Handbook of Applied Behavior Analysis

Edited by

Wayne W. Fisher
Cathleen C. Piazza
Henry S. Roane

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CHAPTER 1

Applied Behavior Analysis

History, Philosophy, Principles, and Basic Methods

Wayne W. Fisher, Rebecca A. Groff, and Henry S. Roane

Behavior analysis is a discipline with three primary branches (Morris, Todd, Midgley, Schneider, & Johnson, 1990): (1) behaviorism, which focuses on the worldview or philosophy of behavior analysis; (2) the experimental analysis of behavior, which focuses on identifying and analyzing the basic principles and processes that explain behavior; and (3) applied behavior analysis (ABA), which focuses on solving problems of social importance using the principles and procedures of behavior analysis. Although this third branch of behavior analysis is the primary topic of our text, a basic knowledge of the other branches is necessary to appreciate fully the development and dimensions of ABA.

Behavior analysis began as a school or subfield within the discipline of psychology. Some still view behavior analysis as a subspecialty within psychology,whereas others believe that the basic tenets of behavior analysis and traditional psychology are so fundamentally at odds that the two cannot coexist within a single discipline (e.g., Fraley & Vargus, 1986). The basic tenets that distinguish behavior analysis from other areas of psychology include its emphasis on (1) behavior as the basic datum for the field rather than the *psyche*, the *self*, or other internal mental or metaphysical structures or phenomena; (2) continuity between publicly observable behavior and private events (e.g., thinking, feeling); (3) prediction and control of the behavior of individuals (rather than groups); (4) environmental explanations of behavior; and (5) the study of behavior as a natural science. We discuss each of these tenets before turning our attention to the dimensions that specifically define ABA.

Behavior as Subject Matter

Behavior analysts believe that the appropriate subject matter for our field is behavior. We define *behavior* quite broadly to include anything an individual does when interacting with the physical environment (Catania, 2007; Skinner, 1938), including crying, speaking, listening, running, jumping, shifting attention, and even thinking. This behavioral philosophy is in contrast to the beliefs of mentalists or cognitive psychologists, who view thinking, feeling, and other internal events as activity that occurs within metaphysical entities such as the *self*, the *psyche*, or the *mind*, and consider these entities to influence or control outward behavior. Mentalists observe behavior in order to

draw inferences about these hypothetical structures, which they view as the appropriate subject matter for the field of psychology. They believe that understanding these inner constructs help to explain observable behavior. Behaviorists believe that behavior itself is the appropriate subject matter for our field, and that it should be studied directly, without references to internal causes. They view the brain as real but the mind as an invention, something thought up rather than something that thinks and controls behavior.

Although people in all walks of life talk about the mind as if it were a real entity, when questioned about its location and its characteristics, they find that the mind is difficult (if not impossible) to locate or describe in precise terms. Another problem that arises when one attempts to explain outward, observable behavior by appealing to causation via internal events is that one then has to explain what causes the internal events. Two philosophical arguments illustrate this problem: One is called Ryle's regress, and the other is called the homunculus fallacy.

Ryle (1949) identified a logical flaw in the traditional (dualist) view of intelligent behavior. The dualist position (i.e., viewing the mind and body as two distinct entities) is that when an individual displays an intelligent act (i.e., an observable response), it must have been preceded and directed by internal (mental) reflection on how to act intelligently. Ryle pointed out that if the logic of the dualist view were accurate, then it would follow that the internal operation of "reflection" would also be an intelligent act (albeit an internal one) that would need to be preceded and guided by reflection about various alternative ways of reflecting, thus creating a potentially never-ending succession of reflecting about reflecting about reflecting, and so forth. The endless need for a predecessor and director of every intelligent act has been labeled *Ryle's regress*.

The homunculus fallacy is analogous to Ryle's regress except that it is focused on the topic of how visual stimulation is interpreted. A mentalist viewpoint is that light is projected onto the back of the retina, and the mind views these images similarly to the way an individual views a motion picture. The mind is thus akin to a little man (or homunculus) who is metaphorically sitting inside of the brain viewing the movie. The question then arises as to how the mind (or the homunculus) sees and interprets the motion picture playing inside the human brain. In keeping with the mentalist hypothesis, there would have to be another, smaller homunculus inside the first one, which would in turn need to have an even smaller homunculus inside of it to interpret its movie. The endless need for another homunculus to explain the visual interpretations of the prior one is known as the *homunculus fallacy* (Uttal, 2000).

