified the basic principles of operant behavior that continue to provide the empirical foundation for behavior analysis today. Description of these principles of behavior—general statements of functional relations between behavior and environmental events—and tactics for changing behavior derived from those principles constitute a major portion of this text.

Skinner's Radical Behaviorism

In addition to being the founder of the experimental analysis of behavior, B. F. Skinner wrote extensively on the philosophy of that science.[6] Without question, Skinner's writings have been the most influential both in guiding the practice of the science of behavior and in proposing the application of the principles of behavior to new areas. In 1948 Skinner published *Walden Two,* a fictional account of how the philosophy and principles of behavior might be used in a utopian community. This was followed by his classic text, *Science and Human Behavior* (1953), in which he speculated on how the principles of behavior might be applied to complex human behavior in areas such as education, religion, government, law, and psychotherapy.

Much of Skinner's writing was devoted to the development and explanation of his philosophy of behaviorism. Skinner began his book *About Behaviorism* (1974) with these words:

> Behaviorism is not the science of human behavior; it is the philosophy of that science. Some of the questions it asks are these: Is such a science really possible? Can it account for every aspect of human behavior? What

[5] Most of the methodological features of the experimental approach pioneered by Skinner (e.g., repeated measurement of rate or frequency of response as the primary dependent variable, within-subject experimental comparisons, visual analysis of graphic data displays) continue to characterize both basic and applied research in behavior analysis. The five chapters in Part III provide detailed descriptions of how applied behavior analysts use this experimental approach.

[6] Skinner, who many consider the most eminent psychologist of the 20th century (Haagbloom et al., 2002), authored or coauthored 291 primary-source works (see Morris & Smith, 2003, for a complete bibliography). In addition to Skinner's three-volume autobiography (*Particulars of My Life,* 1976; *The Shaping of a Behaviorist,* 1979; *A Matter of Consequences,* 1983), numerous biographical books and articles have been written about Skinner, both before and after his death. Students interested in learning about Skinner should read *B.F. Skinner: A Life* by Daniel Bjork (1997), *B.F. Skinner, Organism* by Charles Catania (1992), *Burrhus Frederic Skinner (1904–1990): A Thank You* by Fred Keller (1990), *B. F. Skinner—The Last Few Days* by his daughter Julie Vargas (1990), and *Skinner as Self-Manager* by Robert Epstein. Skinner's contributions to ABA are described by Morris, Smith, and Altus (2005).

> methods can it use? Are its laws as valid as those of physics and biology? Will it lead to a technology, and if so, what role will it play in human affairs? (p. 1)

The behaviorism that Skinner pioneered differed significantly (indeed, radically) from other psychological theories, including other forms of behaviorism. Although there were, and remain today, many psychological models and approaches to the study of behavior, **mentalism** is the common denominator among most.

> In general terms, *mentalism* may be defined as an approach to the study of behavior which assumes that a mental or "inner" dimension exists that differs from a behavioral dimension. This dimension is ordinarily referred to in terms of its neural, psychic, spiritual, subjective, conceptual, or hypothetical properties. Mentalism further assumes that phenomena in this dimension either directly cause or at least mediate some forms of behavior, if not all. These phenomena are typically designated as some sort of act, state, mechanism, process, or entity that is causal in the sense of initiating or originating. Mentalism regards concerns about the origin of these phenomena as incidental at best. Finally, mentalism holds that an adequate causal explanation of behavior must appeal directly to the efficacy of these mental phenomena. (Moore, 2003, pp. 181–182)

Hypothetical constructs and explanatory fictions are the stock and trade of mentalism, which has dominated Western intellectual thought and most psychological theories (Descartes, Freud, Piaget), and it continues to do so into the 21st century. Freud, for example, created a complex mental world of hypothetical constructs—the id, ego, and superego—that he contended were key to understanding a person's actions.

Hypothetical constructs—"theoretical terms that refer to a possibly existing, but at the moment unobserved process or entity" (Moore, 1995, p. 36)—can neither be observed nor experimentally manipulated (MacCorquodale & Meehl, 1948; Zuriff, 1985). Free will, readiness, innate releasers, language acquisition devices, storage and retrieval mechanisms for memory, and information processing are all examples of hypothetical constructs that are inferred from behavior. Although Skinner (1953, 1974) clearly indicated that it is a mistake to rule out events that influence our behavior because they are not accessible to others, he believed that using presumed but unobserved mentalistic fictions (i.e., hypothetical constructs) to explain the causes of behavior contributed nothing to a functional account.

Consider a typical laboratory situation. A food-deprived rat pushes a lever each time a light comes on and receives food, but the rat seldom pushes the lever when the light is off (and if it does, no food is delivered). When asked to explain why the rat pushes the lever only when the light is on, most will say that the rat has "made the association" between the light being on and food being delivered when the lever is pressed. As a result of making that association, the animal now "knows" to press the lever only when the light is on. Attributing the rat's behavior to a hypothetical cognitive process such as associating or to something called "knowledge" adds nothing to a functional account of the situation. First, the environment (in this case, the experimenter) paired the light and food availability for lever presses, not the rat. Second, the knowledge or other cognitive process that is said to explain the observed behavior is itself unexplained, which begs for still more conjecture.

The "knowledge" that is said to account for the rat's performance is an example of an **explanatory fiction,** a fictitious variable that often is simply another name for the observed behavior that contributes nothing to an understanding of the variables responsible for developing or maintaining the behavior. Explanatory fictions are the key ingredient in "a circular way of viewing the cause and effect of a situation" (Heron, Tincani, Peterson, & Miller, 2005, p. 274) that give a false sense of understanding.

> Turning from observed behavior to a fanciful inner world continues unabated. Sometimes it is little more than a linguistic practice. We tend to make nouns of adjectives and verbs and must then find a place for the things the nouns are said to represent. We say that a rope is strong and before long we are speaking of its strength. We call a particular kind of strength tensile, and then explain that the rope is strong *because* it possesses tensile strength. The mistake is less obvious but more troublesome when matters are more complex. . . .
>
> Consider now a behavioral parallel. When a person has been subject to mildly punishing consequences in walking on a slippery surface, he may walk in a manner we describe as cautious. It is then easy to say that he walks with caution or that he shows caution. There is no harm in this until we begin to say that he walks carefully *because* of his caution. (Skinner, 1974, pp. 165–166, emphasis added)

Some believe that behaviorism rejects all events that cannot be operationally defined by objective assessment. Accordingly, Skinner is thought to have rejected all data from his system that could not be independently verified by other people (Moore, 1984). Moore (1985) called this operational view "a commitment to truth by agreement" (p. 59). This common view of the philosophy of behaviorism is limited; in reality, there are many kinds of behaviorism—structuralism, methodological behaviorism, and forms of behaviorism that use cognitions as causal factors (e.g., cognitive behavior modification and social learning theory), in addition to the radical behaviorism of Skinner.

Structuralism and methodological behaviorism do reject all events that are not operationally defined by objective assessment (Skinner, 1974). Structuralists avoid mentalism by restricting their activities to descriptions of behavior. They make no scientific manipulations; accordingly, they do not address questions of causal factors. Methodological behaviorists differ from the structuralists by using scientific manipulations to search for functional relationships between events. Uncomfortable with basing their science on unobservable phenomena, some early behaviorists either denied the existence of "inner variables" or considered them outside the realm of a scientific account. Such an orientation is often referred to as **methodological behaviorism.**

Methodological behaviorists also usually acknowledge the existence of mental events but do not consider them in the analysis of behavior (Skinner, 1974). Methodological behaviorists' reliance on public events, excluding private events, restricts the knowledge base of human behavior and discourages innovation in the science of behavior. Methodological behaviorism is restrictive because it ignores areas of major importance for an understanding of behavior.

Contrary to popular opinion, Skinner did not object to cognitive psychology's concern with private events (i.e., events taking place "inside the skin") (Moore, 2000). Skinner was the first behaviorist to view thoughts and feelings (he called them "private events") as behavior to be analyzed with the same conceptual and experimental tools used to analyze publicly observable behavior, not as phenomena or variables that exist within and operate via principles of a separate mental world.

Essentially, Skinner's behaviorism makes three major assumptions regarding the nature of private events: (a) Private events such as thoughts and feelings are behavior; (b) behavior that takes place within the skin is distinguished from other ("public") behavior only by its inaccessibility; and (c) private behavior is influenced by (i.e., is a function of) the same kinds of variables as publicly accessible behavior.

> We need not suppose that events which take place within an organism's skin have special properties for that reason. A private event may be distinguished by its limited accessibility but not, so far as we know, by any special structure of nature. (Skinner, 1953, p. 257)

By incorporating private events into an overall conceptual system of behavior, Skinner created a **radical behaviorism** that includes and seeks to understand all human behavior. "What is inside the skin, and how do we know about it? The answer is, I believe, the heart of radical behaviorism" (Skinner, 1974, p. 218). The proper connotations of the word *radical* in radical behaviorism are *far-reaching* and *thoroughgoing,* connoting the philosophy's inclusion of all behavior, public and private. *Radical* is also an appropriate modifier for Skinner's form of behaviorism because it represents a dramatic departure from other conceptual systems in calling for

> probably the most drastic change ever proposed in our way of thinking about man. It is almost literally a matter of turning the explanation of behavior inside out. (Skinner, 1974, p. 256)

Skinner and the philosophy of radical behaviorism acknowledge the events on which fictions such as cognitive processes are based. Radical behaviorism does not restrict the science of behavior to phenomena that can be detected by more than one person. In the context of radical behaviorism, the term *observe* implies "coming into contact with" (Moore, 1984). Radical behaviorists consider private events such as thinking or sensing the stimuli produced by a damaged tooth to be no different from public events such as oral reading or sensing the sounds produced by a musical instrument. According to Skinner (1974), "What is felt or introspectively observed is not some nonphysical world of consciousness, mind, or mental life but the observer's own body" (pp. 18–19).

The acknowledgment of private events is a major aspect of radical behaviorism. Moore (1980) stated it concisely:

> For radical behaviorism, private events are those events wherein individuals respond with respect to certain stimuli accessible to themselves alone. . . . The responses that are made to those stimuli may themselves be public, i.e., observable by others, or they may be private, i.e., accessible only to the individual involved. Nonetheless, to paraphrase Skinner (1953), it need not be supposed that events taking place within the skin have any special properties for that reason alone. . . . For radical behaviorism, then, one's responses with respect to private stimuli are equally lawful and alike in kind to one's responses with respect to public stimuli. (p. 460)

Scientists and practitioners are affected by their own social context, and institutions and schools are dominated by mentalism (Heward & Cooper, 1992; Kimball, 2002). A firm grasp of the philosophy of radical behaviorism, in addition to knowledge of principles of behavior, can help the scientist and practitioner resist the mentalistic approach of dropping the search for controlling variables in the environment and drifting toward explanatory fictions in the effort to understand behavior. The principles of behavior and the procedures presented in this text apply equally to public and private events. Radical behaviorism is the philosophical position underlying the content presented in this text.

A thorough discussion of radical behaviorism is far beyond the scope of this text. Still, the serious student of applied behavior analysis should devote considerable study to the original works of Skinner and to other authors who have critiqued, analyzed, and extended the philosophical foundations of the science of behavior.[7] (See Box 1.1 for Don Baer's perspectives on the meaning and importance of radical behaviorism.)

Applied Behavior Analysis

One of the first studies to report the human application of principles of operant behavior was conducted by Fuller (1949). The subject was an 18-year-old boy with profound developmental disabilities who was described in the language of the time as a "vegetative idiot." He lay on his back, unable to roll over. Fuller filled a syringe with a warm sugar-milk solution and injected a small amount of the fluid into the young man's mouth every time he moved his right arm (that arm was chosen because he moved it infrequently). Within four sessions the boy was moving his arm to a vertical position at a rate of three times per minute.

> The attending physicians . . . thought it was impossible for him to learn anything—according to them, he had not learned anything in the 18 years of his life—yet in four experimental sessions, by using the operant conditioning technique, an addition was made to his behavior which, at this level, could be termed appreciable. Those who participated in or observed the experiment are of the opinion that if time permitted, other responses could be conditioned and discriminations learned. (Fuller, 1949, p. 590)

During the 1950s and into the early 1960s researchers used the methods of the experimental analysis of behavior to determine whether the principles of behavior demonstrated in the laboratory with nonhuman subjects could be replicated with humans. Much of the early research with human subjects was conducted in clinic or laboratory settings. Although the participants typically benefited from these studies by learning new behaviors, the researchers' major purpose was to determine whether the basic principles of behavior discovered in the laboratory operated with humans. For example, Bijou (1955, 1957, 1958) researched several principles of behavior with typically developing subjects and people with mental retardation; Baer (1960, 1961, 1962) examined the effects of punishment, escape, and avoidance contingencies on preschool children; Ferster and DeMyer (1961, 1962; DeMyer & Ferster, 1962) conducted a systematic study of the principles of behavior using children with autism as subjects; and Lindsley (1956, 1960) assessed the effects of operant conditioning on the behavior of adults with schizophrenia. These early researchers clearly established that the principles of behavior are applicable to human behavior, and they set the stage for the later development of applied behavior analysis.

The branch of behavior analysis that would later be called applied behavior analysis (ABA) can be traced to the 1959 publication of Ayllon and Michael's paper titled "The Psychiatric Nurse as a Behavioral Engineer." The authors described how direct care personnel in a state hospital used a variety of techniques based on the principles of behavior to improve the functioning of residents with psychotic disorders or mental retardation. During the 1960s many researchers began to apply principles of behavior in an effort to improve socially important behavior, but these early pioneers faced many problems. Laboratory techniques for measuring behavior and for controlling and manipulating variables were sometimes unavailable, or their use was inappropriate in applied settings. As a result, the early practitioners of applied behavior analysis had to develop new experimental procedures as they went along. There was little funding for the new discipline, and researchers had no ready outlet for publishing their studies, making it difficult to communicate among themselves about their findings and solutions to methodological problems. Most journal editors were reluctant to publish studies using an experimental method unfamiliar to mainstream social science, which relied on large numbers of subjects and tests of statistical inference.

Despite these problems it was an exciting time, and major new discoveries were being made regularly. For example, many pioneering applications of behavior principles to education occurred during this period (see, e.g., O'Leary & O'Leary, 1972; Ulrich, Stachnik, & Mabry 1974), from which were derived teaching procedures such as contingent teacher praise and attention (Hall, Lund, & Jackson, 1968), token reinforcement systems (Birnbrauer, Wolf, Kidder, & Tague, 1965), curriculum design (Becker, Englemann, & Thomas, 1975), and programmed instruction (Bijou, Birnbrauer, Kidder, & Tague, 1966; Markle, 1962). The basic methods for reliably improving student performance developed by those early applied behavior analysts provided the foundation for behavioral approaches to curriculum design, instructional methods, classroom management, and the generalization and maintenance of learning that continue to be used decades later (cf., Heward et al., 2005).

University programs in applied behavior analysis were begun in the 1960s and early 1970s at Arizona State

[7]Excellent discussions of radical behaviorism can be found in Baum (1994); Catania and Harnad (1988); Catania and Hineline (1996); Chiesa (1994); Lattal (1992); Lee (1988); and Moore (1980, 1984, 1995, 2000, 2003).

Box 1.1
What Is Behaviorism?

Don Baer loved the science of behavior. He loved to write about it, and he loved to talk about it. Don was famous for his unparalleled ability to speak extemporaneously about complex philosophical, experimental, and professional issues in a way that always made thorough conceptual, practical, and human sense. He did so with the vocabulary and syntax of a great author and the accomplished delivery of a master storyteller. The only thing Don knew better than his audience was his science.

On three occasions, in three different decades, graduate students and faculty in the special education program at Ohio State University were fortunate to have Professor Baer serve as Distinguished Guest Faculty for a doctoral seminar, Contemporary Issues in Special Education and Applied Behavior Analysis. The questions and responses that follow were selected from transcripts of two of Professor Baer's three OSU teleconference seminars.

If a person on the street approached you and asked, "What's behaviorism?" how would you reply?

The key point of behaviorism is that what people do can be understood. Traditionally, both the layperson and the psychologist have tried to understand behavior by seeing it as the outcome of what we think, what we feel, what we want, what we calculate, and etcetera. But we don't have to think about behavior that way. We could look upon it as a process that occurs in its own right and has its own causes. And those causes are, very often, found in the external environment.

Behavior analysis is a science of studying how we can arrange our environments so they make very likely the behaviors we want to be probable enough, and they make unlikely the behaviors we want to be improbable. Behaviorism is understanding how the environment works so that we can make ourselves smarter, more organized, more responsible; so we can encounter fewer punishments and fewer disappointments. A central point of behaviorism is this: We can remake our environment to accomplish some of that much more easily than we can remake our inner selves.

