
A Brief History of Functional Analysis and Applied Behavior Analysis

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The history of functional analysis, as both a concept and a procedure, can be traced back to the earliest days of the discipline of applied behavior analysis (ABA) and even to the earliest days of basic research in behavior analysis that formed the foundation for ABA. Indeed, it is not unreasonable to state that the history of functional analysis is inextricably linked to the history of the discipline of ABA. The general discipline of ABA and the concepts and methods of functional analysis have been built upon the conceptual foundation of operant conditioning, and as advancements have been made in the basic and conceptual arenas of behavior analysis, new refinements have been made in the area of application.

It is sometimes said that the development of experimental functional analysis methodology by Iwata, among others, led to a major shift in focus in the field of ABA toward an acknowledgment of the need for understanding the root causes of behavior before simply applying potent consequences. Some call this a transition from “behavior modification” to “applied behavior analysis” (Mace, 1994). Appreciating the function of behavior when planning treatment is now widely regarded as best practice (as evidenced by the

publication of this volume), but it was not always so. Early applications of behavioral principles to problematic behaviors in humans often failed to acknowledge the underlying function of behavior (Mace, 1994). In this model, the application of potent reinforcers and punishers were effective when they simply overcame the ongoing contingencies with which they were juxtaposed, not because they addressed the core underlying cause or function of the behavior. The shift in focus to understanding the operant function of behavior before treating it marked a major evolution in ABA, but to say such a perspective was not present until standardized experimental assessment methodology had been published is an overstatement. As discussed in this chapter, the importance of understanding the environmental contingencies responsible for maintaining *all* behavior, aberrant or adaptive, was present since the beginnings of the field, in Skinner’s writings and elsewhere. But little in the way of practical procedures was available for directly addressing the functions of behavior in clinical settings. As we outline in this chapter, the pioneering work of Bijou, Lovaas, Iwata, and Carr, among others, spurred a revolution in applied behavioral research by developing a basic experimental format for functional analysis that continues to thrive decades later.

In this chapter, we start by briefly outlining the history of behavior analysis, the development of ABA, and the origins of procedures designed to ascertain the function of challenging behavior. We then describe the landmark paper by Iwata,

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Dorsey, Slifer, Bauman, and Richman (1982), the influence of which is evidenced in that, to date, it has been cited by 235 publications indexed in PsycINFO (plus an additional 533 publications that cite its 1994 reprint). The remainder of the chapter is dedicated to a brief overview of procedural refinements which have been developed up to the current day, the majority of which are described in greater detail in other chapters within this volume.

Historical Roots of Behavior Analysis

A bit of historical background will set the stage for a description of the beginnings of behavior analysis, a thoroughly natural science of psychology. Psychology in the early 1900s was dominated by the study of mental processes and introspection. Carefully observing one's own conscious mental, emotional, or feeling states was the primary method of investigation (Wolf, 1978). Until the introduction of behaviorism, introspective psychology dominated American psychological thinking (Watson, 1913). Even within this context, though, psychologists were grappling with the causes of behavior. Early functionalists, such as William James (1890), posited that mental processes had evolved to serve useful functions for individuals struggling to cope in complex environments.

Watson (1913) argued for an objective study of behavior as a natural science, consisting of direct observation of the relationships between environmental stimuli and behavioral responses. In doing so, he laid the groundwork for an analysis of how the environment determined behavior. He was confident in stimulus–response (S–R) psychology's ability to predict and control human behavior, so much so that many would argue he overstated the potential significantly (Skinner, 1974). Even so, Watson's insistence upon studying relations between behavior and environment, in their own right, was critical in establishing the belief that behavior could be studied as a natural science, on par with biology, physics, and the other natural sciences (Cooper, Heron, & Heward, 2007).