These arguments help to illustrate that it is impossible to prove or disprove the existence of the mind, much the way it is impossible to prove or disprove the existence of ghosts. Modern day mentalists (e.g., cognitive psychologists) do not often talk about the mind per se, but they are much more likely than behaviorists to look to internal variables (e.g., thoughts and feelings within the individual that cannot be observed) to explain behavior, and similar logical problems arise; that is, observable behavior (e.g., preparing a sandwich) is used to formulate hypotheses about internal constructs (e.g., the individual is hungry), which are then used to explain the observed behavior (e.g., the person prepared a sandwich because of the hunger). Skinner (1953) pointed out that the two statements, "He eats" and "He is hungry," describe a single set of facts; thus, one statement, "He is hungry," cannot be used to explain the other, "He eats" (p. 31). Skinner also argued that appeals to such inner causes impede scientific inquiry because once a (supposed) cause of behavior is identified (i.e., "He eats because he is hungry"), there is no reason to continue to search for an explanation of the behavior.

By contrast, B. F. Skinner's approach to explaining behavior represents a constantly evolving one in which experimental findings guide theory much more than theory guides experimentation. In fact, revisions and updates of behavior analytic explanations of behavior are often based on new experimental findings—an approach that has been referred to many times as "a work in progress" (e.g., Catania, 1988, p. 279). One notable example of the way our conceptualizations of behavior have been updated as result of new experimental findings has been the way we define our subject matter "behavior."

Early definitions of *behavior* focused on its physical or topographical characteristics, such as "thought processes are really

motor habits in the larynx, improvements, short cuts, changes, etc." (Watson, 1913, p. 177). Skinner (1938) provided a much broader definition of *behavior* and introduced the concept of the three-term contingency (antecedent–behavior–consequence) that defines "operant behavior." That is, *operant behavior* is defined by not only its topographical features but also its functional properties, namely, the environmental antecedents and consequences that are functionally related to the specific response topography. The topographical features of a person running to catch a bus may be similar to those of someone running out of a burning building, but the two forms of running are distinctly separate operant responses because they are under the control of different environmental antecedents and consequences, and it is these environment–behavior relations that define operant behavior (Donahoe, 2004).

More recent empirical findings have led to additional refinements regarding what constitutes behavior. For example, research has shown that that operant behavior is sensitive to both molecular and molar patterns of reinforcement (e.g., Herrnstein, 1969). Based in part on this empirical finding, teleological behaviorism attempts to explain complex behavior (e.g., building a house, falling in love) through the identification of organized patterns of environment–behavior relations that involve both proximal and ultimate causes (or consequences). Rachlin (1995) explains that hammering a nail is a function of not only the immediate consequence of fastening two boards together but also the larger task of constructing a floor, which in turn is a function of the task of building a house, and all of these nested responses are a function of the ultimate consequence of sheltering and protecting one's family.

Our conception of what constitutes behavior has also expanded as a result of research on stimulus equivalence and relational frame theory (Hayes, Barnes-Holmes, & Roche, 2001; Sidman, 2000). Research in this area has consistently shown that when certain stimulus relations (e.g., Mike is heavier than Bill; Bill is heavier than Sam) are trained with verbally competent human participants, other stimulus relations emerge without specific training (e.g., Sam is lighter than Mike). These emergent (or derived) relations are important because they may be prerequisites to, and form the basis of, generative language acquisition. They are also potentially important because they require a broader definition of what constitutes operant behavior; that is, equivalence classes (or relational frames) represent broader units of operant behavior that include both trained (i.e., reinforced) and untrained stimulus relations.

Private Events

A common misconception of behavior analysis is that it does not acknowledge or attempt to explain internal, private events such as thoughts and dreams. Behavior analysts believe that private events are governed by the same laws that govern overt behavior, and they do not explain these private events using mentalistic processes (Moore, 2003). The major difference between public and private behavior is that whereas the former can be observed and verified by other individuals, private events can only be observed by the individual performing the behavior.