An interviewer once asked Edward Teller, the physicist who helped develop the first atomic bomb, "Can you explain to a nonscientist what you find so fascinating about science, particularly physics?" Teller replied, "No." I sense that Teller was suggesting that a nonscientist would not be able to comprehend, understand, or appreciate physics and his fascination with it. If a nonscientist asked you, "What do you find so fascinating about science, particularly the science of human behavior?" what would you say?

Ed Morris organized a symposium on just this topic a couple of years ago at the Association for Behavior Analysis annual convention, and in that symposium, Jack Michael commented on the fact that although one of our discipline's big problems and challenges is communicating with our society about who we are, what we do, and what we can do, he didn't find it reasonable to try to summarize what behavior analysis is to an ordinary person in just a few words. He gave us this example: Imagine a quantum physicist is approached at a cocktail party by someone who asks, "What is quantum physics?" Jack said that the physicist might very well answer, and probably should answer, "I can't tell you in a few words. You should register for my course."

I'm very sympathetic with Jack's argument. But I also know, as someone who's confronted with the politics of relating our discipline to society, that although it may be a true answer, it's not a good answer. It's not an answer that people will hear with any pleasure, or indeed, even accept. I think such an answer creates only resentment. Therefore, I think we have to engage in a bit of honest show business. So, if I had to somehow state some connotations of what holds me in the field, I guess I would say that since I was a child I always found my biggest reinforcer was something called understanding. I liked to know how things worked. And of all of the things in the world there are to understand, it became clear to me that the most fascinating was what people do. I started with the usual physical science stuff, and it was intriguing to me to understand how radios work, and how electricity works, and how clocks work, etcetera. But when it became clear to me that we could also learn how people work—not just biologically, but behaviorally—I thought that's the best of all. Surely, everyone must agree that that's the most fascinating subject matter. That there could be a science of behavior, of what we do, of who we are? How could you resist that?

Adapted from "Thursday Afternoons with Don: Selections from Three Teleconference Seminars on Applied Behavior Analysis" by W. L. Heward & C. L. Wood (2003). In K. S. Budd & T. Stokes (Eds.), *A Small Matter of Proof: The Legacy of Donald M. Baer* (pp. 293–310). Reno, NV: Context Press. Used by permission.

University, Florida State University, the University of Illinois, Indiana University, the University of Kansas, the University of Oregon, the University of Southern Illinois, the University of Washington, West Virginia University, and Western Michigan University, among others. Through their teaching and research, faculty at each of these programs made major contributions to the rapid growth of the field.[8]

Two significant events in 1968 mark that year as the formal beginning of contemporary applied behavior analysis. First, the *Journal of Applied Behavior Analysis (JABA)* began publication. *JABA* was the first journal in the United States to deal with applied problems that gave researchers using methodology from the experimental analysis of behavior an outlet for publishing their findings. *JABA* was and continues to be the flagship journal of applied behavior analysis. Many of the early articles in *JABA* became model demonstrations of how to conduct and interpret applied behavior analysis, which in turn led to improved applications and experimental methodology.

The second major event of 1968 was the publication of the paper, "Some Current Dimensions of Applied Behavior Analysis" by Donald M. Baer, Montrose M. Wolf, and Todd R. Risley. These authors, the founding fathers of the new discipline, defined the criteria for judging the adequacy of research and practice in applied behavior analysis and outlined the scope of work for those in the science. Their 1968 paper has been the most widely cited publication in applied behavior analysis, and it remains the standard description of the discipline.

Defining Characteristics of Applied Behavior Analysis

Baer, Wolf, and Risley (1968) recommended that applied behavior analysis should be *applied, behavioral, analytic, technological, conceptually systematic, effective,* and capable of appropriately *generalized outcomes.* In 1987 Baer and colleagues reported that the "seven self-conscious guides to behavior analytic conduct" (p. 319) they had offered 20 years earlier "remain functional; they still connote the current dimensions of the work usually called applied behavior analysis" (p. 314). As we write this book, nearly 40 years have passed since Baer, Wolf, and Risley's seminal paper was published, and we find that the seven dimensions they posed continue to serve as the primary criteria for defining and judging the value of applied behavior analysis.

[8]Articles describing the histories of the applied behavior analysis programs at five of these universities can be found in the winter 1994 issue of *JABA*.

Applied

The *applied* in applied behavior analysis signals ABA's commitment to affecting improvements in behaviors that enhance and improve people's lives. To meet this criterion, the researcher or practitioner must select behaviors to change that are socially significant for participants: social, language, academic, daily living, self-care, vocational, and/or recreation and leisure behaviors that improve the day-to-day life experience of the participants and/or affect their significant others (parents, teachers, peers, employers) in such a way that they behave more positively with and toward the participant.

Behavioral

At first it may seem superfluous to include such an obvious criterion—of course applied *behavior* analysis must be *behavioral.* However, Baer and colleagues (1968) made three important points relative to the behavioral criterion. First, not just any behavior will do; the behavior chosen for study must be *the* behavior in need of improvement, not a similar behavior that serves as a proxy for the behavior of interest or the subject's verbal description of the behavior. Behavior analysts conduct studies *of* behavior, not studies *about* behavior. For example, in a study evaluating the effects of a program to teach school children to get along with one another, an applied behavior analyst would directly observe and measure clearly defined classes of interactions between and among the children instead of using indirect measures such as the children's answers on a sociogram or responses to a questionnaire about how they believe they get along with one another.

Second, the behavior must be measurable; the precise and reliable measurement of behavior is just as critical in applied research as it is in basic research. Applied researchers must meet the challenge of measuring socially significant behaviors in their natural settings, and they must do so without resorting to the measurement of nonbehavioral substitutes.

Third, when changes in behavior are observed during an investigation, it is necessary to ask whose behavior has changed. Perhaps only the behavior of the observers has changed. "Explicit measurement of the reliability of human observers thus becomes not merely good technique, but a prime criterion of whether the study was appropriately behavioral" (Baer et al., 1968, p. 93). Or perhaps the experimenter's behavior has changed in an unplanned way, making it inappropriate to attribute any observed change in the subject's behavior to the independent variables that were manipulated. The applied behavior analyst should attempt to monitor the behavior of all persons involved in a study.

Analytic

A study in applied behavior analysis is *analytic* when the experimenter has demonstrated a functional relation between the manipulated events and a reliable change in some measurable dimension of the targeted behavior. In other words, the experimenter must be able to control the occurrence and nonoccurrence of the behavior. Sometimes, however, society does not allow the repeated manipulation of important behaviors to satisfy the requirements of experimental method. Therefore, applied behavior analysts must demonstrate control to the greatest extent possible, given the restraints of the setting and behavior; and then they must present the results for judgment by the consumers of the research. The ultimate issue is believability: Has the researcher achieved experimental control to demonstrate a reliable functional relation?

The analytic dimension enables ABA to not only demonstrate effectiveness, but also to provide the "acid test proof" of functional and replicable relations between the interventions it recommends and socially significant outcomes (D. M. Baer, October 21, 1982, personal communication).

> Because we are a data- and design-based discipline, we are in the remarkable position of being able to prove that behavior can work in the way that our technology prescribes. We are not theorizing about how behavior *can* work; we are describing systematically how it *has* worked many times in real-world applications, in designs too competent and with measurement systems too reliable and valid to doubt. Our ability to prove that behavior can work that way does not, of course, establish that behavior *cannot* work any other way: we are not in a discipline that can deny any other approaches, only in one that can affirm itself as knowing many of its *sufficient* conditions at the level of experimental proof . . . our subject matter is behavior change, and we can specify some *actionable* sufficient conditions for it. (D. M. Baer, personal communication, October 21, 1982, emphasis in original).

Technological

A study in applied behavior analysis is *technological* when all of its operative procedures are identified and described with sufficient detail and clarity "such that a reader has a fair chance of replicating the application with the same results" (Baer et al., 1987, p. 320).

> It is not enough to say what is to be done when the subject makes response R_1; it is essential also whenever possible to say what is to be done if the subject makes the alternative responses, R_2, R_3, etc. For example, one may read that temper tantrums in children are often extinguished by closing the child in his room for the duration of the tantrums plus ten minutes. Unless that procedure description also states what should be done if the child tries to leave the room early, or kicks out the window, or smears feces on the walls, or begins to make strangling sounds, etc., it is not precise technological description. (Baer et al., 1968, pp. 95–96)

No matter how powerful its effects in any given study, a behavior change method will be of little value if practitioners are unable to replicate it. The development of a replicable technology of behavior change has been a defining characteristic and continuing goal of ABA from its inception. Behavioral tactics are replicable and teachable to others. Interventions that cannot be replicated with sufficient fidelity to achieve comparable outcomes are not considered part of the technology.

A good check of the technological adequacy of a procedural description is to have a person trained in applied behavior analysis carefully read the description and then act out the procedure in detail. If the person makes any mistakes, adds any operations, omits any steps, or has to ask any questions to clarify the written description, then the description is not sufficiently technological and requires improvement.

Conceptually Systematic

Although Baer and colleagues (1968) did not state so explicitly, a defining characteristic of applied behavior analysis concerns the types of interventions used to improve behavior. Although there are an infinite number of tactics and specific procedures that can be used to alter behavior, almost all are derivatives and/or combinations of a relatively few basic principles of behavior. Thus, Baer and colleagues recommended that research reports of applied behavior analysis be *conceptually systematic,* meaning that the procedures for changing behavior and any interpretations of how or why those procedures were effective should be described in terms of the relevant principle(s) from which they were derived.

Baer and colleagues (1968) provided a strong rationale for the use of conceptual systems in applied behavior analysis. First, relating specific procedures to basic principles might enable the research consumer to derive other similar procedures from the same principle(s). Second, conceptual systems are needed if a technology is to become an integrated discipline instead of a "collection of tricks." Loosely related collections of tricks do not lend themselves to systematic expansion, and they are difficult to learn and to teach in great number.

Effective

An effective application of behavioral techniques must improve the behavior under investigation to a practical degree. "In application, the theoretical importance of a variable is usually not at issue. Its practical importance, specifically its power in altering behavior enough to be socially important, is the essential criterion" (Baer et al., 1968, p. 96). Whereas some investigations produce results of theoretical importance or statistical significance, to be judged *effective* an applied behavior analysis study must produce behavior changes that reach clinical or social significance.

How much a given behavior of a given subject needs to change for the improvement to be considered socially important is a practical question. Baer and colleagues stated that the answer is most likely to come from the people who must deal with the behavior; they should be asked how much the behavior needs to change. The necessity of producing behavioral changes that are meaningful to the participant and/or those in the participant's environment has pushed behavior analysts to search for "robust" variables, interventions that produce large and consistent effects on behavior (Baer, 1977a).

When they revisited the dimension of effectiveness 20 years later, Baer, Wolf, and Risley (1987) recommended that the effectiveness of ABA also be judged by a second kind of outcome: the extent to which changes in the target behaviors result in noticeable changes in the reasons those behaviors were selected for change originally. If such changes in the subjects' lives do not occur, ABA may achieve one level of effectiveness yet fail to achieve a critical form of social validity (Wolf, 1978).

> We may have taught many social skills without examining whether they actually furthered the subject's social life; many courtesy skills without examining whether anyone actually noticed or cared; many safety skills without examining whether the subject was actually safer thereafter; many language skills without measuring whether the subject actually used them to interact differently than before; many on-task skills without measuring the actual value of those tasks; and, in general, many survival skills without examining the subject's actual subsequent survival. (Baer et al., 1987, p. 322)

Generality

A behavior change has *generality* if it lasts over time, appears in environments other than the one in which the intervention that initially produced it was implemented, and/or spreads to other behaviors not directly treated by the intervention. A behavior change that continues after the original treatment procedures are withdrawn has generality. And generality is evident when changes in targeted behavior occur in nontreatment settings or situations as a function of treatment procedures. Generality also exists when behaviors change that were not the focus of the intervention. Although not all instances of generality are adaptive (e.g., a beginning reader who has just learned to make the sound for the letter *p* in words such as *pet* and *ripe,* might make the same sound when seeing the letter *p* in the word *phone*), desirable generalized behavior changes are important outcomes of an applied behavior analysis program because they represent additional dividends in terms of behavioral improvement. Strategies and tactics for promoting desirable generalization of behavior changes are detailed in Chapter 28.

Some Additional Characteristics of ABA

Applied behavior analysis offers society an approach toward solving problems that is accountable, public, doable, empowering, and optimistic (Heward, 2005). Although not among ABA's defining dimensions, these characteristics should help increase the extent to which decision makers and consumers in many areas look to behavior analysis as a valuable and important source of knowledge for achieving improvements.

Accountable

The commitment of applied behavior analysts to effectiveness, their focus on accessible environmental variables that reliably influence behavior, and their reliance on direct and frequent measurement to detect changes in behavior yield an inescapable and socially valuable form of accountability. Direct and frequent measurement—the foundation and most important component of ABA practices—enables behavior analysts to detect their successes and, equally important, their failures so they can make changes in an effort to change failure to success (Bushell & Bear, 1994; Greenwood & Maheady, 1997).

> Failure is always informative in the logic of behavior analysis, just as it is in engineering. The constant reaction to lack of progress [is] a definitive hallmark of ABA. (Baer, 2005, p. 8)

Gambrill (2003) described the sense of accountability and self-correcting nature of applied behavior analysis very well.

> Applied behavior analysis is a scientific approach to understanding behavior in which we guess and critically test ideas, rather than guess and guess again. It is a process for solving problems in which we learn from our mistakes. Here, false knowledge and inert knowledge are not valued. (p. 67)

Public

"Everything about ABA is visible and public, explicit and straightforward. . . . ABA entails no ephemeral, mystical, or metaphysical explanations; there are no hidden treatments; there is no magic" (Heward, 2005, p. 322). The transparent, public nature of ABA should raise its value in fields such as education, parenting and child care, employee productivity, geriatrics, health and safety, and social work—to name only a few—whose goals, methods, and outcomes are of vital interest to many constituencies.

Doable

Classroom teachers, parents, coaches, workplace supervisors, and sometimes the participants themselves implemented the interventions found effective in many ABA studies. This demonstrates the pragmatic element of ABA. "Although 'doing ABA' requires far more than learning to administer a few simple procedures, it is not prohibitively complicated or arduous. As many teachers have noted, implementing behavioral strategies in the classroom . . . might best be described as good old-fashioned hard work" (Heward, 2005, p. 322).

Empowering

ABA gives practitioners real tools that work. Knowing how to do something and having the tools to accomplish it instills confidence in practitioners. Seeing the data showing behavioral improvements in one's clients, students, or teammates, or in oneself, not only feels good, but also raises one's confidence level in assuming even more difficult challenges in the future.

Optimistic

Practitioners knowledgeable and skilled in behavior analysis have genuine cause to be optimistic for four reasons. First, as Strain and Joseph (2004) noted:

> The environmental view promoted by behaviorism is essentially optimistic; it suggests that (except for gross genetic factors) all individuals possess roughly equal potential. Rather than assuming that individuals have some essential internal characteristic, behaviorists assume that poor outcomes originate in the way the environment and experience shaped the individual's current behavior. Once these environmental and experiential factors are identified, we can design prevention and intervention programs to improve the outcomes. . . . Thus, the emphasis on external control in the behavioral approach . . . offers a conceptual model that celebrates the possibilities for each individual. (Strain et al., 1992, p. 58)

Second, direct and continuous measurement enables practitioners to detect small improvements in performance that might otherwise be overlooked. Third, the more often a practitioner uses behavioral tactics with positive outcomes (the most common result of behaviorally based interventions), the more optimistic she becomes about the prospects for future success.

> A sense of optimism, expressed by the question "Why not?" has been a central part of ABA and has had an enormous impact on its development from its earliest days. Why can't we teach a person who does not yet talk to talk? Why shouldn't we go ahead and try to change the environments of young children so that they will display more creativity? Why would we assume that this person with a developmental disability could not learn to do the same things that many of us do? Why not try to do it? (Heward, 2005, p. 323)

Fourth, ABA's peer-reviewed literature provides many examples of success in teaching students who had been considered unteachable. ABA's continuous record of achievements evokes a legitimate feeling of optimism that future developments will yield solutions to behavioral challenges that are currently beyond the existing technology. For example, in response to the perspective that some people have disabilities so severe and profound that they should be viewed as ineducable, Don Baer offered this perspective:

> Some of us have ignored both the thesis that all persons are educable and the thesis that some persons are ineducable, and instead have experimented with ways to teach some previously unteachable people. Those experiments have steadily reduced the size of the apparently ineducable group relative to the obviously educable group. Clearly, we have not finished that adventure. Why predict its outcome, when we could simply pursue it, and just as well without a prediction? Why not pursue it to see if there comes a day when there is such a small class of apparently ineducable persons left that it consists of one elderly person who is put forward as ineducable. If that day comes, it will be a very nice day. And the next day will be even better. (D. M. Baer, February 15, 2002, personal communication, as cited in Heward, 2006, p. 473)

Definition of Applied Behavior Analysis

We began this chapter by stating that applied behavior analysis is concerned with the improvement and understanding of human behavior. We then described some of the attitudes and methods that are fundamental to scientific inquiry, briefly reviewed the development of the science and philosophy of behavior analysis, and examined the characteristics of ABA. All of that provided necessary context for the following definition of applied behavior analysis:

Applied behavior analysis is the science in which tactics derived from the principles of behavior are applied systematically to improve socially significant behavior and experimentation is used to identify the variables responsible for behavior change.