B. F. Skinner's first major treatise, *The Behavior of Organisms* (1938), spurred the development of what would come to be known as the “experimental analysis of behavior,” now known simply as “behavior analysis.” Like Watson, Skinner was interested in giving a scientific account for all behavior, but unlike other psychologists of his time, he found the S–R paradigm insufficient to explain the majority of behavior, especially for those behaviors for which there appeared to be no obvious antecedent environmental causes (Cooper et al., 2007). Somewhat serendipitously, while studying the ingestive behavior of rats, Skinner observed that environmental events that immediately followed behaviors had as much or more influence on the future occurrence of those behaviors as did the antecedents. Skinner then promoted the idea that the traditional model of S–R cause-and-effect should be abandoned and replaced by a more descriptive, functional analysis of the relationship between independent and dependent variable (Sturmey & Bernstein, 2004), consisting of the three-term contingency (antecedent–behavior–consequence or stimulus–response–stimulus). It was soon found that Skinner's S–R–S model was able to account for behaviors that the S–R model did not sufficiently explain—behaviors that did not have apparent antecedent causes or for which the consequences figured more prominently. He called these behaviors “operant,” that is, those behaviors are influenced by the consequences of similar behaviors in an organism's past (Cooper et al., 2007).

The three-term contingency provided a model for studying behavior in a new way. Rather than searching for inner psychic causes of behavior, as traditional psychologists had done, and rather than searching for simplistic antecedent causes, as S–R psychologists had done, the task of the behaviorist was now to identify reliable three-term contingencies that describe behavior/environment relations. Scientific understanding of behavior, then, was achieved by identifying and manipulating the environmental variables that change the probability of its occurrence. Through repeated manipulation of environmental variables, a functional relationship between environment (independent variable) and behavior

(dependent variable) can be discovered. For Skinner, the term “functional relationship,” which describes the relationship between behavior and environment, essentially became synonymous with “cause-and-effect” relationship (Skinner, 1953). In Skinner’s words, “the external variables of which behavior is a function provide for what may be called a causal or functional analysis. We undertake to predict and control the behavior of the individual organism” (Skinner, 1953, p. 35).

The term “functional analysis,” in its original use, simply meant an activity that shed light upon the potential ways in which the environment may control behavior (Skinner, 1953). It did not originally connote an experimental analysis, as it often does today, although Skinner always preferred experimental over descriptive analyses. In *Verbal Behavior* (1957), Skinner described the book, an almost entirely conceptual treatment of language, as a “functional analysis of language,” clearly not referring to an experimental procedure. In the most general sense, the term retains the same meaning today, although, practically speaking, many people are referring to an experimental functional analysis when they use the term “functional analysis.”

Skinner’s early work described essential methods, concepts, and functional relations that would serve as the foundation for the development of a functional analysis of behavior. These included the focus on a single organism, the rate of response as the main dependent variable, the operant–respondent distinction with related difference between conditioned stimulus and discriminative stimulus, and the effects of various kinds of intermittent reinforcement (Michael, 1980). In its most simplistic form, Skinner recorded the rate at which a single animal emitted a given behavior in a controlled operant chamber. His investigative procedures evolved into an experimental approach that “enabled clear and powerful demonstrations of orderly and reliable functional relations between behavior and various types of environmental events” (Cooper et al., 2007, p. 11). However, behavior analysis was never intended as a science of animal behavior. In *Science and Human Behavior* (1953), Skinner proposed that the techniques of behavior analysis

should be extended to explain and change the behavior of people in everyday arenas such as education, work, clinical problems, and social behavior. While most experimental psychologists were inherently conservative in describing the generalizability of their work to practical situations, Skinner managed to address a wide array of human situations from an entirely behavioral point of view. In the 1950s and 1960s, research on application of behavior analysis began in earnest.

Applying Behavioral Principles to Humans

Research during the 1950s and 1960s utilized the methods of the experimental analysis of behavior to examine whether the principles of behavior derived from experimentation with nonhumans could be replicated with human subjects (Cooper et al., 2007). Early researchers established that the principles of behavior observed in animal studies were applicable to human behavior (Baer, 1960; Bijou, 1955; Ferster & DeMyer, 1961, 1962; Lindsley, 1956, 1960) and provided the foundation for the development of ABA in general and the functional analysis of clinically relevant behavior in particular (Cooper et al., 2007).

One of the first studies to apply operant principles to human behavior was conducted by Fuller (1949), who used positive reinforcement (sugar solution) to teach an 18-year-old man with profound intellectual disabilities to raise his hand. Prior to this, it was widely assumed that individuals with severe intellectual disabilities were not capable of learning. Indeed, Fuller wrote that in regard to the specific participant, doctors “thought it was impossible for him to learn anything,” but the results of this study demonstrated that “if time permitted, other responses could be conditioned and discriminations learned” (Fuller, 1949, p. 590). A few years later, Lindsley, Skinner, and Solomon (1953) applied the principles of operant conditioning to inpatients at a psychiatric state hospital, further establishing the basic concept that the behavior of all individuals is subject to behavioral principles of learning and motivation.