Consider the scenario of a married man driving home with his spouse in one car and a single man driving home alone in another car. The married man looks at his spouse while stopped at a traffic light and says, "Remind me to take the garbage out when we get home." At the same stoplight, the single man thinks silently to himself, "I've got to remember to take the garbage out when I get home."

Behaviorists would view the talking done by the married man and the thinking done by the single man as distinct forms of behavior governed by the same laws, in which talking is a public behavior that can be observed by others and thinking is a private behavior that can only be observed by the single man. Behavior analysts almost exclusively study public behavior because it can be objectively observed, quantified, and subjected to the scientific method. However, behaviorists believe that the general principles of behavior derived from the study of public responses (e.g., talking aloud) also apply to and can be used to explain private responses (e.g., thinking or talking silently to oneself).

Behaviorists are particularly focused on general principles that relate to the function of behavior (its purpose or why it occurs). Behaviorists believe that the function of a

response is largely determined by environmental events that occur in close physical and temporal proximity to the behavior. Important environmental events that influence behavior include (1) the context in which the response occurs (e.g., teenagers behave differently at home with parents than at a party with peers), (2) motivational factors (e.g., searching for a restaurant is more likely if one has not eaten in a while), (3) antecedents that signal which responses will be successful (e.g., proceeding if the traffic light is green because it signals safety, and stopping if it is red because it signals danger), and (4) the consequences or outcomes of responses that influence whether they will reoccur in the future (e.g., studying for a test is more likely to be repeated if it results in a better grade).

Applying these general principles to the previous scenario, a behavior analyst might hypothesize that the married man asked his wife to remind him to take out the trash because (1) stopping at a traffic light provided a signal or cue indicating that it was momentarily safe to shift his attention to matters other than driving the car; (2) the man had previously experienced the negative outcome associated with forgetting to take out the trash (e.g., trash piling up because the cans would not hold it all); and (3) asking his wife to remind him to take out the garbage increased the likelihood that the trash would be removed, avoiding the negative consequence of the trash piling up. The same three reasons would apply to the single man, except that he had no companion in the car to help him remember to take out the trash, so he said the words silently to himself rather than aloud. Thus, although the two responses in this example (talking aloud and thinking about the trash) are quite different topographically (whereas talking can be observed by others, thinking cannot), they are quite similar functionally because both are occasioned by the same antecedent (sitting at the stoplight) and reinforced by the same consequence (avoidance of the trash piling up).

Because covert behaviors cannot be observed by others, the only way to identify whether a private event has occurred is through self-report, and self-observation is often unreliable (Skinner, 1953). In fact, Skinner points out the irony in the fact that an individual is taught to "know oneself" by the verbal community; that is, the two primary ways in which an individual learns to identify appropriately and label his or her private events is to (1) "find commonalities between private and public events," or (2) for others to "identify things that usually occasion it [the private event] or behavior that usually co-occurs" (p. 259). For example, if a child and her mother both cover their ears as a low-flying jet passes them, and then the parent says, "That hurt my ears," the child may subsequently learn to use the label "hurt" to describe (or tact) a similar sensation in the ear caused by an ear infection.

Similarly, if a child vomits, refuses to eat food, and has a temperature, a parent might tell him that his stomach hurts. Skinner explains that if a culture cannot teach an individual to discriminate between private events, then the skill of properly identifying one's own private events may never be developed and, consequently, one may not have an extensive knowledge of "self" (Skinner, 1953).

Studying the Behavior of Individuals

Modern psychology often focuses on the study of groups in order to identify patterns of individual differences. Psychological research focused on topics such as personality, intelligence, self-concept, and self-efficacy generally follows this approach. By contrast, behavior analysis generally focuses on the behavior of individuals in order to identify general principles describing behavior relations that show consistency within and across species (pigeon, dog, human) and environmental contexts (laboratory, home, school) (Keller & Schoenfeld, 1950; Mace, 1996). This fundamental difference between mainstream psychology, which studies groups, and behavior analysis, which studies individuals, is also reflected in their experimental methods. Most psychological researchers employ group-comparison designs and use inferential statistics to identify significant differences between various groups, whereas behavior analysts use single-subject designs to study the generality of general principles of behavior (e.g., behavioral momentum, delay discounting). Behavior analysts find the prediction and control of the behavior of individuals (rather than groups) advantageous because whereas individuals

engage in behavior, groups do not (Johnston & Pennypacker, 1993, p. 23).