This definition includes six key components. First, the practice of applied behavior analysis is guided by the attitudes and methods of scientific inquiry. Second, all behavior change procedures are described and implemented in a systematic, technological manner. Third, not any means of changing behavior qualifies as applied behavior analysis: Only those procedures conceptually derived from the basic principles of behavior are circumscribed by the field. Fourth, the focus of applied behavior analysis is socially significant behavior. The fifth and sixth parts of the definition specify the twin goals of applied behavior analysis: improvement and understanding. Applied behavior analysis seeks to make meaningful improvement in important behavior and to produce an analysis of the factors responsible for that improvement.

Four Interrelated Domains of Behavior Analytic Science and Professional Practices Guided by That Science

The science of behavior analysis and its application to human problems consists of four domains: the three branches of behavior analysis—behaviorism, EAB, and ABA—and professional practice in various fields that is informed and guided by that science. Figure 1.2 identifies some of the defining features and characteristics of these four interrelated domains. Although most behavior analysts work primarily in one or two of the domains shown in Figure 1.2, it is common for a behavior analyst to function in multiple domains at one time or another (Hawkins & Anderson, 2002; Moore & Cooper, 2003).

A behavior analyst who pursues theoretical and conceptual issues is engaged in behaviorism, the philosophical domain of behavior analysis. A product of such work is Delprato's (2002) discussion of the importance of countercontrol (behavior by people experiencing aversive control by others that helps them escape and avoid the control while not reinforcing and sometimes punishing the controller's responses) toward an understanding of effective interventions for interpersonal relations and cultural design.

The experimental analysis of behavior is the basic research branch of the science. Basic research consists of experiments in laboratory settings with both human and nonhuman subjects with a goal of discovering and clarifying fundamental principles of behavior. An example is Hackenberg and Axtell's (1993) experiments investigating how choices made by humans are affected by the dynamic interaction of schedules of reinforcement that entail short- and long-term consequences.[9]

Applied behavior analysts conduct experiments aimed at discovering and clarifying functional relations between socially significant behavior and its controlling variables, with which they can contribute to the further development of a humane and effective technology of behavior change. An example is research by Tarbox, Wallace, and Williams (2003) on the assessment and treatment of elopement (running or walking away from a caregiver without permission), a behavior that poses great danger for young children and people with disabilities.

The delivery of behavior analytic professional services occurs in the fourth domain. Behavior analysis practitioners design, implement, and evaluate behavior change programs that consist of behavior change tactics derived from fundamental principles of behavior discovered by basic researchers, and that have been experimentally validated for their effects on socially significant behavior by applied researchers. An example is when a therapist providing home-based treatment for a child with autism embeds frequent opportunities for the child to use his emerging social and language skills in the context of naturalistic, daily routines and ensures that the child's responses are followed with reinforcing events. Another example is a classroom teacher trained in behavior analysis who uses positive reinforcement and stimulus fading to teach students to identify and classify fish into their respective species by the shape, size, and location of their fins.

Although each of the four domains of ABA can be defined and practiced in its own right, none of the domains are, or should be, completely independent of and uninformed by developments in the others. Both the science and the application of its findings benefit when the four domains are interrelated and influence one another (cf., Critchfield & Kollins, 2001; Lattal & Neef; 1996; Stromer, McComas, & Rehfeldt, 2000). Evidence of the symbiotic relations between the basic and applied domains is evident in research that "bridges" basic and applied areas and in applied research that translates the knowledge derived from basic research "into state-of-the-art clinical practices for use in the community" (Lerman, 2003, p. 415).[10]

[9]Schedules of reinforcement are discussed in Chapter 13.

[10]Examples and discussions of bridge or translational research can be found in the winter 1994 and winter 2003 issues of *JABA;* Fisher and Mazur (1997); Lattal and Neef (1996); and Vollmer and Hackenberg (2001).

Figure 1.2 Some comparisons and relationships among the four domains of behavior analysis science and practice.

	Behaviorism	*Experimental Analysis of Behavior (EAB)*	*Applied Behavior Analysis (ABA)*	*Practice Guided by Behavior Analysis*
	The Science of Behavior Analysis (Behaviorism – ABA)		**The Application of Behavior Analysis** (ABA – Practice)	
Province	Theory and philosophy	Basic research	Applied research	Helping people behave more successfully
Primary activity	Conceptual and philosophical analysis	Design, conduct, interpret, and report basic experiments	Design, conduct, interpret, and report applied experiments	Design, implement, and evaluate behavior change programs
Primary goal and product	Theoretical account of all behavior consistent with existing data	Discover and clarify basic principles of behavior; functional relations between behavior and controlling variables	A technology for improving socially significant behavior; functional relations between socially significant behavior and controlling variables	Improvements in the lives of participants/clients as a result of changes in their behavior
Secondary goals	Identify areas in which empirical data are absent and/or conflict and suggest resolutions	Identify questions for EAB and/or ABA to investigate further; raise theoretical issues	Identify questions for EAB and/or ABA to investigate further; raise theoretical issues	Increased efficiency in achieving primary goal; may identify questions for ABA and EAB
Agreement with existing database	As much as possible, but theory must go beyond database by design	Complete—Although differences among data sets exist, EAB provides the basic research database	Complete—Although differences among data sets exist, ABA provides the applied research database	As much as possible, but practitioners must often deal with situations not covered by existing data
Testability	Partially—All behavior and variables of interest are not accessible (e.g., phylogenic contingencies)	Mostly—Technical limitations preclude measurement and experimental manipulation of some variables	Mostly—Same limitations as EAB plus those posed by applied settings (e.g., ethical concerns, uncontrolled events)	Partially—All behavior and variables of interest are not accessible (e.g., a student's home life)
Scope	**Most** ←			→ **Least**
	Wide scope because theory attempts to account for all behavior	As much scope as the EAB database enables	As much scope as the ABA database enables	Narrow scope because practitioner's primary focus is helping the specific situation
Precision	**Least** ←			→ **Most**
	Minimal precision is possible because experimental data do not exist for all behavior encompassed by theory	As much precision as EAB's current technology for experimental control and the researcher's skills enable	As much precision as ABA's current technology for experimental control and the researcher's skills enable	Maximum precision is sought to change behavior most effectively in specific instance.

The Promise and Potential of ABA

In a paper titled, "A Futuristic Perspective for Applied Behavior Analysis," Jon Bailey (2000) stated that

> It seems to me that applied behavior analysis is more relevant than ever before and that it offers our citizens, parents, teachers, and corporate and government leaders advantages that cannot be matched by any other psychological approach. . . . I know of no other approach in psychology that can boast state-of-the-art solutions to the most troubling social ills of the day. (p. 477)

We, too, believe that ABA's pragmatic, natural science approach to discovering environmental variables that reliably influence socially significant behavior and to developing a technology to take practical advantage of those discoveries offers humankind its best hope for solving many of its problems. It is important, however, to recognize that behavior analysis's knowledge of "how behavior works," even at the level of fundamental principles, is incomplete, as is the technology for changing socially significant behavior derived from those principles. There are aspects of about which relatively little is known, and additional research, both basic and applied, is needed to clarify, extend, and fine-tune all existing knowledge (e.g., Critchfield & Kollins, 2001; Friman, Hayes, & Wilson, 1998; Murphy, McSweeny, Smith, & McComas, 2003; Stromer, McComas, & Rehfeldt, 2000).

Nevertheless, the still young science of applied behavior analysis has contributed to a full range of areas in which human behavior is important. Even an informal, cursory survey of the research published in applied behavior analysis reveals studies investigating virtually the full range of socially significant human behavior from A to Z and almost everywhere in between: AIDS prevention (e.g., DeVries, Burnette, & Redmona, 1991), conservation of natural resources (e.g., Brothers, Krantz, & McClannahan, 1994), education (e.g., Heward et al., 2005), gerontology (e.g., Gallagher & Keenan, 2000), health and exercise (e.g., De Luca & Holborn, 1992), industrial safety (e.g., Fox, Hopkins, & Anger, 1987), language acquisition (e.g., Drasgow, Halle, & Ostrosky, 1998), littering (e.g., Powers, Osborne, & Anderson, 1973), medical procedures (e.g., Hagopian & Thompson, 1999), parenting (e.g., Kuhn, Lerman, & Vorndran, 2003), seatbelt use (e.g., Van Houten, Malenfant, Austin, & Lebbon, 2005), sports (e.g., Brobst & Ward, 2002), and zoo management and care of animals (e.g., Forthman & Ogden, 1992).

Applied behavior analysis provides an empirical basis for not only understanding human behavior but also improving it. Equally important, ABA continually tests and evaluates its methods. The remainder of this text will present a foundation of knowledge that can lead to a full understanding of applied behavior analysis.

Summary

Some Basic Characteristics and a Definition of Science

1. Different types of scientific investigations yield knowledge that enables the description, prediction, and/or control of the phenomena studied.
2. Descriptive studies yield a collection of facts about the observed events that can be quantified, classified, and examined for possible relations with other known facts.
3. Knowledge gained from a study that finds the systematic covariation between two events—termed a correlation—can be used to predict the probability that one event will occur based on the occurrence of the other event.
4. Results of experiments that show that specific manipulations of one event (the independent variable) produce a reliable change in another event (the dependent variable), and that the change in the dependent variable was unlikely the result of extraneous factors (confounding variables)—a finding known as a functional relation—can be used to control the phenomena under investigation.
5. The behavior of scientists in all fields is characterized by a common set of assumptions and attitudes:
   - Determinism—the assumption that the universe is a lawful and orderly place in which phenomena occur as a result of other events.
   - Empiricism—the objective observation of the phenomena of interest.
   - Experimentation—the controlled comparison of some measure of the phenomenon of interest (the dependent variable) under two or more different conditions in which only one factor at a time (the independent variable) differs from one condition to another.
   - Replication—repeating experiments (and independent variable conditions within experiments) to determine the reliability and usefulness of findings
   - Parsimony—simple, logical explanations must be ruled out, experimentally or conceptually, before more complex or abstract explanations are considered.
   - Philosophic doubt—continually questioning the truthfulness and validity of all scientific theory and knowledge.

A Brief History of the Development of Behavior Analysis

6. Behavior analysis consists of three major branches: behaviorism, the experimental analysis of behavior (EAB), and applied behavior analysis (ABA).
7. Watson espoused an early form of behaviorism known as stimulus–response (S–R) psychology, which did not account for behavior without obvious antecedent causes.

8. Skinner founded the experimental analysis of behavior (EAB), a natural science approach for discovering orderly and reliable relations between behavior and various types of environmental variables of which it is a function.
9. EAB is characterized by these methodological features:
   - Rate of response is the most common dependent variable.
   - Repeated or continuous measurement is made of carefully defined response classes.
   - Within-subject experimental comparisons are used instead of designs comparing the behavior of experimental and control groups.
   - The visual analysis of graphed data is preferred over statistical inference.
   - A description of functional relations is valued over formal theory testing.
10. Through thousands of laboratory experiments, Skinner and his colleagues and students discovered and verified the basic principles of operant behavior that provide the empirical foundation for behavior analysis today.
11. Skinner wrote extensively about a philosophy for a science of behavior he called radical behaviorism. Radical behaviorism attempts to explain all behavior, including private events such as thinking and feeling.
12. Methodological behaviorism is a philosophical position that considers behavioral events that cannot be publicly observed to be outside the realm of the science.
13. Mentalism is an approach to understanding behavior that assumes that a mental, or "inner," dimension exists that differs from a behavioral dimension and that phenomena in this dimension either directly cause or at least mediate some forms of behavior; it relies on hypothetical constructs and explanatory fictions.
14. The first published report of the application of operant conditioning with a human subject was a study by Fuller (1949), in which an arm-raising response was conditioned in an adolescent with profound retardation.
15. The formal beginnings of applied behavior analysis can be traced to 1959 and the publication of Ayllon and Michael's article, "The Psychiatric Nurse as a Behavioral Engineer."
16. Contemporary applied behavior analysis (ABA) began in 1968 with the publication of the first issue of the *Journal of Applied Behavior Analysis (JABA).*

Defining Characteristics of Applied Behavior Analysis

17. Baer, Wolf, and Risley (1968, 1987) stated that a research study or behavior change program should meet seven defining dimensions to be considered applied behavior analysis:
   - Applied—investigates socially significant behaviors with immediate importance to the subject(s).
   - Behavioral—entails precise measurement of the actual behavior in need of improvement and documents that it was the subject's behavior that changed.
   - Analytic—demonstrates experimental control over the occurrence and nonoccurrence of the behavior—that is, if a functional relation is demonstrated.
   - Technological—the written description of all procedures used in the study is sufficiently complete and detailed to enable others to replicate it.
   - Conceptually systematic—behavior change interventions are derived from basic principles of behavior.
   - Effective—improves behavior sufficiently to produce practical results for the participant/client.
   - Generality—produces behavior changes that last over time, appear in other environments, or spread to other behaviors.
18. ABA offers society an approach toward solving many of its problems that is accountable, public, doable, empowering, and optimistic.

A Definition of Applied Behavior Analysis

19. Applied behavior analysis is the science in which tactics derived from the principles of behavior are applied to improve socially significant behavior and experimentation is used to identify the variables responsible for behavior change.
20. Behavior analysts work in one or more of four interrelated domains: behaviorism (theoretical and philosophical issues), the experimental analysis of behavior (basic research), applied behavior analysis (applied research), and professional practice (providing behavior analytic services to consumers).
21. ABA's natural science approach to discovering environmental variables that reliably influence socially significant behavior and developing a technology to take practical advantage of those discoveries offers humankind its best hope for solving many of its problems.

CHAPTER 2

Basic Concepts

Key Terms

antecedent
automaticity of reinforcement
aversive stimulus
behavior
behavior change tactic
conditioned punisher
conditioned reflex
conditioned reinforcer
conditioned stimulus
consequence
contingency
contingent
deprivation
discriminated operant
discriminative stimulus (S^D)
environment
extinction
habituation
higher order conditioning
history of reinforcement
motivating operation
negative reinforcement
neutral stimulus
ontogeny
operant behavior
operant conditioning
phylogeny
positive reinforcement
principle of behavior
punisher
punishment
reflex
reinforcement
reinforcer
repertoire
respondent behavior
respondent conditioning
respondent extinction
response
response class
satiation
selection by consequences
stimulus
stimulus class
stimulus control
stimulus–stimulus pairing
three-term contingency
unconditioned punisher
unconditioned reinforcer
unconditioned stimulus

Behavior Analyst Certification Board® BCBA® & BCABA® Behavior Analyst Task List,© Third Edition

Content Area 3: Principles, Processes, and Concepts	
3-1	Define and provide examples of behavior/response/response class.
3-2	Define and provide examples of stimulus and stimulus class.
3-3	Define and provide examples of positive and negative reinforcement.
3-4	Define and provide examples of conditioned and unconditioned reinforcement.
3-5	Define and provide examples of positive and negative punishment.
3-6	Define and provide examples of conditioned and unconditioned punishment.
3-7	Define and provide examples of stimulus control.
3-8	Define and provide examples of establishing operations.
3-9	Define and provide examples of behavioral contingencies.

(continued)

Content Area 3: Principles, Processes, and Concepts (*continued*)	
3-13	Describe and provide examples of the respondent conditioning paradigm.
3-14	Describe and provide examples of the operant conditioning paradigm.