While a variety of methods and procedures were available for use within the animal studies, little had been done to extend these procedures to human subjects. Sidney Bijou's early work (e.g., Bijou, 1955, 1957, 1958) was fundamental in extending the methods and findings of animal research so that the behavior of humans could be experimentally analyzed. He proposed descriptions of methodologies for "a systematic approach to an experimental analysis of child behavior" (Bijou, 1957, p. 250). He described specific instrumentation, how data was to be recorded, and how to maximize control over independent variables. He said that once the methodology was properly refined, it would enable researchers to study behavior "by relating the direct effect of one variable upon another" (Bijou, 1957, p. 243). These publications were seminal in establishing a methodology through which the functional relationships of human behavior could be analyzed in a well-controlled environment.

Ogden Lindsley was another pioneer in adapting the methods of animal studies to the study of human behavior and was among the first to apply free-operant procedures to studying the behavior of chronic and acute psychotic children and adults. Addressing the methodological limitations of the emerging field, Lindsley (1956) described how American psychologists had used a "confusing variety of apparatuses" (p. 120) to measure behavior, and psychology as an experimental field had not yet agreed upon a universal instrument to measure behavior; thus, researchers were constantly designing new instruments or modifying old ones. Lindsley cited Pavlov's studies as exhibiting a higher degree of experimental control than any other researcher in the early 1900s, and while more contemporary researchers described their various apparatuses, they failed to design well-controlled experimental situations. He argued that "American psychologists in the early part of this century imitated Pavlov's verbal behavior, but they did not imitate his experimental behavior" (Lindsley, 1956, p. 124).

A significant step toward applying the methods developed in animal studies to address abnormal behavior among humans was made by Ferster (1958), who was one of the first to recognize that aberrant behaviors were often maintained by other

individuals. In other words, Ferster conceptualized that a deficient behavioral repertoire is a social problem. He argued that problem behaviors may arise because of (a) an inadequate reinforcement history, (b) the schedule of reinforcement, or (c) punishment that may distort a performance which otherwise would be reinforced (Ferster, 1958). In order to treat an individual's inadequate behavioral repertoire, Ferster promoted the use of a "functional program of therapy" (Ferster, 1958, p. 105) in which the therapist manipulates variables in the patient's environment to identify potential reinforcers that maintain the problem behavior. Thus, Ferster was one of the first to acknowledge the importance of functional relations between problematic behaviors and environmental events.

The studies in the 1940s and 1950s did not attempt to make clinically meaningful behavior changes in the individuals they studied, but they served to establish further the notion that behavior change in severely challenged populations was possible and that human behavior, too, was a function of the environment (Wilkins & Matson, 2009). By demonstrating that operant principles could be applied to the behavior of humans, the groundwork was laid for the development of a discipline centered on using behavioral principals to bring about socially meaningful behavior change.

The Birth of Applied Behavior Analysis

The late 1950s through the 1960s saw the birth of what came to be known as the field or discipline of ABA. Ayllon & Michael's, 1959 paper is often cited as the first ABA publication. In "The Psychiatric Nurse as a Behavioral Engineer," personnel in a state hospital were trained to use techniques that were derived from behavioral principles to improve the functioning of residents with schizophrenia and other psychiatric diagnoses. While no systematic approach to studying such problems was in existence, the authors stated that the aim of their research was "an attempt to discover and manipulate some of the environmental variables for the purpose of modifying

problem behavior” (Ayllon & Michael, 1959, p. 323). Over the next decade, the researchers began to apply these same principles of behavior to a variety of socially problematic behavior and developmental disabilities (Jacobson & Holburn, 2004). This new line of research represented a major advance in how severe behavior problems were conceptualized. Studies were able to demonstrate experimentally that maladaptive behaviors, such as self-injury or aggression, could be explained as functional responses to environmental stimuli (Durand, 1987).