When group studies are conducted, the results are often presented in terms of statistical means to describe how the "average" individual in the group behaved, and standard deviations are used to describe how much behavioral variability was present in the group. From a behavioral perspective, these statistics are limited, in that they do not accurately describe the behavior of any single individual in the group (Johnston & Pennypacker, 1993, p. 324). Each individual in the group has a genetic makeup and an extensive learning history that is unique. Consequently, environmental manipulations may evoke different behavior in one individual compared to another individual. To illustrate, one treatment that may be effective for one individual in a group may not be as effective for another individual.

Conversely, in a single-subject design experiment, an individual serves as his or her own experimental control. Thus, the experiment takes into account the individual's unique genetic makeup and operant learning history. Because the individual in a single-subject experiment serves as his or her own control (i.e., his or her behavior in baseline and control conditions is compared to that in treatment conditions), this type of research can more accurately determine whether or not a treatment is effective for a specific individual.

Environmental Explanations of Behavior

As discussed previously, behavior analysts identify causes of behavior in the environment. Skinner (1969b) proposed that variables influencing behavior can fall into two categories: phylogenetic and ontogenetic.

Phylogenetic variables are genetic traits passed from parent to offspring through reproduction. *Natural selection*, as originally described by Charles Darwin, is the process by which the traits most likely to aid in survival are passed on to offspring via reproduction. Individuals with traits that are well adapted to their environment are more likely to survive and procreate; consequently, those adaptive traits are more likely to appear in the next generation than traits that do not facilitate survival and procreation. Natural selection is a gradual process, in that only after many generations does the genetic makeup of an individual evolve to a point where it is drastically different than the genetic makeup of its ancestors (Skinner, 1969b). These genetic variables, in conjunction with an individual's environment, contribute to both respondent and operant behavior. In fact, Skinner (1981) postulated that "operant behavior is an evolved process" (p. 502); that is, operant behavior was selected through the phylogenetic process of natural selection because it provided a means by which individuals could acquire behavior that was adaptive to novel and changing environments during their lifetime.

Ontogenetic variables are similar to phylogenetic variables and natural selection, except that the changes occur within an individual's lifetime (and often from momement to moment) rather than across multiple generations of individuals (Skinner, 1969b). *Ontogeny* refers to the "natural selection" of behaviors as a result of their consequences. If an individual emits a response (e.g., betting on the most muscular looking horse) that produces a favorable (or reinforcing) consequence (e.g., winning the bet), the probability that he or she will repeat that response in similar environmental contexts increases; that is, the behavior is "selected" and "shaped" by the environment because responses that produce favorable outcomes or consequences tend to get repeated in that environment. Similarly, if an individual emits a behavior (e.g., reaching into a hole in the ground) that results in an unfavorable (or punishing) consequence (e., being bitten by an unseen animal), the probability that he or she will emit a similar response in the future decreases. Thus, both natural selection and operant selection involve selection by consequences. With natural selection, the environment selects traits that are correlated with survival of the species, and changes in such traits evolve slowly over many generations. With operant selection, the environment selects responses that are correlated with favorable consequences (e.g., satiation of hunger, quenching of thirst, numbing of pain), and changes in response pattern can occur from one moment to the next or over a person's lifetime.

In both phylogeny and ontogeny, some genetic traits and behaviors are not directly selected; rather, they are *spandrels* (i.e., a by-product or free rider) of selection of other traits or behaviors (Skinner, 1969b). For ex-

ample, suppose a genetic trait for fast twitch muscles aids in survival, allowing organisms to outrun predators. These organisms are more likely to reproduce compared to organisms that run more slowly and are eaten by their prey; consequently, the genetics for fast twitch muscles will be passed on to the next generation of organisms. By contrast, suppose that the organism also has blue eyes. Blue eyes may not aid in the survival of the organism, but because the organism gets the opportunity to reproduce partially because of its fast twitch muscles, the trait of blue eyes will also be passed on to the next generation of organisms. Thus, blue eyes are a spandrel or by-product of natural selection. Similarly, reading a textbook before taking a test may increase the probability that an individual achieves a good grade on a test; consequently, reading behavior may increase in the future. This behavior is being directly reinforced by its consequences. If the individual drinks green tea while reading, then the behavior of drinking green tea may increase as a by-product of the behavior of reading being reinforced. The increase in green tea does not cause the individual to do well on his or her test, but the behavior increases as a by-product of the behavior of reading being reinforced.