This chapter defines the basic elements involved in a scientific analysis of behavior and introduces several principles that have been discovered through such an analysis. The first concept we examine—behavior—is the most fundamental of all. Because the controlling variables of primary importance in applied behavior analysis are located in the environment, the concepts of environment and stimulus are defined next. We then introduce several essential findings that the scientific study of behavior–environment relations has discovered. Two functionally distinct types of behavior—respondent and operant—are described, and the basic ways the environment influences each type of behavior—respondent conditioning and operant conditioning—are introduced. The three-term contingency—a concept for expressing and organizing the temporal and functional relations between operant behavior and environment—and its importance as a focal point in applied behavior analysis are then explained.[1] The chapter's final section recognizes the incredible complexity of human behavior, reminds us that behavior analysts possess an incomplete knowledge, and identifies some of the obstacles and challenges faced by those who strive to change behavior in applied settings.

Behavior

What, exactly, is behavior? Behavior is the activity of living organisms. Human behavior is everything people do, including how they move and what they say, think, and feel. Tearing open a bag of peanuts is behavior, and so is thinking how good the peanuts will taste once the bag is open. Reading this sentence is behavior, and if you're holding the book, so is feeling its weight and shape in your hands.

[1]The reader should not be overwhelmed by the many technical terms and concepts contained in this chapter. With the exception of the material on respondent behavior, all of the concepts introduced in this chapter are explained in greater detail in subsequent chapters. This initial overview of basic concepts is intended to provide background information that will facilitate understanding those portions of the text that precede the more detailed explanations.

Although words such as *activity* and *movement* adequately communicate the general notion of behavior, a more precise definition is needed for scientific purposes. How a scientific discipline defines its subject matter exerts profound influence on the methods of measurement, experimentation, and theoretical analysis that are appropriate and possible.

Building on Skinner's (1938) definition of behavior as "the movement of an organism or of its parts in a frame of reference provided by the organism or by various external objects or fields" (p. 6), Johnston and Pennypacker (1980, 1993a) articulated the most conceptually sound and empirically complete definition of **behavior** to date.

> The behavior of an organism is that portion of an organism's interaction with its environment that is characterized by detectable displacement in space through time of some part of the organism and that results in a measurable change in at least one aspect of the environment. (p. 23)

Johnston and Pennypacker (1993a) discussed the major elements of each part of this definition. The phrase *behavior of an organism* restricts the subject matter to the activity of living organisms, leaving notions such as the "behavior" of the stock market outside the realm of the scientific use of the term.

The phrase *portion of the organism's interaction with the environment* specifies "the necessary and sufficient conditions for the occurrence of behavior as (a) the existence of two separate entities, organism and environment, and (b) the existence of a relation between them" (Johnston & Pennypacker, 1993a, p. 24). The authors elaborated on this part of the definition as follows:

> Behavior is not a property or attribute of the organism. It happens only when there is an interactive condition between an organism and its surroundings, which include its own body. This means that independent states of the organism, whether real or hypothetical, are not behavioral events, because there is no interactive process. Being hungry or being anxious are examples of states that are sometimes confused with the behavior that they are supposed to explain. Neither phrase specifies an environmental agent with which the hungry or anxious organism interacts, so no behavior is implied.

> Similarly, independent conditions or changes in the environment do not define behavioral occurrences because no interaction is specified. Someone walking in the rain gets wet, but "getting wet" is not an instance of behavior. A child may receive tokens for correctly working math problems, but "receiving a token" is not behavior. Receiving a token implies changes in the environment but does not suggest or require change in the child's movement. In contrast, both doing math problems and putting the token in a pocket are behavioral events because the environment both prompts the child's actions and is then changed by them. (Johnston & Pennypacker, 1993a, p. 24)

Behavior is movement, regardless of scale; hence the phrase *displacement in space through time.* In addition to excluding static states of the organism, the definition does not include bodily movements produced by the action of independent physical forces as behavioral events. For example, being blown over by a strong gust of wind is not behavior; given sufficient wind, nonliving objects and organisms move similarly. Behavior can be accomplished only by living organisms. A useful way to tell whether movement is behavior is to apply the dead man test: "If a dead man can do it, it ain't behavior. And if a dead man can't do, then it is behavior" (Malott & Trojan Suarez, 2004, p. 9). So, although being knocked down by strong wind is not behavior (a dead man would also be blown over), moving arms and hands in front of one's face, tucking and rolling, and yelling "Whoa!" as one is being blown over are behaviors.[2]

The *displacement in space through time* phrase also highlights the properties of behavior most amenable to measurement. Johnston and Pennypacker (1993a) referred to these fundamental properties by which behavior can be measured as *temporal locus* (when in time a specified behavior occurs), *temporal extent* (the duration of a given behavioral event), and *repeatability* (the frequency with which a specified behavior occurs over time). The methods used by applied behavior analysts to measure those properties are detailed in Chapter 4.

Acknowledging that the last phrase of the definition—*that results in a measurable change in at least one aspect of the environment*—is somewhat redundant, Johnston and Pennypacker (1993a) noted that it emphasizes an important qualifier for the scientific study of behavior.

> Because the organism cannot be separated from an environment and because behavior is the relation between organism and environment, it is impossible for a behavioral event not to influence the environment in some way. . . . This is an important methodological point because it says that behavior must be detected and measured in terms of its effects on the environment. (p. 27)

As Skinner (1969) wrote, "To be observed, a response must affect the environment—it must have an effect upon an observer or upon an instrument which in turn can affect an observer. This is as true of the contraction of a small group of muscle fibers as of pressing a lever or pacing a figure 8" (p. 130).

The word *behavior* is usually used in reference to a larger set or class of responses that share certain physical dimensions (e.g., hand-flapping behavior) or functions (e.g., study behavior).[3] The term *response* refers to a specific instance of behavior. A good technical definition of **response** is an "*action of an organism's effector.* An effector is an organ at the end of an efferent nerve fiber that is specialized for altering its environment mechanically, chemically, or in terms of other energy changes" (Michael, 2004, p. 8, italics in original). Human effectors include the striped muscles (i.e., skeletal muscles such as biceps and quadriceps), smooth muscles (e.g., stomach and bladder muscles), and glands (e.g., adrenal gland).

Like stimulus changes in the environment, behavior can be described by its form, or physical characteristics. *Response topography* refers to the physical shape or form of behavior. For example, the hand and finger movements used to open a bag of peanuts can be described by their topographical elements. However, careful observation will reveal that the topography differs somewhat each time a person opens a bag of snacks. The difference may be significant or slight, but each "bag opening response" will vary somewhat from all others.

Although it is sometimes useful to describe behavior by its topography, behavior analysis is characterized by a *functional analysis* of the effects of behavior on the environment. A group of responses with the same function (that is, each response in the group produces the same effect on the environment) is called a **response class.** Membership in some response classes is open to responses of widely varying form (e.g., there are many ways to open a bag of peanuts), whereas the topographical variation among members of other response classes is limited (e.g., a person's signature, grip on a golf club).

Another reason underscoring the importance of a functional analysis of behavior over a structural or

[2]Odgen Lindsley originated the dead man test in the mid-1960s as a way to help teachers determine whether they were targeting real behaviors for measurement and change as opposed to inanimate states such as "being quiet."

[3]Most behavior analysts use the word *behavior* both as a mass noun to refer to the subject matter of the field in general or a certain type or class of behavior (e.g., operant behavior, study behavior) and as a count noun to refer to specific instances (e.g., two aggressive behaviors). The word *behavior* is often implied and unnecessary to state. We agree with Friman's (2004) recommendation that, "If the object of our interest is hitting and spitting, let's just say 'hitting' and 'spitting.' Subsequently, when we are gathering our thoughts with a collective term, we can call them behaviors" (p. 105).

topographical description is that two responses of the same topography can be vastly different behaviors depending on the controlling variables. For example, saying the word *fire* while looking the letters, *f-i-r-e,* is a vastly different behavior from yelling "*Fire!*" when smelling smoke or seeing flames in a crowded theatre.

Behavior analysts use the term **repertoire** in at least two ways. *Repertoire* is sometimes used to refer to all of the behaviors that a person can do. More often the term denotes a set or collection of knowledge and skills a person has learned that are relevant to particular settings or tasks. In the latter sense, each person has acquired or learned multiple repertoires. For example, each of us has a repertoire of behaviors appropriate for informal social situations that differs somewhat (or a lot) from the behaviors we use to navigate formal situations. And each person has repertoires with respect to language skills, academic tasks, everyday routines, recreation, and so on. When you complete your study of this text, your repertoire of knowledge and skills in applied behavior analysis will be enriched.

Environment

All behavior occurs within an environmental context; behavior cannot be emitted in an environmental void or vacuum. Johnston and Pennypacker (1993a) offered the following definition of **environment** and two critical implications of that definition for a science of behavior:

> "Environment" refers to the conglomerate of real circumstances in which the organism or referenced part of the organism exists. A simple way to summarize its coverage is as "everything except the moving parts of the organism involved in the behavior." One important implication . . . is that only real physical events are included.
>
> Another very important consequence of this conception of the behaviorally relevant environment is that it can include other aspects of the organism. That is, the environment for a particular behavior can include not only the organism's external features but physical events inside its skin. For instance, scratching our skin is presumably under control of the external visual stimulus provided by your body, particularly that part being scratched, as well as the stimulation that we call itching, which lies inside the skin. In fact, both types of stimulation very often contribute to behavioral control. This means that the skin is not an especially important boundary in the understanding of behavioral laws, although it can certainly provide observational challenges to discovering those laws. (p. 28)

The environment is a complex, dynamic universe of events that differs from instance to instance. When behavior analysts describe particular aspects of the environment, they talk in terms of stimulus conditions or events.[4] A good definition of **stimulus** is "an energy change that affects an organism through its receptor cells" (Michael, 2004, p. 7). Humans have receptor systems that detect stimulus changes occurring outside and inside the body. *Exteroceptors* are sense organs that detect external stimuli and enable vision, hearing, olfaction, taste, and cutaneous touch. Two types of sense organs sensitive to stimulus changes within the body are *interoceptors,* which are sensitive to stimuli originating in the viscera (e.g., feeling a stomach ache), and *proprioceptors,* which enable the kinesthetic and vestibular senses of movement and balance. Applied behavior analysts most often study the effects of stimulus changes that occur outside the body. External stimulus conditions and events are not only more accessible to observation and manipulation than are internal conditions, but also they are key features of the physical and social world in which people live.

The environment influences behavior primarily by stimulus change and not static stimulus conditions. As Michael (2004) noted, when behavior analysts speak of the presentation or occurrence of a stimulus, they usually mean stimulus change.

> For example, in respondent conditioning the conditioned stimulus may be referred to as a tone. However, the relevant event is actually a change from the absence of tone to the tone sounding . . . , and although this is usually understood without having to be mentioned, it can be overlooked in the analysis of more complex phenomena. Operant discriminative stimuli, conditioned reinforcers, conditioned punishers, and conditioned motivative variables are also usually important as stimulus changes, not static conditions (Michael, 2004, pp. 7–8).[5]

Stimulus events can be described formally (by their physical features), temporally (by when they occur with respect to a behavior of interest), and functionally (by their effects on behavior). Behavior analysts used the term **stimulus class** to refer to any group of stimuli sharing a predetermined set of common elements in one or more of these dimensions.

[4]Although the concepts of stimulus and response have proven useful for conceptual, experimental, and applied analyses of behavior, it is important to recognize that stimuli and responses do not exist as discrete events in nature. Stimuli and responses are detectable "slices" of the continuous and ever-changing interaction between an organism and its environment chosen by scientists and practitioners because they have proven useful in understanding and changing behavior. However, the slices imposed by the behavior analyst may not parallel naturally occurring divisions.

[5]Respondent conditioning and the operant principles mentioned here are introduced later in this chapter.

Formal Dimensions of Stimuli

Behavior analysts often describe, measure, and manipulate stimuli according to their formal dimensions, such as size, color, intensity, weight, and spatial position relative to other objects. Stimuli can be nonsocial (e.g., a red light, a high-pitched sound) or social (e.g., a friend asking, "Want some more peanuts?").

Temporal Loci of Stimuli

Because behavior and the environmental conditions that influence it occur within and across time, the temporal location of stimulus changes is important. In particular, behavior is affected by stimulus changes that occur prior to and immediately after the behavior. The term **antecedent** refers to environmental conditions or stimulus changes that exist or occur prior to the behavior of interest.

Because behavior cannot occur in an environmental void or vacuum, every response takes place in the context of a particular situation or set of antecedent conditions. These antecedent events play a critical part in learning and motivation, and they do so irrespective of whether the learner or someone in the role of behavior analyst or teacher has planned or is even aware of them.

> For example, just some of the functionally relevant antecedents for a student's performance on a timed math test might include the following: the amount of sleep the student had the night before; the temperature, lighting, and seating arrangements in the classroom; the teacher reminding the class that students who beat their personal best scores on the test will get a free homework pass; and the specific type, format, and sequence of math problems on the test. Each of those antecedent variables (and others) has the potential to exert a great deal, a little, or no noticeable effect on performance as a function of the student's experiences with respect to a particular antecedent. (Heward & Silvestri, 2005, p. 1135)

A **consequence** is a stimulus change that follows a behavior of interest. Some consequences, especially those that are immediate and relevant to current motivational states, have significant influence on future behavior; other consequences have little effect. Consequences combine with antecedent conditions to determine what is learned. Again, this is true whether the individual or someone trying to change his behavior is aware of or systematically plans the consequences.

Like antecedent stimulus events, consequences may also be social or nonsocial events. Table 2.1 shows examples of various combinations of social and nonsocial antecedent and consequent events for four behaviors.

Behavioral Functions of Stimulus Changes

Some stimulus changes exert immediate and powerful control over behavior, whereas others have delayed effects, or no apparent effect. Even though we can and often do describe stimuli by their physical characteristics (e.g., the pitch and decibel level of a tone, the topography of a person's hand and arm movements), stimulus changes are understood best through a functional analysis of their effects on behavior. For example, the same decibel tone that functions in one environment and set of conditions as a prompt for checking the clothes in the dryer may function as a warning signal to fasten a seat belt in another setting or situation; the same hand and arm motion that produces a smile and a "Hi" from another person in one set of conditions receives a scowl and obscene gesture in another.

Stimulus changes can have one or both of two basic kinds of functions or effects on behavior: (a) an immediate but temporary effect of increasing or decreasing the current frequency of the behavior, and/or (b) a delayed but relatively permanent effect in terms of the frequency of that type of behavior in the future (Michael, 1995). For example, a sudden downpour on a cloudy day is likely to increase immediately the frequency of all behavior that has resulted in the person successfully escaping rain in the

Table 2.1 Antecedent (Situation) and Consequent Events Can Be Nonsocial (Italicized), Social (Boldface), or a Combination of Social and Nonsocial

Situation	*Response*	*Consequence*
Drink machine	Deposit coins	*Cold drink*
Five cups on table	"One-two-three-four-five cups"	***Teacher nods and smiles***
Friend says "turn left"	Turn left	*Arrive at destination*
Friend asks "What time is it?"	"Six-fifteen"	***Friend says "Thanks"***

From "Individual Behavior, Culture, and Social Change" by S. S. Glenn, 2004, *The Behavior Analyst, 27,* p. 136. Copyright 2004 by the Association for Behavior Analysis. Used by permission.

past, such as running for cover under an awning or pulling her jacket over her head. If the person had decided not to carry her umbrella just before leaving the house, the downpour may decrease the frequency of that behavior on cloudy days in the future.

Respondent Behavior

All intact organisms enter the world able to respond in predictable ways to certain stimuli; no learning is required. These ready-made behaviors protect against harmful stimuli (e.g., eyes watering and blinking to remove particles on the cornea), help regulate the internal balance and economy of the organism (e.g., changes in heart rate and respiration in response to changes in temperature and activity levels), and promote reproduction (e.g., sexual arousal). Each of these stimulus–response relations, called a **reflex,** is part of the organism's genetic endowment, a product of natural evolution because of its survival value to the species. Each member of a given species comes equipped with the same repertoire of unconditioned (or unlearned) reflexes. Reflexes provide the organism with a set of built-in responses to specific stimuli; these are behaviors the individual organism would not have time to learn. Table 2.2 shows examples of reflexes common to humans.