The application of operant principles and experimental method to the analysis of human behavior emerged as its own discipline in the 1960s with a mission to solve important social problems in a systematic and individualized manner (Jacobson & Holburn, 2004). In the inaugural issue of the *Journal of Applied Behavior Analysis*, Baer, Wolf, and Risley (1968) described some of the defining features of ABA, distinct from the experimental analysis of behavior. They outlined seven dimensions of ABA: applied, behavioral, analytic, technological, conceptually systematic, effective, and generalizable. Baer et al. (1968) described ABA as a discipline which “will make obvious the importance of the behavior changed, the experimental manipulations which analyze with clarity what was responsible for the change, the technologically exact description of all procedures contributing to that change, the effectiveness of those procedures in making sufficient change for value, and the generality of that change” (Baer et al., 1968, p. 97). Of particular relevance to the current chapter is the dimension of ABA referred to as “analytic.” The analytic component stressed the importance of using valid single-subject experimental designs to manipulate environmental variables and observe the effects such variables have on behavior, a practice at the very heart of experimental functional analysis methodology.

A Focus on the Function of Challenging Behaviors

Early research in ABA attempted to reduce the frequency and severity of challenging behaviors and facilitate the acquisition of adaptive skills

(Wilkins & Matson, 2009). While much early research demonstrated that mere management of behavioral consequences could effectively decrease challenging behaviors, behavior analysts have long had concerns about unnecessary use of punishment-based procedures. Skinner and many early behaviorists warned that punishment may bring about undesirable side effects and that striving to promote control of behavior through positive reinforcement as much as possible was a valuable goal in and of itself. In addition, the operant perspective assumes that different behaviors have different functions for different people, and even multiple functions within the same person, and so a prior understanding of the cause or function of the behavior will inevitably aid in designing an effective treatment. This belief was implicit from the beginning, but it was not until the 1960s that research began which attempted to directly identify the function of challenging behavior.

An early study on the function of self-injurious behavior (SIB) in a child with schizophrenia was conducted by Lovaas, Freitag, Gold, and Kassorla (1965). This study is noteworthy because it was the first to systematically investigate a problem behavior wherein “the investigator has attempted control over self-destruction by systematically manipulating the variables of which it might be a function” (Lovaas et al., 1965, p. 68). In the first phase of the study, the participant initially received social approval for appropriate behaviors, and following a period of acquisition, the behavior was then extinguished by withholding the social reinforcers. The second study occurred in a different experimental setting than the first but procedurally was very similar. Social approval was delivered contingent upon the subject pressing a lever, and once the lever-pressing rate had stabilized, the behavior was then again extinguished by withholding the social attention. In the third phase, the authors demonstrated that delivering verbal attention contingent upon SIB resulted in an increase in the frequency of the behavior (Lovaas, et al., 1965).

Carr (1977) was among the first researchers in ABA to promote a system in which interventionists would develop hypotheses for conditions that maintain problem behavior and then develop

treatment strategies on the basis of those hypotheses. Carr's, 1977 review of the functions of self-injury greatly influenced the development of a method of conducting functional analysis (Sturme y & Bernstein, 2004). His review concluded that self-injury could be maintained by three general classes of environmental contingencies: positive reinforcement, negative reinforcement, and sensory or automatic consequences of the behavior (Carr, 1977). As noted by Sturme y and Bernstein (2004), Carr and his colleagues conducted a series of important studies demonstrating functional relationships between the occurrence of certain events and SIB, all of which developed experimental conditions that could be used to experimentally identify the functions of maladaptive behaviors (Carr, Newsom, & Binkoff, 1980; Rincover, Newsom, & Carr, 1979).

Early Research on Specific Functions of Challenging Behavior

Before the landmark paper by Iwata et al. (1982) was published, several early studies focused on individual functions of behavior. These papers helped establish the foundations upon which more comprehensive experimental assessments were later developed.

Positive Reinforcement

One of the most prominent theories presented in the early literature on functions of aberrant behavior was that maladaptive behaviors were shaped and maintained by socially mediated positive reinforcement (Carr, 1977). One of the first empirical demonstrations of how attention can positively reinforce aberrant behavior was conducted by Ayllon and Michael (1959). An informal analysis led the authors to suggest that attention from nursing staff was inadvertently positively reinforcing the psychotic speech of a psychiatric inpatient. When the nurses ceased replying to the patient's statements, the rate of aberrant speech dropped dramatically. The authors observed that within the overcrowded,

understaffed wards of mental hospitals, outbursts of problem behavior were often the only way for individuals to attract a nurse's attention. Unfortunately, the more adaptive, socially acceptable behaviors often went unnoticed or were even punished by overworked hospital orderlies, a circumstance that many clinicians sadly still observe to this day in residential settings for individuals with developmental and other disabilities.