Knowledge of spandrels plays a role in the application of behavior analysis. To illustrate, when a behavioral intervention is implemented either to decrease or increase a specific target behavior, it is important to consider what other behaviors in an individual's repertoire will be modified as a by-product of the targeted behavior and to plan accordingly. For example, *extinction* (i.e., no longer providing reinforcement for a behavior that is maintained by that reinforcer) of disruptive behavior may result in an increase in aggression even if this latter response did not produce the reinforcer in the past. Thus, an additional component of treatment should be added to account for this (e.g., providing access to the reinforcer that is contingent on an alternative behavior).

Structural versus Functional Classification of Behavior

Most approaches to classifying and understanding aberrant behavior emphasize its structural properties and how certain responses tend to co-occur. For example, a boy who avoids physical contact and eye contact with others, and displays peculiar vocal and motor responses (e.g., referring to himself as "you" and others as "I," and repetitively spinning objects) may receive the diagnosis of autism. This diagnosis is then often used as an explanation of the aberrant behavior that leads to the diagnosis (e.g., "He repetitively spins objects because he has autism"). As discussed earlier in the example provided by Skinner (1953; i.e., "He eats," "He is hungry"), the statements "He has autism" and "He repetitively spins objects" are two ways of describing the same set of facts; thus, one statement does not explain the other.

Behavior analysts frequently work with children with autism, but they view the diagnosis as descriptive rather than explanative. Because behavior analysts work to identify operant contingencies that are maintaining a behavior, they assess and categorize aberrant behavior according to its function. Other fields of science, such as microbiology, have long understood the importance of analyzing both the structure and function of dynamic entities. Behavior analysts employ a similar practice by categorizing behavior in terms of not only its structural characteristics (e.g., hitting one's self constitutes self-injury) but also its function. For example, one child with autism might slap other people because, when he does, others are less likely to approach him with schoolwork to complete. In this case, the function of aggression would be to avoid schoolwork. By contrast, another child with autism might slap other people because, when she does, her caregivers are more likely to give her physical attention in the form of tactile stimulation (e.g., sensory integration). In this case, the function of aggression would be to gain a specific form of caregiver attention. Thus, although both cases involve slapping others (an aggressive act), the function of the behavior differs. Analyzing the function of an individual's aberrant behavior allows us better to predict which treatments will and will not be effective. For example, a time-out from attention would be an effective treatment for self-injurious behavior maintained by attention, but it would likely worsen self-injurious behavior maintained by avoidance or escape from social interaction.

The Study of Behavior as a Natural Science

The final tenet that distinguishes behavior analysis from traditional psychology is that it examines behavior as a natural science, thus conducting research and developing theories in a similar manner as the natural sciences of chemistry and physics. Behaviors of scientists, like that of any other organism, are a consequence of their interaction with the environment. Consequently, the behavior analyst must apply the same behavior analytic principles to themselves as they do to the individuals with whom they conduct research (Johnston & Pennypacker, 1993). Skinner (1953) stated that "science is first of all a set of attitudes," and it is important that "science reject even its own authorities when they interfere with the observation of nature" (p. 12). Skinner emphasized that "science is a willingness to accept facts even when they are opposed to wishes," and that it is important for scientists to "remain without an answer until a satisfactory one can be found" (pp. 12–13). This approach to science (and the attitudes of the scientist) is equally relevant to clinicians who wish to apply the natural science of behavior analysis to problems of social importance.

Dimensions of the Experimental Analysis of Behavior

In addition to Skinner's (1969a) general views on the attitudes, there are several specific attitudes that form the basis of the experimental analysis of behavior as a natural science. These attitudes include (1) determinism, (2) experimentation, (3) empiricism, (4) reliability, (5) philosophical doubt, and (6) parsimony. If behavior analysts maintain these attitudes, it is more likely that they will conduct objective research that aids in furthering the theories and principles of behavior analysis.