The response component of the stimulus–response reflex is called respondent behavior. **Respondent behavior** is defined as behavior that is elicited by antecedent stimuli. Respondent behavior is induced, or brought out, by a stimulus that precedes the behavior; nothing else is required for the response to occur. For example, bright light in the eyes (antecedent stimulus) will elicit pupil contraction (respondent). If the relevant body parts (i.e., receptors and effectors) are intact, pupil contraction will occur every time. However, if the eliciting stimulus is presented repeatedly over a short span of time, the strength or magnitude of the response will diminish, and in some cases the response may not occur at all. This

Table 2.2 Examples of Unconditioned Human Reflexes Susceptible to Respondent Conditioning

Unconditioned stimulus	*Unconditioned response*	*Type of effector*
Loud sound or touch to cornea	Eye blink (lid closes)	Striped muscle
Tactile stimulus under lid or chemical irritant (smoke)	Lachrimal gland secretion (eyes watering)	Gland (duct)
Irritation to nasal mucosa	Sneezing	Striped and smooth muscle
Irritation to throat	Coughing	Striped and smooth muscle
Low temperature	Shivering, surface vasoconstriction	Striped and smooth muscle
High temperature	Sweating, surface vasodilation	Gland, smooth muscle
Loud sound	Contraction of tensor tympani and stapedius muscles (reduces amplitude of ear drum vibrations)	Striped muscles
Food in mouth	Salivation	Gland
Undigestible food in stomach	Vomiting	Striped and smooth muscle
Pain stimulus to hand or foot	Hand or foot withdrawal	Striped muscle
A single stimulus that is painful or very intense or very unusual	Activation syndrome—all of the following:	
	Heart rate increase	Cardiac muscle
	Adrenaline secretion	Gland (ductless)
	Liver release of sugar into bloodstream	Gland (duct)
	Constriction of visceral blood vessels	Smooth muscle
	Dilation of blood vessels in skeletal muscles	Smooth muscle
	Galvanic skin response (GSR)	Gland (duct)
	Pupillary dilation (and many more)	Smooth muscle

From *Concepts and Principles of Behavior Analysis* (rev. ed.) by J. L. Michael, 2004, pp. 10–11. Copyright 2004 by Society for the Advancement of Behavior Analysis, Kalamazoo, MI process of gradually diminishing response strength is known as **habituation.**

Respondent Conditioning

New stimuli can acquire the ability to elicit respondents. Called **respondent conditioning,** this type of learning is associated most with the Russian physiologist Ivan Petrovich Pavlov (1849–1936).[6] While studying the digestive system of dogs, Pavlov noticed that the animals salivated every time his laboratory assistant opened the cage door to feed them. Dogs do not naturally salivate at the sight of someone in a lab coat, but in Pavlov's laboratory they consistently salivated when the door was opened. His curiosity aroused, Pavlov (1927) designed and conducted an historic series of experiments. The result of this work was the experimental demonstration of respondent conditioning.

Pavlov started a metronome just an instant before feeding the dogs. Prior to being exposed to this **stimulus–stimulus pairing** procedure, food in the mouth, an **unconditioned stimulus (US),** elicited salivation, but the sound of the metronome, a **neutral stimulus (NS),** did not. After experiencing several trials consisting of the sound of the metronome followed by the presentation of food, the dogs began salivating in response to the sound of the metronome. The metronome had thus become a **conditioned stimulus (CS),** and a **conditioned reflex** was established.[7] Respondent conditioning is most effective when the NS is presented immediately before or simultaneous with the US. However, some conditioning effects can sometimes be achieved with considerable delay between the onset of the NS and the onset of the US, and even with backward conditioning in which the US precedes the NS.

Respondent Extinction

Pavlov also discovered that once a conditioned reflex was established, it would weaken and eventually cease altogether if the conditioned stimulus was presented repeatedly in the absence of the unconditioned stimulus. For example, if the sound of the metronome was presented repeatedly without being accompanied or followed by food, it would gradually lose its ability to elicit salivation. The procedure of repeatedly presenting a conditioned stimulus without the unconditioned stimulus until the conditioned stimulus no longer elicits the conditioned response is called **respondent extinction.**

Figure 2.1 shows schematic representations of respondent conditioning and respondent extinction. In this example, a puff of air produced by a glaucoma-testing machine is the US for the eye blink reflex. The opthalmologist's finger pressing the button of the machine makes a faint clicking sound. But prior to conditioning, the clicking sound is an NS: It has no effect on eye blinking. After being paired with the air puff just a few times, the finger-on-the-button sound becomes a CS: It elicits eye blinking as a conditioned reflex.

Conditioned reflexes can also be established by stimulus–stimulus pairing of an NS with a CS. This form of respondent conditioning is called **higher order** (or *secondary*) **conditioning.** For example, secondary respondent conditioning could occur in a patient who has learned to blink at the clicking sound of the button during the glaucoma-testing situation as follows. The patient detects a slight movement of the ophthalmologist's finger (NS) just before it contacts the button that makes the clicking sound (CS). After several NS–CS pairings, movement of the ophthalmologist's finger may become a CS capable of eliciting blinking.

The form, or topography, of respondent behaviors changes little, if at all, during a person's lifetime. There are two exceptions: (a) Certain reflexes disappear with maturity, such as that of grasping an object placed in the palm of the hand, a reflex usually not seen after the age of 3 months (Bijou & Baer, 1965); and (b) several unconditioned reflexes first appear later in life, such as those related to sexual arousal and reproduction. However, during a person's lifetime an infinite range of stimuli that were previously neutral (e.g., the high-pitched whine of the dentist's drill) can come to elicit respondents (i.e., increased heartbeat and perspiration).

Respondents make up a small percentage of the behaviors typically of interest to the applied behavior analyst. As Skinner (1953) pointed out, "Reflexes, conditioned or otherwise, are mainly concerned with the internal physiology of the organism. We are most often interested, however, in behavior which has some effect upon the surrounding world" (p. 59). It is this latter type of behavior, and the process by which it is learned, that we will now examine.

[6]Respondent conditioning is also referred to as classical or Pavlovian conditioning. Pavlov was not the first to study reflexes; like virtually all scientists, his work was an extension of others, most notably Ivan Sechenov (1829–1905) (Kazdin, 1978). See Gray (1979) and Rescorla (1988) for excellent and interesting descriptions of Pavlov's research.

[7]*Unconditioned stimulus* and *conditioned stimulus* are the most commonly used terms to denote the stimulus component of respondent relations. However, because the terms ambiguously refer to both the immediate evocative (eliciting) effect of the stimulus change and its somewhat permanent and delayed function-altering effect (the conditioning effect on other stimuli), Michael (1995) recommended that the terms *unconditioned elicitor* (UE) and *conditioned elicitor* (CE) be used when referring to the evocative function of these variables.

Before Conditioning	US (air puff)	⟶	UR (eye blink)
	NS (clicking sound)	----------	no eye blink
Respondent Conditioning	NS + US (click & air puff)	⟶	UR (eye blink)
	⇓		
	NS + US (click & air puff)	⟶	UR (eye blink)
	⇓		
	(more trials)		
Product of Respondent Conditioning	US (air puff)	⟶	UR (eye blink)
	CS (clicking sound)	⟶	CR (eye blink)
Respondent Extinction	CS (clicking sound)	⟶	CR (eye blink)
	⇓		
	CS (clicking sound)	⟶	CR (eye blink)
	⇓		
	CS (clicking sound)	⟶	CR (eye blink)
	⇓		
	(more trials)		
Results of Respondent Extinction	US (air puff)	⟶	UR (eye blink)
	NS (clicking sound)	----------	no eye blink

Figure 2.1 Schematic representation of respondent conditioning and respondent extinction. The top panel shows an unconditioned reflex: a puff of air (unconditioned stimulus, or US) elicits an eye blink (an unconditioned response, or UR). Before conditioning, a clicking sound (a neutral stimulus, or NS) has no effect on eye blinking. Respondent conditioning consists of a stimulus–stimulus pairing procedure in which the clicking sound is presented repeatedly just prior to, or simultaneously with, the air puff. The product of respondent conditioning is a conditioned reflex (CR): In this case the clicking sound has become a conditioned stimulus (CS) that elicits an eye blink when presented alone. The bottom two panels illustrate the procedure and outcome of respondent extinction: Repeated presentations of the CS alone gradually weaken its ability to elicit eye blinking to the point where the CS eventually becomes an NS again. The unconditioned reflex remains unchanged before, during, and after respondent conditioning.

Operant Behavior

A baby in a crib moves her hands and arms, setting in motion a mobile dangling above. The baby is literally operating on her environment, and the mobile's movement and musical sounds—stimulus changes produced by the baby's batting at the toy with her hands—are immediate consequences of her behavior. Her movements are continuously changing as a result of those consequences.

Members of a species whose only way of interacting with the world is a genetically determined fixed set of responses would find it difficult to survive, let alone thrive, in a complex environment that differed from the environment in which their distant ancestors evolved. Although respondent behavior comprises a critically important set of "hardwired" responses, respondent behavior does not provide an organism with the ability to learn from the consequences of its actions. An organism whose behavior is unchanged by its effects on the environment will be unable to adapt to a changing one.

Fortunately, in addition to her repertoire of genetically inherited respondent behaviors, our baby entered her world with some *uncommitted behavior* that is highly malleable and susceptible to change through its consequences. This type of behavior, called operant behavior, enables the baby over the course of her life to learn novel, increasingly complex responses to an ever-changing world.[8]

Operant behavior is any behavior whose future frequency is determined primarily by its history of consequences. Unlike respondent behavior, which is elicited by antecedent events, operant behavior is selected, shaped, and maintained by the consequences that have followed it in the past.

[8]The verb *emit* is used in conjunction with operant behavior. Its use fits in well with the definition of operant behavior, allowing reference to the consequences of behavior as the major controlling variables. The verb *elicit* is inappropriate to use with operant behavior because it implies that an antecedent stimulus has primary control of the behavior.

Unlike respondent behaviors, whose topography and basic functions are predetermined, operant behaviors can take a virtually unlimited range of forms. The form and function of respondent behaviors are constant and can be identified by their topography (e.g., the basic form and function of salivation is always the same). By comparison, however, the "meaning" of operant behavior cannot be determined by its topography. Operants are defined functionally, by their effects. Not only does the same operant often include responses of widely different topographies (e.g., a diner may obtain a glass of water by nodding his head, pointing to a glass of water, or saying yes to a waiter), but also, as Skinner (1969) explained, the same movements comprise different operants under different conditions.

> Allowing water to pass over one's hands can perhaps be adequately described as topography, but "washing one's hands" is an "operant" defined by the fact that, when one has behaved this way in the past, one's hands have become clean—a condition which has become reinforcing because, say, it has minimized a threat of criticism or contagion. Behavior of precisely the same topography would be part of another operant if the reinforcement had consisted of simple stimulation (e.g., "tickling") of the hands or the evocation of imitative behavior in a child whom one is teaching to wash his hands. (p. 127)

Table 2.3 compares and contrasts defining features and key characteristics of respondent behavior and operant behavior.

Selection by Consequences

> Human behavior is the joint product of (i) the contingencies of survival responsible for the natural selection of the species and (ii) the contingencies of reinforcement responsible for the repertoires acquired by its members, including (iii) the special contingencies maintained by the social environment. [Ultimately, of course, it is all a matter of natural selection, since operant conditioning is an evolved process, of which cultural practices are special applications.]
>
> —B. F. Skinner (1981, p. 502)

Skinner's discovery and subsequent elucidation of operant selection by consequences have rightly been called "revolutionary" and "the bedrock on which other behavioral principles rest" (Glenn, 2004, p. 134). **Selection by consequences** "anchors a new paradigm in the life sciences known as *selectionism.* A basic tenet of this position is that all forms of life, from single cells to complex cultures, evolve as a result of selection with respect to function" (Pennypacker, 1994, pp. 12–13).

Selection by consequences operates during the lifetime of the individual organism (**ontogeny**) and is a conceptual parallel to Darwin's (1872/1958) natural selection in the evolutionary history of a species (**phylogeny**). In response to the question, "Why do giraffes have long necks?" Baum (1994) gave this excellent description of natural selection:

> Darwin's great contribution was to see that a relatively simple mechanism could help explain why phylogeny followed the particular course it did. The explanation about giraffes' necks requires reference to the births, lives, and deaths of countless giraffes and giraffe ancestors over many millions of years. . . . Within any population of organisms, individuals vary. They vary partly because of environmental factors (e.g., nutrition), and also because of genetic inheritance. Among the giraffe ancestors that lived in what is now the Serengeti Plain, for instance, variation in genes meant that some had shorter necks and some had longer necks. As the climate gradually changed however, new, taller types of vegetation became more frequent. The giraffe ancestors that had longer necks, being able to reach higher, got a little more to eat, on the average. As a result, they were a little healthier, resisted disease a little better, evaded predators a little better—on the average. Any one individual with a longer neck may have died without offspring, but on the average longer-necked individuals had more offspring, which tended on the average to survive a little better and produce more offspring. As longer necks became more frequent, new genetic combinations occurred, with the result that some offspring had still longer necks than those before, and they did still better. As the longer-necked giraffes continued to out-reproduce the shorter-necked ones, the average neck length of the whole population grew. (p. 52)

Just as natural selection requires a population of individual organisms with varied physical features (e.g., giraffes with necks of different lengths), operant selection by consequences requires variation in behavior. Those behaviors that produce the most favorable outcomes are selected and "survive," which leads to a more adaptive repertoire. Natural selection has endowed humans with an initial population of uncommitted behavior (e.g., babies babbling and moving their limbs about) that is highly malleable and susceptible to the influence of the consequences that follow it. As Glenn (2004) noted,

> By outfitting humans with a largely uncommitted behavioral repertoire, natural selection gave our species a long leash for local behavioral adaptations. But the uncommitted repertoire of humans would be lethal without the . . . susceptibility of human behavior to operant selection. Although this behavioral characteristic is shared by many species, humans appear to be most exquisitely sensitive to behavioral contingencies of selection. (Schwartz, 1974, p. 139)

Table 2.3 Comparing and Contrasting Defining Features and Key Characteristics of Respondent and Operant Behavior

Characteristics or features	*Respondent behavior*	*Operant behavior*
Definition	Behavior elicited by antecedent stimuli.	Behavior selected by its consequences.
Basic unit	Reflex: an antecedent stimulus elicits a particular response (S–R).	Operant response class: A group of responses all of which produce the same effect on the environment; described by three-term contingency relation of antecedent stimulus conditions, behavior, and consequence (A–B–C).
Examples	Newborn's grasping and suckling to touch; pupil constriction to bright light; cough/gag to irritation in throat; salivation at smell of food; withdrawing hand from painful stimulus; sexual arousal to stimulation.	Talking, walking, playing the piano, riding a bike, counting change, baking a pie, hitting a curveball, laughing at a joke, thinking about a grandparent, reading this book.
Body parts (effectors) that most often produce the response (not a defining feature)	Primarily smooth muscles and glands (adrenaline squirt); sometimes striated (skeletal) muscles (e.g., knee-jerk to tap just below patella).	Primarily striated (skeletal) muscles; sometimes smooth muscles and glands.
Function or usefulness for individual organism	Maintains internal economy of the organism; provides a set of "ready-made" survival responses the organism would not have time to learn.	Enables effective interaction and adaptation in an ever-changing environment that could not be anticipated by evolution.
Function or usefulness for species	Promotes continuation of species indirectly (protective reflexes help individuals survive to reproductive age) and directly (reflexes related to reproduction).	Individuals whose behavior is most sensitive to consequences are more likely to survive and reproduce.
Conditioning process	Respondent (also called, classical or Pavlovian) conditioning: Through a stimulus–stimulus pairing procedure in which a neutral stimulus (NS) presented just prior to or simultaneous with an unconditioned (US) or conditioned (CS) eliciting stimulus, the NS becomes a CS that elicits the response and a conditioned reflex is created. (See Figure 2.1.)	Operant conditioning: Some stimulus changes immediately following a response increase (reinforcement) or decrease (punishment) the future frequency of similar responses under similar conditions. Previously neutral stimulus changes become conditioned reinforcers or punishers as result of stimulus–stimulus pairing with other reinforcers or punishers.
Repertoire limits	Topography and function of respondents determined by natural evolution of species (phylogeny). All biologically intact members of a species possess the same set of unconditioned reflexes. Although new forms of respondent behavior are not learned, an infinite number of conditioned reflexes may emerge in an individual's repertoire depending on the stimulus–stimulus pairing he has experienced (ontogeny).	Topography and function of each person's repertoire of operant behaviors are selected by consequences during the individual's lifetime (ontogeny). New and more complex operant response classes can emerge. Response products of some human operants (e.g., airplanes) enable some behaviors not possible by anatomical structure alone (e.g., flying).

Operant Conditioning

> Operant conditioning may be seen everywhere in the multifarious activities of human beings from birth until death. . . . It is present in our most delicate discriminations and our subtlest skills; in our earliest crude habits and the highest refinements of creative thought.
>
> —Keller and Schoenfeld (1950, p. 64)

Operant conditioning refers to the process and selective effects of consequences on behavior.[9] From an operant conditioning perspective a functional consequence is a stimulus change that follows a given behavior

[9]Unless otherwise noted, the term *behavior* will refer to operant behavior throughout the remainder of the text.

in a relatively immediate temporal sequence and alters the frequency of that type of behavior in the future. "In operant conditioning we 'strengthen' an operant in the sense of making a response more probable or, in actual fact, more frequent" (Skinner, 1953, p. 65). If the movement and sounds produced by the baby's batting at the mobile with her hands increase the frequency of hand movements in the direction of the toy, operant conditioning has occurred.