Determinism

The belief or attitude that all events in the universe (including behavioral events) are orderly, lawful, predictable, and determined by physical causes is called *determinism* (Cooper, Heron, & Heward, 2007; Mazur, 2006). In general, this means that behavior does not spontaneously occur (e.g., a child does not hit his brother "out of the blue"); there is always a reason an individual or organism emits a behavior (e.g., hitting in the past resulted in the brother leaving the play area and the child gaining access to the video game). Behavior analysts believe that current behavior is determined by phylogenetic and ontogenetic variables described previously, and we focus on current operant contingencies because they can be altered in ways that promote socially important changes (e.g., reducing sibling aggression).

It is not the case that to be a behavior analyst and to approach the study of behavior as a natural science, one must accept the premise that all behavior is determined. To do so would conflict with the attitudes described below as *philosophical doubt* (which maintains that we should continually question our assumptions, findings, and conclusions) and empiricism (which requires that determinism be empirically demonstrated before it is fully accepted).

Scientists in the field of physics, which is clearly a natural science, have adopted stochastic models and quantum mechanics (which are not deterministic) to explain certain phenomena that are not well accounted for through classical (Newtonian) mechanics (which is deterministic). Nevertheless, a general belief in determinism at this juncture in the development of behavior analysis, if not essential, is at least useful because it helps to focus our attention on the functional characteristics of behavior. Once the functional variables maintaining the behavior are identified, these variables can be manipulated for the purpose of either increasing desirable behavior or decreasing problem behavior. If the behavior of organisms were neither completely nor for the most part lawful, scientists would be unable to identify why an individual emits a behavior and thus be unable to modify the behavior.

Experimentation

If one accepts that behavior is wholly or largely determined by natural physical causes, and that the primary goals of a natural science of behavior are the prediction and control of its subject matter, then one is necessarily led to adopt experimentation as the principal method of studying behavior.

Skinner speculated that "perhaps the greatest contribution which a science of behavior may make to the evaluation of cultural practices is an insistence upon experimentation" (1953, p. 436).

Behavior analysts are interested in experimentation involving the manipulation of environmental antecedents and/or consequences as the independent variables, and behavior as the dependent variable. The purpose of this type of experimentation is to identify the specific environmental variables of which a particular behavior is a function. A *functional relation* is said to exist when a change in an independent behavior reliably produces a defined change in the dependent variable. Describing a functional relation between a response and its reinforcer under a specified environmental context is more precise than saying that the environmental events caused the behavior.

Skinner (1953) acknowledged that other, nonexperimental methods are a part of the scientific analysis of behavior, including casual, clinical, and controlled observations. He also acknowledged the rigor and control achieved in the laboratory with nonhuman species, and that simple responses may be obtained at the price of ecological validity or "unreality in conditions" (p. 37). However, this limitation is countered by the fact that the experimental analysis of behavior focuses on the identification of the basic behavioral processes that underlie both simple animal and complex human behavior.

Skinner (1953) argued that "the commonest objection to a thoroughgoing functional analysis [of complex human behavior] is simply that it cannot be carried out, but the only evidence for this is that it has not yet been carried out" (p. 41). As will be evident in a number of chapters in this book, considerable progress has been made in carrying out functional analyses of complex human response (e.g., self-injurious behavior; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

Empiricism

Empiricism is the attitude or viewpoint that the information available to science comes from the senses, and that scientific conclusions should be based primarily on sensory evidence. This basically means that scientists should be careful observers and believe what they observe the world to be rather than what they have been taught that it should be.

When conducting an experiment, it is important that behavior analysts maintain the attitude of empiricism, which is the practice of making scientific decisions regarding interventions, research, and theory development in an objective manner, and based on factual data. As described previously, a scientist's behavior is a function of environmental variables (Johnston & Pennypacker, 1993); thus, at any given time, numerous variables are controlling his or her behavior. These variables may include personal experiences, personal advancement, opinions, or beliefs. As much as possible, a behavior analyst's decisions should be a function of the available empirical data and not of these other variables. Conversely, if variables other than objective data are controlling a scientist's behavior, then the results of the experiment will not be empirical or valid.