When operant conditioning consists of an increase in response frequency, *reinforcement* has taken place, and the consequence responsible, in this case the movement and sound of the mobile, would be called a **reinforcer.**[10] Although operant conditioning is used most often to refer to the "strengthening" effects of reinforcement, as Skinner described earlier, it also encompasses the principle of punishment. If the mobile's movement and musical sounds resulted in a decrease in the baby's frequency of moving it with her hands, *punishment* has occurred, and the mobile's movement and sound would be called **punishers.** Before we examine the principles of reinforcement and punishment further, it is important to identify several important qualifications concerning how consequences affect behavior.

Consequences Can Affect Only Future Behavior

Consequences affect only future behavior. Specifically, a behavioral consequence affects the relative frequency with which similar responses will be emitted in the future under similar stimulus conditions. This point may seem too obvious to merit mention because it is both logically and physically impossible for a consequent event to affect a behavior that preceded it, when that behavior is over before the consequent event occurs. Nevertheless, the statement "behavior is controlled by its consequences" raises the question. (See Box 2.1 for further discussion of this apparent logical fallacy.)

Consequences Select Response Classes, Not Individual Responses

Responses emitted because of the effects of reinforcement of previous responses will differ slightly from the previous responses but will share enough common elements with the former responses to produce the same consequence.

> Reinforcement strengthens responses which differ in topography from the response reinforced. When we reinforce pressing a lever, for example, or saying Hello, responses differing quite widely in topography grow more probable. This is a characteristic of behavior which has strong survival value . . . , since it would be very hard for an organism to acquire an effective repertoire if reinforcement strengthened only identical responses. (Skinner, 1969, p. 131)

These topographically different, but functionally similar, responses comprise an operant response class. Indeed, "an operant is a class of acts all of which have the same environmental effect" (Baum, 1994, p. 75). It is the response class that is strengthened or weakened by operant conditioning. The concept of response class is "implied when it is said that reinforcement increases the future frequency of the *type* of behavior that immediately preceded the reinforcement" (Michael, 2004, p. 9). And, as will be shown in later chapters, the concept of response class is a key to the development and elaboration of new behavior.

If consequences (or natural evolution) selected only a very narrow range of responses (or genotypes), the effect would "tend toward uniformity and a perfection of sorts" (Moxley, 2004, p. 110) that would place the behavior (or species) at risk of extinction should the environment change. For example, if the mobile's movement and sound reinforced only arm and hand movements that fell within an exact and narrow range of motion and no similar movements survived, the baby would be unable to contact that reinforcement if one day her mother mounted the mobile in a different location above the crib.

Immediate Consequences Have the Greatest Effect

Behavior is most sensitive to stimulus changes that occur immediately after, or within a few seconds of, the responses.

> It is essential to emphasize the importance of the immediacy of reinforcement. Events that are delayed more than a few seconds after the response do not *directly* increase its future frequency. When human behavior is apparently affected by long-delayed consequences, the change is accomplished by virtue of the human's complex social and verbal history, and should not be thought of as an instance of the simple strengthening of behavior by reinforcement. . . . [As with reinforcement,] the longer the time delay between the occurrence of the response and the occurrence of the stimulus change (between R and S^P), the less effective the punishment will be in changing the relevant response frequency, but not

[10]Skinner (1966) used rate of responding as the fundamental datum for his research. To strengthen an operant is to make it more frequent. However, rate (or frequency) is not the only measurable and malleable dimension of behavior. As we will see in Chapters 3 and 4, sometimes the duration, latency, magnitude, and/or topography of behavior changes are of pragmatic importance.

Box 2.1
When the Phone Rings: A Dialogue about Stimulus Control

The professor was ready to move on to his next point, but a raised hand in the front row caught his attention.

Professor: Yes?

Student: You say that operant behavior, like talking, writing, running, reading, driving a car, most everything we do—you say all of those behaviors are controlled by their consequences, by things that happen *after* the response was emitted?

Professor: Yes, I said that. Yes.

Student: Well, I have a hard time with that. When my telephone rings and I pick up the receiver, that's an operant response, right? I mean, answering the phone when it rings certainly didn't evolve genetically as a reflex to help our species survive. So, we are talking about operant behavior, correct?

Professor: Correct.

Student: All right then. How can we say that my picking up my telephone is controlled by its consequence? I pick up the phone *because* it is ringing. So does everybody else. Ringing controls the response. And ringing can't be a consequence because it comes before the response.

The professor hesitated with his reply just long enough for the student to believe himself the hero, nailing a professor for pontificating about some theoretical concept with little or no relevance to the everyday real world. Simultaneously sensing victory, other students began to pile on with their comments.

Another Student: How about stepping on the brake when you see a stop sign? The sign controls the braking response, and that's not a consequence either.

A Student from the Back of the Room: And take a common classroom example. When a kid sees the problem 2 + 2 on his worksheet and he writes 4, the response of writing 4 has to be controlled by the written problem itself. Otherwise, how could anyone learn the correct answers to any question or problem?

Most of the Class: Yah, that's right!

Professor: (with a wry smile) All of you are correct. . . . So too am I.

Someone Else in the Class: What do you mean?

Professor: That was exactly my next point, and I was hoping you would pick up on it. (The professor smiled a thank you at the student who had started the discussion and went on.) All around us, every day, we are exposed to thousands of changing stimulus conditions. All of the situations you've described are excellent examples of what behavior analysts call stimulus control. When the frequency of a given behavior is higher in the presence of a given stimulus than when that stimulus is absent, we say that stimulus control is at work. Stimulus control is a very important and useful principle in behavior analysis, and it will be the subject of much discussion this semester.

But, and here's the important point: A discriminative stimulus, the antecedent event that comes before the response of interest, acquires its ability to control a particular response class because it has been associated with certain consequences in the past. So it is not just the sound of the phone's ring that causes you to pick up the receiver. It is the fact that in the past answering the phone when it was ringing was followed by a person's voice. It's that person talking to you, the consequence of picking up the receiver, that really controlled the behavior in the first place, but you pick up the phone only when you hear it ringing. Why? Because you have learned that there's someone on the other end only when the phone's ringing. So we can still speak of consequences as having the ultimate control in terms of controlling operant behavior, but by being paired with differential consequences, antecedent stimuli can indicate what kind of consequence is likely. This concept is called the three-term contingency, and its understanding, analysis, and manipulation is central to applied behavior analysis.

much is known about upper limits. (Michael, 2004, p. 110, 36 emphasis in original, words in brackets added)

Consequences Select Any Behavior

Reinforcement and punishment are "equal opportunity" selectors. No logical or healthy or (in the long run) adaptive connection between a behavior and the consequence that functions to strengthen or weaken it is necessary. Any behavior that immediately precedes reinforcement (or punishment) will be increased (or decreased).

It is the *temporal relation* between behavior and consequence that is functional, not the topographical or logical ones. "So far as the organism is concerned, the only important property of the contingency is temporal. The reinforcer simply *follows* the response. How this is brought about does not matter" (Skinner, 1953, p. 85, emphasis in original). The arbitrary nature of which behaviors are reinforced (or punished) in operant conditioning is exemplified by the appearance of idiosyncratic behaviors that have no apparent purpose or function. An example is the superstitious routine of a poker player who taps and arranges his cards in a peculiar fashion because similar movements in the past were followed by winning hands.

Operant Conditioning Occurs Automatically

Operant conditioning does not require a person's awareness. "A reinforcing connection need not be obvious to the individual [whose behavior is] reinforced" (Skinner, 1953, p. 75, words in brackets added). This statement refers to the **automaticity of reinforcement;** that is, behavior is modified by its consequences regardless of whether the individual is aware that she is being reinforced.[11] A person does not have to understand or verbalize the relation between her behavior and a consequence, or even know that a consequence has occurred, for reinforcement to "work."

Reinforcement

Reinforcement is the most important principle of behavior and a key element of most behavior change programs designed by behavior analysts (Flora, 2004; Northup, Vollmer, & Serrett, 1993). If a behavior is followed closely in time by a stimulus event and as a result the future frequency of that type of behavior increases in similar conditions, **reinforcement** has taken place.[12] Sometimes the delivery of just one reinforcer results in significant behavior change, although most often several responses must be followed by reinforcement before significant conditioning will occur.

Most stimulus changes that function as reinforcers can be described operationally as either (a) a new stimulus added to the environment (or increased in intensity), or (b) an already present stimulus removed from the environment (or reduced in intensity).[13] These two operations provide for two forms of reinforcement, called positive and negative (see Figure 2.2).

Positive reinforcement occurs when a behavior is followed immediately by the presentation of a stimulus and, as a result, occurs more often in the future. Our baby's increased frequency of batting the mobile with her hands, when doing so produces movement and music, is an example of positive reinforcement. Likewise, a child's independent play is reinforced when it increases as a result of his parent's giving praise and attention when he plays. Positive reinforcement and procedures for using it to promote desired behaviors are described in detail in Chapter 11.

When the frequency of a behavior increases because past responses have resulted in the withdrawal or termination of a stimulus, the operation is called **negative reinforcement.** Skinner (1953) used the term **aversive stimulus** to refer to, among other things, stimulus conditions whose termination functioned as reinforcement. Let us assume now that a parent programs the mobile to automatically play music for a period of time. Let us also assume that if the baby bats the mobile with hands or feet, the music immediately stops for a few seconds. If the baby bats the mobile more frequently when doing so terminates the music, negative reinforcement is at work, and the music can be called *aversive.*

Negative reinforcement is characterized by escape or avoidance contingencies. The baby escaped the music by striking the mobile with her hand. A person who jumps out of the shower when water suddenly becomes too hot

[11] *Automaticity of reinforcement* is a different concept from that of *automatic reinforcement,* which refers to responses producing their "own" reinforcement (e.g., scratching an insect bite). Automatic reinforcement is described in Chapter 11.

[12] The basic effect of reinforcement is often described as increasing the probability or strength of the behavior, and at times we use these phrases also. In most instances, however, we use *frequency* when referring to the basic effect of operant conditioning, following Michael's (1995) rationale: "I use frequency to refer to number of responses per unit time, or number of response occurrences relative to the number of opportunities for a response. In this way I can avoid such terms as *probability, likelihood* and *strength* when referring to behavior. The controlling variables for these terms are problematic, and because of this, their use encourages a language of intervening variables, or an implied reference to something other than an observable aspect of behavior" (p. 274).

[13] Malott and Trojan Suarez (2004) referred to these two operations as "stimulus addition" and "stimulus subtraction."

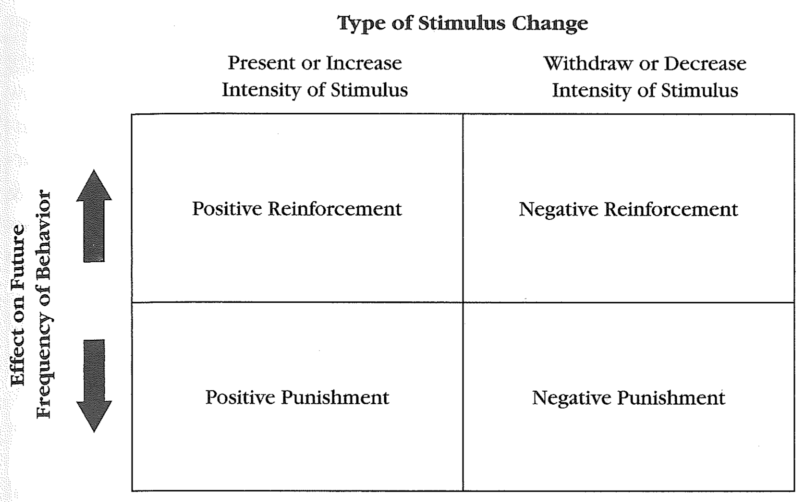


Figure 2.2 Positive and negative reinforcement and positive and negative punishment are defined by the type of stimulus change operation that immediately follows a behavior and the effect that operation has on the future frequency of that type of behavior.

escapes the overly hot water. Likewise, when the frequency of a student's disruptive behavior increases as a result of being sent to the principal's office, negative reinforcement has occurred. By acting out, the misbehaving student escapes (or avoids altogether, depending on the timing of his misbehavior) the aversive (to him) classroom activity.

The concept of negative reinforcement has confused many students of behavior analysis. Much of the confusion can be traced to the inconsistent early history and development of the term and to psychology and education textbooks and professors who have used the term inaccurately.[14] The most common mistake is equating negative reinforcement with punishment. To help avoid the error, Michael (2004) suggested the following:

> Think about how you would respond if someone asked you (1) whether or not you like negative reinforcement; also if you were asked (2) which you prefer, positive or negative reinforcement. Your answer to the first question should be that you do indeed like negative reinforcement, which consists of the removal or termination of an aversive condition that is already present. The term *negative reinforcement* refers **only** to the termination of the stimulus. In a laboratory procedure the stimulus must, of course, be turned on and then its termination can be made contingent upon the critical response. No one wants an aversive stimulus turned on, but once it is on, its termination is usually desirable. Your answer to the second question should be that you cannot choose without knowing the specifics of the positive and negative reinforcement involved. The common error is to choose positive reinforcement, but removal of a very severe pain would certainly be preferred over the presentation of a small monetary reward or an edible, unless the food deprivation was very severe. (p. 32, italics and bold type in original)

Negative reinforcement is examined in detail in Chapter 12. Remembering that the term *reinforcement* always means an increase in response rate and that the modifiers *positive* and *negative* describe the type of stimulus change operation that best characterizes the consequence (i.e., adding or withdrawing a stimulus) should facilitate the discrimination of the principles and application of positive and negative reinforcement.

After a behavior has been established with reinforcement, it need not be reinforced each time it occurs. Many behaviors are maintained at high levels by schedules of *intermittent reinforcement.* Chapter 13 describes various *schedules of reinforcement* and their effects on behavior. However, if reinforcement is withheld for all members of a previously reinforced response class, a procedure based on the principle of **extinction,** the frequency of the behavior will gradually decrease to its prereinforcement level or cease to occur altogether. Chapter 21 describes the principle of extinction and the use of behavior change tactics based on extinction to decrease undesired behavior.

Punishment

Punishment, like reinforcement, is defined functionally. When a behavior is followed by a stimulus change that decreases the future frequency of that type of behavior in similar conditions, **punishment** has taken place. Also, like reinforcement, punishment can be accomplished by either of two types of stimulus change operations. (See the bottom two boxes of Figure 2.2.)

[14]For examples and discussions of the implications of inaccurate representations of principles of behavior and behaviorism in psychology and education textbooks, see Cameron (2005), Cooke (1984), Heward (2005), Heward and Cooper (1992), and Todd and Morris (1983, 1992).

Although most behavior analysts support the definition of *punishment* as a consequence that decreases the future frequency of the behavior it follows (Azrin & Holz, 1966), a wide variety of terms have been used in the literature to refer to the two types of consequence operations that fit the definition. For example, the Behavior Analyst Certification Board (BACB, 2005) and textbook authors (e.g., Miltenberger, 2004) use the terms *positive punishment* and *negative punishment,* paralleling the terms *positive reinforcement* and *negative reinforcement.* As with reinforcement, the modifiers *positive* and *negative* used with *punishment* connote neither the intention nor the desirability of the behavior change produced; they only specify how the stimulus change that served as the punishing consequence was affected—whether it was presented (positive) or withdrawn (negative).

Although the terms *positive punishment* and *negative punishment* are consistent with the terms used to differentiate the two reinforcement operations, they are less clear than the descriptive terms for the two punishment operations—*punishment by contingent stimulation* and *punishment by contingent withdrawal of a positive reinforcer*—first introduced by Whaley and Malott (1971) in their classic text, *Elementary Principles of Behavior.* These terms highlight the procedural difference between the two forms of punishment. Differences in procedure as well as in the type of stimulus change involved—reinforcer or punisher—hold important implications for application when a punishment-based behavior-reduction technique is indicated. Foxx (1982) introduced the terms *Type I punishment* and *Type II punishment* for punishment by contingent stimulation and punishment by contingent withdrawal of a stimulus, respectively. Many behavior analysts and teachers continue to use Foxx's terminology today. Other terms such as *penalty principle* have also been used to refer to negative punishment. (Malott & Trojan Suarez, 2004). However, it should be remembered that these terms are simply brief substitutes for the more complete terminology introduced by Whaley and Malott.

As with positive and negative reinforcement, numerous behavior change procedures incorporate the two basic punishment operations. Although some textbooks reserve the term *punishment* for procedures involving positive (or Type I) punishment and describe *time-out from positive reinforcement* and *response cost* as separate "principles" or types of punishment, both the methods for reducing behavior are derivatives of negative (or Type II) punishment. Therefore, time-out and response cost should be considered behavior change tactics and *not* basic principles of behavior.

Reinforcement and punishment can each be accomplished by either of two different operations, depending on whether the consequence consists of presenting a new stimulus (or increasing the intensity of a current stimulus) or withdrawing (or decreasing the intensity of) a currently present stimulus in the environment (Morse & Kelleher, 1977; Skinner, 1953). Some behavior analysts argue that from a functional and theoretical standpoint only two principles are required to describe the basic effects of behavioral consequences—reinforcement and punishment.[15] However, from a procedural perspective (a critical factor for the applied behavior analyst), a number of behavior change tactics are derived from each of the four operations represented in Figure 2.2.

Most behavior change procedures involve several principles of behavior (see Box 2.2). It is critical for the behavior analyst to have a solid conceptual understanding of the basic principles of behavior. Such knowledge permits better analysis of current controlling variables as well as more effective design and assessment of behavioral interventions that recognize the role various principles may be playing in a given situation.

Stimulus Changes That Function as Reinforcers and Punishers

Because operant conditioning involves the consequences of behavior, it follows that anyone interested in using operant conditioning to change behavior must identify and control the occurrence of relevant consequences. For the applied behavior analyst, therefore, an important question becomes, What kinds of stimulus changes function as reinforcers and punishers?

Unconditioned Reinforcement and Punishment

Some stimulus changes function as reinforcement even though the organism has had no particular learning history with those stimuli. A stimulus change that can increase the future frequency of behavior without prior pairing with any other form of reinforcement is called an **unconditioned reinforcer.**[16] For example, stimuli such as food, water, and sexual stimulation that support the biological maintenance of the organism and survival of the species often function as unconditioned reinforcers. The words *can* and *often* in the two previous sentences

[15]Michael (1975) and Baron and Galizio (2005) present cogent arguments for why positive and negative reinforcement are examples of the same fundamental operant relation. This issue is discussed further in Chapter 12.

[16]Some authors use the modifiers *primary* or *unlearned* to identify *unconditioned reinforcers* and *unconditioned punishers.*

Box 2.2
Distinguishing between Principles of Behavior and Behavior Change Tactics

A principle of behavior describes a basic behavior–environment relation that has been demonstrated repeatedly in hundreds, even thousands, of experiments. A **principle of behavior** describes a functional relation between behavior and one or more of its controlling variables (in the form of $b = fx$) that has thorough generality across individual organisms, species, settings, and behaviors. A principle of behavior is an empirical generalization inferred from many experiments. Principles describe how behavior works. Some examples of principles are reinforcement, punishment, and extinction.

In general, a behavior change tactic is a method for operationalizing, or putting into practice, the knowledge provided by one or more principles of behavior. A **behavior change tactic** is a research-based, technologically consistent method for changing behavior that has been derived from one or more basic principles of behavior and that possesses sufficient generality across subjects, settings, and/or behaviors to warrant its codification and dissemination. Behavior change tactics constitute the technological aspect of applied behavior analysis. Examples of behavior change procedures include backward chaining, differential reinforcement of other behavior, shaping, response cost, and time-out.

So, principles describe how behavior works, and behavior change tactics are how applied behavior analysts put the principles to work to help people learn and use socially significant behaviors. There are relatively few principles of behavior, but there are many derivative behavior change tactics. To illustrate further, reinforcement is a behavioral principle because it describes a lawful relation between behavior, an immediate consequence, and an increased frequency of the behavior in the future under similar conditions. However, the issuance of checkmarks in a token economy or the use of contingent social praise are behavior change tactics derived from the principle of reinforcement. To cite another example, punishment is a principle behavior because it describes the established relations between the presentation of a consequence and the decreased frequency of similar behavior in the future. Response cost and time-out, on the other hand, are methods for changing behavior; they are two different tactics used by practitioners to operationalize the principle of punishment.

recognize the important qualification that the momentary effectiveness of an unconditioned reinforcer is a function of current **motivating operations.** For example, a certain level of food **deprivation** is necessary for the presentation of food to function as a reinforcer. However, food is unlikely to function as reinforcement for a person who has recently eaten a lot of food (a condition of **satiation**). The nature and functions of motivating operations are described in detail in Chapter 16.

Similarly, an **unconditioned punisher** is a stimulus change that can decrease the future frequency of any behavior that precedes it without prior pairing with any other form of punishment. Unconditioned punishers include painful stimulation that can cause tissue damage (i.e., harm body cells). However, virtually any stimulus to which an organism's receptors are sensitive—light, sound, and temperature, to name a few—can be intensified to the point that its delivery will suppress behavior even though the stimulus is below levels that actually cause tissue damage (Bijou & Baer, 1965).

Events that function as unconditioned reinforcers and punishers are the product of the natural evolution of the species (phylogeny). Malott, Tillema, and Glenn (1978) described the natural selection of "rewards" and "aversives" as follows:[17]

> Some rewards and aversives control our actions because of the way our species evolved; we call these unlearned rewards or aversives. We inherit a biological structure that causes some stimuli to be rewarding or aversive. This structure evolved because rewards helped our ancestors survive, while aversives hurt their survival. Some of these unlearned rewards, such as food and fluid, help us survive by strengthening our body cells. Others help

[17]In addition to using *aversive stimulus* as a synonym for a *negative reinforcer,* Skinner (1953) also used the term to refer to stimuli whose onset or presentation functions as punishment, a practice continued by many behavior analysts (e.g., Alberto & Troutman, 2006; Malott & Trojan Suarez, 2004; Miltenberger, 2004). The term *aversive stimulus* (and *aversive control* when speaking of behavior change techniques involving such stimuli) is used widely in the behavior analysis literature to refer to one or more of three different behavioral functions: an aversive stimulus may be (a) a negative reinforcer if its termination increases behavior, (b) a punisher if its presentation decreases behavior, and/or (c) a motivating operation if its presentation increases the current frequency of behaviors that have terminated it in the past (see Chapter 16). When speaking or writing technically, behavior analysts must be careful that their use of omnibus terms such as *aversive* does not imply unintended functions (Michael, 1995).

> our species survive by causing us to produce and care for our offspring—these stimuli include the rewarding stimulation resulting from copulation and nursing. And many unlearned aversives harm our survival by damaging our body cells; such aversives include burns, cuts and bruises. (p. 9)

While unconditioned reinforcers and punishers are critically important and necessary for survival, relatively few behaviors that comprise the everyday routines of people as they go about working, playing, and socializing are directly controlled by such events. For example, although going to work each day earns the money that buys food, eating that food is far too delayed for it to exert any direct operant control over the behavior that earned it. Remember: Behavior is most affected by its immediate consequences.

Conditioned Reinforcers and Punishers

Stimulus events or conditions that are present or that occur just before or simultaneous with the occurrence of other reinforcers (or punishers) may acquire the ability to reinforce (or punish) behavior when they later occur on their own as consequences. Called **conditioned reinforcers** and **conditioned punishers,** these stimulus changes function as reinforcers and punishers only because of their prior pairing with other reinforcers or punishers.[18] The stimulus–stimulus pairing procedure responsible for the creation of conditioned reinforcers or punishers is the same as that used for respondent conditioning except that the "outcome is a stimulus that functions as a reinforcer [or punisher] rather than a stimulus that will elicit a response" (Michael, 2004, p. 66, words in brackets added).

Conditioned reinforcers and punishers are not related to any biological need or anatomical structure; their ability to modify behavior is a result of each person's unique history of interactions with his or her environment (ontogeny). Because no two people experience the world in exactly the same way, the roster of events that can serve as conditioned reinforcers and punishers at any particular time (given a relevant motivating operation) is idiosyncratic to each individual and always changing. On the other hand, to the extent that two people have had similar experiences (e.g., schooling, profession, the culture in general), they are likely to be affected in similar ways to many similar events. Social praise and attention are examples of widely effective conditioned reinforcers in our culture. Because social attention and approval (as well as disapproval) are often paired with so many other reinforcers (and punishers), they exert powerful control over human behavior and will be featured in later chapters when specific tactics for changing behavior are presented.

Because people who live in a common culture share similar histories, it is not unreasonable for a practitioner to search for potential reinforcers and punishers for a given client among classes of stimuli that have proven effective with other similar clients. However, in an effort to help the reader establish a fundamental understanding of the nature of operant conditioning, we have purposely avoided presenting a list of stimuli that may function as reinforcers and punishers. Morse and Kelleher (1977) made this important point very well.

> Reinforcers and punishers, as environmental "things," appear to have a greater reality than orderly temporal changes in ongoing behavior. Such a view is deceptive. There is no concept that predicts reliably when events will be reinforcers or punishers; *the defining characteristics of reinforcers and punishers are how they change behavior* [italics added). Events that increase or decrease the subsequent occurrence of one response may not modify other responses in the same way.
>
> In characterizing reinforcement as the presentation of a reinforcer contingent upon a response, the tendency is to emphasize the event and to ignore the importance of both the contingent relations and the antecedent and subsequent behavior. It is *how* [italics added] they change behavior that defines the terms *reinforcer* and *punisher;* thus it is the orderly change in behavior that is the key to these definitions. It is *not* [italics added] appropriate to presume that particular environmental events such as the presentation of food or electric shock are reinforcers or punishers until a change in the rate of responding has occurred when the event is scheduled in relation to specified responses.
>
> A stimulus paired with a reinforcer is said to have become a conditioned reinforcer, but actually it is the behaving subject that has changed, not the stimulus. . . . It is, of course, useful shorthand to speak of conditioned reinforcers . . . just as it is convenient to speak about a reinforcer rather than speaking about an event that has followed an instance of a specific response and resulted in a subsequent increase in the occurrence of similar responses. The latter may be cumbersome, but it has the advantage of empirical referents. Because many different responses can be shaped by consequent events, and because a given consequent event is often effective in modifying the behavior of different individuals, it becomes common practice to refer to reinforcers without specifying the behavior that is being modified. These common practices have unfortunate consequences. They lead to erroneous views that responses are arbitrary and that the reinforcing or punishing effect of an event is a specific property of the event itself. (pp. 176–177, 180)

The point made by Morse and Kelleher (1977) is of paramount importance to understanding behavior–

[18]Some authors use the modifiers *secondary* or *learned* to identify *conditioned reinforcers* and *conditioned punishers.*

environment relations. Reinforcement and punishment are not simply the products of certain stimulus events, which are then called reinforcers and punishers without reference to a given behavior and environmental conditions. There are no inherent or standard physical properties of stimuli that determine their permanent status as reinforcers and punishers. In fact, a stimulus can function as a positive reinforcer under one set of conditions and a negative reinforcer under different conditions. Just as positive reinforcers are not defined with terms such as *pleasant* or *satisfying,* aversive stimuli should not be defined with terms such as *annoying* or *unpleasant.* The terms *reinforcer* and *punisher* should not to be used on the basis of a stimulus event's assumed effect on behavior or on any inherent property of the stimulus event itself. Morse and Kelleher (1977) continued:

> When the borders of the table are designated in terms of stimulus classes (positive–negative; pleasant–noxious) and experimental operations (stimulus presentation–stimulus withdrawal), the cells of the table are, by definition, varieties of reinforcement and punishment. One problem is that the processes indicated in the cells have already been assumed in categorizing stimuli as positive or negative; a second is that there is a tacit assumption that the presentation or withdrawal of a particular stimulus will have an invariant effect. These relations are clearer if empirical operations are used to designate the border conditions. . . . The characterization of behavioral processes depends upon empirical observations. The same stimulus event, under different conditions, may increase behavior or decrease behavior. In the former case the process is called *reinforcement* and in the latter the process is called *punishment.* (p. 180)

At the risk of redundancy, we will state this important concept again. Reinforcers and punishers denote functional classes of stimulus events, the membership to which is not based on the physical nature of the stimulus changes or events themselves. Indeed, given a person's individual history and current motivational state, and the current environmental conditions, "any stimulus change can be a 'reinforcer' if the characteristics of the change, and the temporal relation of the change to the response under observation, are properly selected" (Schoenfeld, 1995, p. 184). Thus, the phrase "everything is relative" is thoroughly relevant to understanding functional behavior–environment relations.

The Discriminated Operant and Three-Term Contingency

We have discussed the role of consequences in influencing the future frequency of behavior. But operant conditioning does much more than establish a functional relation between behavior and its consequences. Operant conditioning also establishes functional relations between behavior and certain antecedent conditions.

> In contrast to *if-A-then-B* formulations (such as S-R formulations), the *AB-because-of-C* formulation is a general statement that the relation between an event (B) and its context (A) is because of consequences (C). . . . Applied to Skinner's three-term contingency, the relation between (A) the setting and (B) behavior exists because of (C) consequences that occurred for previous AB (setting-behavior) relations. The idea [is] that reinforcement strengthens the setting-behavior relation rather than simply strengthening behavior. (Moxley, 2004, p. 111)

Reinforcement selects not just certain forms of behavior; it also selects the environmental conditions that in the future will evoke (increase) instances of the response class. A behavior that occurs more frequently under some antecedent conditions than it does in others is called a **discriminated operant.** Because a discriminated operant occurs at a higher frequency in the presence of a given stimulus than it does in the absence of that stimulus, it is said to be under **stimulus control.** Answering the phone, one of the everyday behaviors discussed by the professor and his students in Box 2.1, is a discriminated operant. The telephone's ring functions as a **discriminative stimulus (S^D)** for answering the phone. We answer the phone when it is ringing, and we do not answer the phone when it is silent.

Just as reinforcers or punishers cannot be identified by their physical characteristics, stimuli possess no inherent dimensions or properties that enable them to function as discriminative stimuli. Operant conditioning brings behavior under the control of various properties or values of antecedent stimuli (e.g., size, shape, color, spatial relation to another stimulus), and what those features are cannot be determined a priori. (Stimulus control is described in detail in Chapter 17.)

> Any stimulus present when an operant is reinforced acquires control in the sense that the rate will be higher when it is present. Such a stimulus does not act as a goad; it does not elicit the response in the sense of forcing it to occur. It is simply an essential aspect of the occasion upon which a response is made and reinforced. The difference is made clear by calling it a discriminative stimulus (or S^D). An adequate formulation of the interaction between an organism and its environment must always specify three things: (1) the occasion upon which a response occurs; (2) the response itself; and (3) the reinforcing consequences. The interrelationships among them are the "contingencies of reinforcement." (Skinner, 1969, p. 7)

The discriminated operant has its origin in the three-term contingency. The **three-term contingency**—*a*ntecedent, *b*ehavior, and *c*onsequence—is sometimes

Figure 2.3 Three-term contingencies illustrating reinforcement and punishment operations.

Antecedent Stimulus	Behavior	Consequence	Future Frequency of Behavior in Similar Conditions	Operation
"Name a carnivorous dinosaur."	"Tyrannosaurus Rex."	"Well done!"	↑	Positive Reinforcement
Foul smell under kitchen sink	Take trash outside	Foul smell is gone	↑	Negative Reinforcement
Icy road	Drive at normal speed	Crash into car ahead	↓	Positive Punishment
Popup box asks, "Warn when deleting unread messages?"	Click on "No"	Important e-mail message is lost	↓	Negative Punishment

called the ABCs of behavior analysis. Figure 2.3 shows examples of three-term contingencies for positive reinforcement, negative reinforcement, positive punishment, and negative punishment.[19] Most of what the science of behavior analysis has discovered about the prediction and control of human behavior involves the three-term contingency, which is "considered the basic unit of analysis in the analysis of operant behavior" (Glenn, Ellis, & Greenspoon, 1992, p. 1332).

The term **contingency** appears in behavior analysis literature with several meanings signifying various types of temporal and functional relations between behavior and antecedent and consequent variables (Lattal, 1995; Lattal & Shahan, 1997; Vollmer & Hackenberg, 2001). Perhaps the most common connotation of contingency refers to the *dependency* of a particular consequence on the occurrence of the behavior. When a reinforcer (or punisher) is said to be **contingent** on a particular behavior, the behavior must be emitted for the consequence to occur. For example, after saying, "Name a carnivorous dinosaur," a teacher's "Well done!" depends on the student's response, "Tyrannosaurus Rex" (or another dinosaur of the same class).[20]

The term *contingency* is also used in reference to the *temporal contiguity* of behavior and its consequences. As stated previously, behavior is selected by the consequences that immediately follow it, irrespective of whether those consequences were produced by or depended on the behavior. This is the meaning of contingency in Skinner's (1953) statement, "So far as the organism is concerned, the only important property of the contingency is temporal" (1953, p. 85).