Reliability

Conducting a single experiment is not sufficient evidence to conclude how an independent variable affects a dependent variable. Behavior analysts hold the attitude that experimental control must be reliable. Behavior analysts evaluate reliability at multiple levels. One can demonstrate a functional relation between an independent variable (e.g., contingent praise) and a dependent variable (e.g., compliance with instructional requests) in one experiment with only one participant. This typically is done by repeatedly measuring the participant's level of compliance in the absence of praise across multiple sessions, until a stable baseline is obtained. Next, the independent variable is introduced (i.e., compliance would consistently result in praise on a prespecified schedule) and levels of compliance are again repeatedly measured across multiple sessions until stable levels are observed. These two steps (multiple sessions of measuring levels of compliance, with and without praise) are repeated. A functional relation between contingent praise and compliance is demonstrated for this one individual if the phases in which compliance produced praise showed consistently higher levels of compliance than the phases in which compliance did not produce praise. However, demonstrating that contingent praise increased compliance with just one individual does not allow us to draw conclusions about the relation between praise and compliance for other individuals; additional replication is required; that is, the generality of the finding would be greatly enhanced by replicating this same functional relation with multiple participants in a given experiment, and replicating it across experiments with different types of participants (e.g., children, adolescents, adults), in different contexts, and over time.

Philosophical Doubt

Even after behavior analysts reliably demonstrate a relation between an independent and dependent variable numerous times, it is important to maintain a reasonable degree of skepticism or *philosophical doubt*, meaning that they "continually question the truthfulness of what is regarded as fact" (Cooper et al., 2007, p. 6). Within the application of philosophical doubt, it is important for behavior analysts to acknowledge that the obtained data are limited and often exploratory because it is almost impossible to collect all of the data and facts. Philosophical doubt is an important attitude for behavior analysts to hold because it ensures that the field of applied behavior analysis continues to expand its theoretical and behavioral principle base and to implement the most efficient and effective behavioral interventions for those who are served.

Parsimony

Another attitude that behavior analysts practice is that of *parsimony*, the viewpoint that when two alternative explanations account for the available observations and facts equally well, the scientist should favor the simpler or more parsimonious explanation. The attitude of parsimony was first discussed by William Occam and is sometimes referred to as "Occam's razor." Similarly, the principle of parsimony is reflected in Einstein's famous quote: "Make things as simple as possible but no simpler." For a behavior analyst, parsimony involves a preference for explanations of behavior that are simple and based on previously established basic principles of behavior analysis, before resorting to explanations that require more assumptions and variables to explain the behavior (Johnston & Pennypacker, 1993). The principle of parsimony is also important for applied behavior analysts because simple interventions (that are effective) are more likely to be implemented and carried out with integrity.

Applied Behavior Analysis

The general principles on which ABA was founded were developed (and continue to be refined) from the results of laboratory experiments in the experimental analysis of behavior. Hence, it is important that the attitudes emphasized in the experimental analysis of behavior also are implemented in applied settings. This text presents detailed accounts of a range of variables within ABA. Thus, the following section briefly describes the basic tenets of the field of ABA.

ABA differs from the experimental analysis of behavior in that it is a clinical discipline in which the general principles of learning and behavior are used to solve or reduce problems of social relevance. Early in ABA's development, applied behavior analysts worked primarily in the fields of psychology and education. As described by Baer, Wolf, and Risley (1968), seven dimensions of applied behavior analysis help to focus our discipline on its central goal of solving problems of social importance. These include (1) applied, (2) behavioral, (3) analytic, (4) technological, (5) conceptually systematic, (6) effective, and (7) generalizable dimensions.

Applied behavior analysts select behaviors that are *applied*, meaning that they are socially acceptable and currently important to the individual whose behavior is being modified and his or her family (Baer et al., 1968). For example, teaching a child with a diagnosis of autism, who does not speak or communicate through gestures or picture symbols, to imitate speech sounds (echoic responses) or to request preferred items (i.e., mands) would represent a socially relevant target of treatment, whereas teaching the child to hammer a nail would not. At any point in time a behavior analyst might target several response classes, and it is important to prioritize which behaviors are most important to modify.

Consistent with the other two branches of behavior analysis, a principal dimension is ABA's focus on direct observation, objective measurement, quantification, prediction, and control of *behavior* (Baer et al., 1968). Behavior analysts typically do not rely on indirect measures of behavior such as self-report, interviews, or checklists (Baer, Wolf, & Risley, 1987). In addition, they do not attribute behavior to characteristics of inner qualities, such as personality traits. Instead, they attempt to identify a function of the behavior by manipulating environmental events as independent variables and observing changes in behavior as the dependent variable.

The third dimension of ABA is that it is *analytic*, which means that when we treat behavior, we use objective and controlled single-case designs that permit a believable demonstration of the effectiveness of our intervention whenever we can. Basically, this means that we strive to demonstrate a functional relation (as previously defined) between our treatment and any observed changes in the target behavior (Baer et al., 1968). In ABA, functional control is demonstrated by various experimental designs, including reversal, multielement, and multiple-baseline designs (see Roane, Rihgdahl, Kelley, & Glover, Chapter 8, this volume, for an explanation of each of these designs). Baer and colleagues (1987) emphasized that when selecting an experimental design to implement, one should select the design that is best suited for the experimental question rather than adjust the experimental question to fit a specific experimental design.

In addition to selecting an appropriate design for evaluating a functional relation, it is important that behavior analysts be *technological*, which means thoroughly and accurately describing their procedures when conducting experiments and implementing behavioral interventions. This information, which includes written procedures, operational definitions of target behaviors, and procedural integrity data, must be documented in a way that allows another reasonably competent applied behavior analyst to replicate the study after reading these documents (Baer et al., 1968, 1987).

The assessments and interventions applied behavior analysts implement are applied in nature. However, these interventions and the approaches used to develop the interventions should be *conceptually systematic* (Baer et al., 1968), which means that they are based on the basic behavior principles that have been empirically validated over many years by scientists who conduct basic research on the behavioral theories of the experimental analysis of behavior. Examples of conceptually systematic intervention components are extinction and schedules of reinforcement.

Many experiments that use group designs incorporate inferential statistics to determine whether there are statistically significant differences between groups. Applied behavior analysts rarely use statistics to determine whether a behavior change is significant. Instead, behavior analysts determine the *effectiveness* of their procedures by evaluating their data, often through visual inspection (Fisher, Kelley, & Lomas, 2003), that is, whether the individual whose behavior was changed and the family, caregivers, and friends of that individual find the behavior change significant. Just because a behavior change is statistically significant does not mean that the change is socially important. For example, a reduction of head banging from a rate of 12 per minute to 6 per minute may be statistically significant. However, the individual is still hitting his or her head over 300 times an hour. Consequently, this is not a socially acceptable level of reduction of head banging. A more significant reduction needs to occur in order to classify the intervention as effective.

The last principle of ABA is that the findings must be *generalizable* to other settings, caregivers, or behaviors (Baer et al., 1968). If a child's aggressive and disruptive behaviors are decreased to near-zero levels at a clinic, but at school and at home the child still engages in the problem behavior, then the behavior reduction has not generalized. Generalization is important because it is not beneficial to decrease negative behavior if the child only spends a few hours a week in the clinic. The behavioral intervention is only beneficial if it decreases the child's behavior across different settings when different caregivers implement it. The most effective way to ensure that the generalization occurs is to program it into the intervention (Stokes & Baer, 1977).

Summary

To summarize, there are three branches of behavior analysis: behaviorism, experimental behavior analysis, and ABA. Each branch is interested in directly studying, predicting, and controlling behavior rather than observing behavior as means of drawing inferences about the *mind*, the *psyche*, the *self*, or other internal mental or metaphysical structures or phenomena. Behaviorists believe that there is continuity between the behavior of human and nonhuman species, and between public and private behavior (e.g., thinking, feeling). Behaviorists believe that all behavior is lawful, that it occurs for a reason, and that it can be studied using the rigorous scientific methods applied in other natural or hard sciences. Finally, behaviorists focus on the function(s) of behavior and believe that it can be explained and controlled by observing and manipulating environmental events that occur in relation to the behavior.

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