Recognizing the Complexity of Human Behavior

> Behavior—human or otherwise—remains an extremely difficult subject matter.
>
> —B. F. Skinner (1969, p. 114)

The experimental analysis of behavior has discovered a number of basic principles—statements about how behavior works as a function of environmental variables. These principles, several of which have been introduced

[19]Contingency diagrams, such as those shown in Figure 2.3, are an effective way to illustrate temporal and functional relationships between behavior and various environmental events. See Mattaini (1995) for examples of other types of contingency diagrams and suggestions for using them to teach and learn about behavior analysis. State notation is another means for visualizing complex contingency relations and experimental procedures (Mechner, 1959; Michael & Shafer, 1995).

[20]The phrase *to make reinforcement contingent* describes the behavior of the researcher or practitioner: delivering the reinforcer only after the target behavior has occurred.

in this chapter, have been demonstrated, verified, and replicated in hundreds and even thousands of experiments; they are scientific facts.[21] Tactics for changing behavior derived for these principles have also been applied, in increasingly sophisticated and effective ways, to a wide range of human behaviors in natural settings. A summary of what has been learned from many of those applied behavior analyses comprises the majority of this book.

The systematic application of behavior analysis techniques sometimes produces behavior changes of great magnitude and speed, even for clients whose behavior had been unaffected by other forms of treatment and appeared intractable. When such a happy (but not rare) outcome occurs, the neophyte behavior analyst must resist the tendency to believe that we know more than we do about the prediction and control of human behavior. As acknowledged in Chapter 1, applied behavior analysis is a young science that has yet to achieve anything near a complete understanding and technological control of human behavior.

A major challenge facing applied behavior analysis lies in dealing with the complexity of human behavior, especially in applied settings where laboratory controls are impossible, impractical, or unethical. Many of the factors that contribute to the complexity of behavior stem from three general sources: the complexity of the human repertoire, the complexity of controlling variables, and individual differences.

Complexity of the Human Repertoire

Humans are capable of learning an incredible range of behaviors. Response sequences, sometimes of no apparent logical organization, contribute to the complexity of behavior (Skinner, 1953). In a response chain, effects produced by one response influence the emission of other responses. Returning a winter coat to the attic leads to rediscovering a scrapbook of old family photographs, which evokes a phone call to Aunt Helen, which sets the occasion for finding her recipe for apple pie, and so on.

Verbal behavior may be the most significant contributor to the complexity of human behavior (Donahoe & Palmer, 1994; Michael, 2003; Palmer, 1991; Skinner, 1957). Not only is a problem generated when the difference between saying and doing is not recognized, but verbal behavior itself is often a controlling variable for many other verbal and nonverbal behaviors. The analysis of verbal behavior is introduced in Chapter 25.

Operant learning does not always occur as a slow, gradual process. Sometimes new, complex, repertoires appear quickly with little apparent direct conditioning (Epstein, 1991; Sidman, 1994). One type of rapid learning has been called *contingency adduction,* a process whereby a behavior that was initially selected and shaped under one set of conditions is recruited by a different set of contingencies and takes on a new function in the person's repertoire (Adronis, 1983; Layng & Adronis, 1984). Johnson and Layng (1992, 1994) described several examples of contingency adduction in which simple (component) skills (e.g., addition, subtraction, and multiplication facts, isolating and solving for *X* in a simple linear equation), when taught to fluency, combined without apparent instruction to form new complex (composite) patterns of behavior (e.g., factoring complex equations).

Intertwined lineages of different operants combine to form new complex operants (Glenn, 2004), which produce response products that in turn make possible the acquisition of behaviors beyond the spatial and mechanical restraints of anatomical structure.

> In the human case, the range of possibilities may be infinite, especially because the products of operant behavior have become increasingly complex in the context of evolving cultural practices. For example, anatomical constraints prevented operant flying from emerging in a human repertoire only until airplanes were constructed as behavioral products. Natural selection's leash has been greatly relaxed in the ontogeny of operant units. (Glenn et al., 1992, p. 1332)

Complexity of Controlling Variables

Behavior is selected by its consequences. This megaprinciple of operant behavior sounds deceptively (and naively) simple. However, "Like other scientific principles, its simple form masks the complexity of the universe it describes" (Glenn, 2004, p. 134). The environment and its effects on behavior are complex.

Skinner (1957) noted that, "(1) the strength of a single response may be, and usually is, a function of more than one variable and (2) a single variable usually affects more than one response" (p. 227). Although Skinner was writing in reference to verbal behavior, multiple causes and multiple effects are characteristics of many behavior–environment relations. Behavioral covariation illustrates one type of multiple effect. For example, Sprague and Horner (1992) found that blocking the emission of one problem behavior decreased the frequency of that behavior but produced a collateral increase in other topographies of problem behaviors in the same functional class. As another example of multiple effects, the presentation of an aversive stimulus may, in addition to suppressing the future occurrences of the behavior it follows, elicit

[21] Like all scientific findings, these facts are subject to revision and even replacement should future research reveal better ones.

respondent behaviors and evoke escape and avoidance behaviors—three different effects from one event.

Many behaviors are the result of multiple causes. In a phenomena called *joint control* (Lowenkron, 2004), two discriminative stimuli can combine to evoke a common response class. Concurrent contingencies can also combine to make a behavior more or less likely to occur in a given situation. Perhaps we finally return our neighbor's weed trimmer not just because he usually invites us in for a cup of coffee, but also because returning the tool reduces the "guilt" we are feeling for keeping it for 2 weeks.

Concurrent contingencies often vie for control of incompatible behaviors. We cannot watch "Baseball Tonight" and study (properly) for an upcoming exam. Although not a technical term in behavior analysis, *algebraic summation* is sometimes used to describe the effect of multiple, concurrent contingencies on behavior. The behavior that is emitted is thought to be the product of the competing contingencies "canceling portions of each other out" as in an equation in algebra.

Hierarchies of response classes within what was presumed to be a single response class may be under multiple controlling variables. For example, Richman, Wacker, Asmus, Casey, and Andelman (1999) found that one topography of aggressive behavior was maintained by one type of reinforcement contingency while another form of aggression was controlled by a different contingency.

All of these complex, concurrent, interrelated contingencies make it difficult for behavior analysts to identify and control relevant variables. It should not be surprising that the settings in which applied behavior analysts ply their trade are sometimes described as places where "reinforcement occurs in a noisy background" (Vollmer & Hackenberg, 2001, p. 251).

Consequently, as behavior analysts, we should recognize that meaningful behavior change might take time and many trials and errors as we work to understand the interrelationships and complexities of the controlling variables. Don Baer (1987) recognized that some of the larger problems that beset society (e.g., poverty, substance addiction, illiteracy), given our present level of technology, might be too difficult to solve. He identified three barriers to solving such complex problems:

> (a) We are not empowered to solve these bigger remaining problems, (b) we have not yet made the analysis of how to empower ourselves to try them, and (c) we have not yet made the system-analytic task analyses that will prove crucial to solving those problems when we do empower ourselves sufficiently to try them. . . . In my experience, those projects that seem arduously long are arduous because (a) I do not have a strong interim reinforcer compared to those in the existing system for status quo and must wait for opportunities when weak control may operate, even so, or (b) I do not yet have a correct task analysis of the problem and must struggle through trials and errors. By contrast (c) when I have an effective interim reinforcer and I know the correct task analysis of this problem, long problems are simply those in which the task analysis requires a series of many behavior changes, perhaps in many people, and although each of them is relatively easy and quick, the series of them requires not so much effort as time, and so it is not arduous but merely tedious. (pp. 335, 336–337)

Individual Differences

You did not need to read this textbook to know that people often respond very differently to the same set of environmental conditions. The fact of individual differences is sometimes cited as evidence that principles of behavior based on environmental selection do not exist, at least not in a form that could provide the basis for a robust and reliable technology of behavior change. It is then argued that because people often respond differently to the same set of contingencies, control of behavior must come from within each person.

As each of us experiences varying contingencies of reinforcement (and punishment), some behaviors are strengthened (selected by the contingencies) and others are weakened. This is the nature of operant conditioning, which is to say, human nature. Because no two people ever experience the world in exactly the same way, each of us arrives at a given situation with a different **history of reinforcement.** The repertoire of behaviors each person brings to any situation has been selected, shaped, and maintained by his or her unique history of reinforcement. Each human's unique repertoire defines him or her as a person. We are what we do, and we do what we have learned to do. "He begins as an organism and becomes a person or self as he acquires a repertoire of behavior" (Skinner, 1974, p. 231).

Individual differences in responding to current stimulus conditions, then, do not need to be attributed to differences in internal traits or tendencies, but to the orderly result of different histories of reinforcement. The behavior analyst must also consider people's varying sensitivities to stimuli (e.g., hearing loss, visual impairment) and differences in response mechanisms (e.g., cerebral palsy) and design program components to ensure that all participants have maximum contact with relevant contingencies (Heward, 2006).

Additional Obstacles to Controlling Behavior in Applied Settings

Compounding the difficulty of tackling the complexity of human behavior in the "noisy" applied settings where people live, work, and play, applied behavior analysts are sometimes prevented from implementing an effective behavior change program due to logistical, financial, sociopolitical, legal, and/or ethical factors. Most applied behavior analysts work for agencies with limited resources, which may make the data collection required for a more complete analysis impossible. In addition, participants, parents, administrators, and even the general public may at times limit the behavior analyst's options for effective intervention (e.g., "We don't want students working for tokens"). Legal or ethical considerations may also preclude determining experimentally the controlling variables for an important behavior. Ethical considerations for behavior analysts are discussed in Chapter 29.

Each of these practical complexities combines with the behavioral and environmental complexities previously mentioned to make the applied behavior analysis of socially important behavior a challenging task. However, the task need not be overwhelming, and few tasks are as rewarding or as important for the betterment of humankind.

It is sometimes expressed that a scientific account of behavior will somehow diminish the quality or enjoyment of the human experience. For example, will our increasing knowledge of the variables responsible for creative behavior lessen the feelings evoked by a powerful painting or a beautiful symphony, or reduce our appreciation of the artists who produced them? We think not, and we encourage you, as you read and study about the basic concepts introduced in this chapter and examined in more detail throughout the book, to consider Nevin's (2005) response to how a scientific account of behavior adds immeasurably to the human experience:

> At the end of *Origin of Species* (1859), Darwin invites us to contemplate a tangled bank, with its plants and its birds, its insects and its worms; to marvel at the complexity, diversity, and interdependence of its inhabitants; and to feel awe at the fact that all of it follows from the laws of reproduction, competition, and natural selection. Our delight in the tangled bank and our love for its inhabitants are not diminished by our knowledge of the laws of evolution; neither should our delight in the complex world of human activity and our love for its actors be diminished by our tentative but growing knowledge of the laws of behavior. (Tony Nevin, personal communication, December 19, 2005)

Summary

Behavior

1. In general, behavior is the activity of living organisms.
2. Technically, behavior is "that portion of an organism's interaction with its environment that is characterized by detectable displacement in space through time of some part of the organism and that results in a measurable change in at least one aspect of the environment" (Johnston & Pennypacker, 1993a, p. 23).
3. The term *behavior* is usually used in reference to a larger set or class of responses that share certain topographical dimensions or functions.
4. *Response* refers to a specific instance of behavior.
5. *Response topography* refers to the physical shape or form of behavior.
6. A response class is a group of responses of varying topography, all of which produce the same effect on the environment.
7. *Repertoire* can refer to all of the behaviors a person can do or to a set of behaviors relevant to a particular setting or task.

Environment

8. Environment is the physical setting and circumstances in which the organism or referenced part of the organism exists.
9. Stimulus is "an energy change that affects an organism through its receptor cells" (Michael, 2004, p. 7).
10. The environment influences behavior primarily by stimulus change, not static stimulus conditions.
11. Stimulus events can be described formally (by their physical features), temporally (by when they occur), and functionally (by their effects on behavior).
12. A stimulus class is a group of stimuli that share specified common elements along formal, temporal, and/or functional dimensions.
13. Antecedent conditions or stimulus changes exist or occur prior to the behavior of interest.
14. Consequences are stimulus changes that follow a behavior of interest.
15. Stimulus changes can have one or both of two basic effects on behavior: (a) an immediate but temporary effect of increasing or decreasing the current frequency of the behavior, and/or (b) a delayed but relatively permanent effect in terms of the frequency of that type of behavior in the future.

Respondent Behavior

16. Respondent behavior is elicited by antecedent stimuli.
17. A reflex is a stimulus–response relation consisting of an antecedent stimulus and the respondent behavior it elicits (e.g., bright light–pupil contraction).
18. All healthy members of a given species are born with the same repertoire of unconditioned reflexes.

19. An unconditioned stimulus (e.g., food) and the respondent behavior it elicits (e.g., salivation) are called unconditioned reflexes.
20. Conditioned reflexes are the product of respondent conditioning: a stimulus–stimulus pairing procedure in which a neutral stimulus is presented with an unconditioned stimulus until the neutral stimulus becomes a conditioned stimulus that elicits the conditioned response.
21. Pairing a neutral stimulus with a conditioned stimulus can also produce a conditioned reflex—a process called higher order (or secondary) respondent conditioning.
22. Respondent extinction occurs when a conditioned stimulus is presented repeatedly without the unconditioned stimulus until the conditioned stimulus no longer elicits the conditioned response.

Operant Behavior

23. Operant behavior is selected by its consequences.
24. Unlike respondent behavior, whose topography and basic functions are predetermined, operant behavior can take a virtually unlimited range of forms.
25. Selection of behavior by consequences operates during the lifetime of the individual organism (ontogeny) and is a conceptual parallel to Darwin's natural selection in the evolutionary history of a species (phylogeny).
26. Operant conditioning, which encompasses reinforcement and punishment, refers to the process and selective effects of consequences on behavior:
    - Consequences can affect only future behavior.
    - Consequences select response classes, not individual responses.
    - Immediate consequences have the greatest effect.
    - Consequences select any behavior that precedes them.
    - Operant conditioning occurs automatically.
27. Most stimulus changes that function as reinforcers or punishers can be described as either (a) a new stimulus added to the environment, or (b) an already present stimulus removed from the environment.
28. Positive reinforcement occurs when a behavior is followed immediately by the presentation of a stimulus that increases the future frequency of the behavior.
29. Negative reinforcement occurs when a behavior is followed immediately by the withdrawal of a stimulus that increases the future frequency of the behavior.
30. The term *aversive stimulus* is often used to refer to stimulus conditions whose termination functions as reinforcement.
31. Extinction (withholding all reinforcement for a previously reinforced behavior) produces a decrease in response frequency to the behavior's prereinforcement level.
32. Positive punishment occurs when a behavior is followed by the presentation of a stimulus that decreases the future frequency of the behavior.
33. Negative punishment occurs when a behavior is followed immediately by the withdrawal of a stimulus that decreases the future frequency of the behavior.
34. A principle of behavior describes a functional relation between behavior and one or more of its controlling variables that has thorough generality across organisms, species, settings, and behaviors.
35. A behavior change tactic is a technologically consistent method for changing behavior that has been derived from one or more basic principles of behavior.
36. Unconditioned reinforcers and punishers function irrespective of any prior learning history.
37. Stimulus changes that function as conditioned reinforcers and punishers do so because of previous pairing with other reinforcers or punishers.
38. One important function of motivating operations is altering the current value of stimulus changes as reinforcement or punishment. For example, deprivation and satiation are motivating operations that make food more or less effective as reinforcement.
39. A discriminated operant occurs more frequently under some antecedent conditions than it does under others, an outcome called stimulus control.
40. Stimulus control refers to differential rates of operant responding observed in the presence or absence of antecedent stimuli. Antecedent stimuli acquire the ability to control operant behavior by having been paired with certain consequences in the past.
41. The three-term contingency—*a*ntecedent, *b*ehavior, and *c*onsequence—is the basic unit of analysis in the analysis of operant behavior.
42. If a reinforcer (or punisher) is contingent on a particular behavior, the behavior must be emitted for the consequence to occur.
43. All applied behavior analysis procedures involve manipulation of one or more components of the three-term contingency.

Recognizing the Complexity of Human Behavior

44. Humans are capable of acquiring a huge repertoire of behaviors. Response chains and verbal behavior also make human behavior extremely complex.
45. The variables that govern human behavior are often highly complex. Many behaviors have multiple causes.
46. Individual differences in histories of reinforcement and organic impairments also make the analysis and control of human behavior difficult.
47. Applied behavior analysts are sometimes prevented from conducting an effective analysis of behavior because of practical, logistical, financial, sociopolitical, legal, and/or ethical reasons.