Many studies in the 1960s applied this same principle of adjusting the contingencies of adult attention in seeking to modify challenging behaviors of children. Hart, Allen, Buell, Harris, and Wolf (1964) treated the frequent crying of two preschool children, starting with the hypothesis that the behavior was reinforced by teacher attention. The authors successfully extinguished crying by training teachers to give no attention to excessive crying and to provide immediate positive attention for more appropriate responses. Subsequent studies found the same mediating effects of attention on the presence of problem behavior in both the classroom (Harris, Wolf, & Baer, 1964; Thomas, Becker, & Armstrong, 1968) and the home (Baskett & Johnson, 1982; Budd, Green, & Baer, 1976; Hawkins, Peterson, Schweid, & Bijou, 1966). A substantial body of literature published in the 1960s and 1970s supported the positive reinforcement hypothesis, indicating that the complete removal of social consequences greatly reduced or eliminated SIB (Jones, Simmons, & Frankel, 1974; Lovaas & Simmons, 1969; Tate & Baroff, 1966; Wolf, Risley, Johnston, Harris, & Allen, 1967; Wolf, Risley, & Mees, 1964).

Lovaas et al. (1965) experimentally investigated variables that controlled self-destructive behavior in a child with schizophrenia. In a series of three studies, it was found that, following several sessions of social extinction, reinstatement of social attention contingent on self-destructive behavior produced the highest magnitude and frequency of the problem behavior. A later study by Lovaas and Simmons (1969) built upon this work in an attempt to isolate some of the environmental conditions that controlled the self-destructive behavior of three children with severe developmental disabilities. Similar to Lovass and

colleagues' earlier study, when the children were placed in a room where they were allowed to engage in SIB, isolated from interpersonal contact and social consequences, they eventually ceased to hurt themselves (Lovaas & Simmons, 1969).

While a significant amount of evidence supported the concept of an attention function for challenging behavior, some early work also suggested that aberrant behavior may be maintained by other types of socially mediated positive reinforcement. For example, Patterson, Littman, and Bricker (1967) conducted an early descriptive analysis of aggressive behavior and discussed the possibility that access to food, candy, or preferred toys may maintain it. They described cases in which children emitted aggressive behavior, resulting in their victims relinquishing toys or other preferred materials.

Negative Reinforcement

In addition to investigating socially mediated positive reinforcement as a potential function of challenging behavior, early work on behavioral function hypothesized that aberrant behavior may be maintained by negative reinforcement. The negative reinforcement hypothesis stated that aberrant behavior was learned behavior, reinforced by escape or avoidance of an aversive stimulus or situation (Carr, Newsom, & Binkoff, 1976). Much early work on the negative reinforcement hypothesis focused on SIB. Early anecdotal reports noted that children who engaged in SIB often did so in order to terminate an aversive situation. For example, Freud and Burlingham (1944) described a girl living in an institution who would bang her head against her crib when she was put to bed, noting that this behavior resulted in being removed from the crib.

Ferster (1958) recognized that the problem behaviors of many psychiatric patients were inadvertently maintained by negative reinforcement. He noted that, rather than providing an individual with an adaptive behavioral repertoire, attempts at punishment often reinforced aberrant behaviors by allowing the individual to avoid or escape aversive consequences (Ferster, 1958).

Other descriptive reports noted that demands were very likely to increase SIB in children (e.g., Jones et al., 1974; Myers & Deibert, 1971; Wolf et al., 1967). In these early papers, it was observed that following such self-destructive behavior, the adults who were working with the children would often terminate the demands they were placing upon the children. Taken together, these reports suggested that demands may constitute aversive stimuli, and SIB functioned as an escape response maintained by the termination of demands; however, no studies had yet attempted to experimentally manipulate environmental variables to confirm this hypothesis.

The first attempt at experimentally manipulating the environment to evaluate the negative reinforcement hypothesis appeared in Carr, Newsom, and Binkoff's seminal paper (1976). Carr and colleagues focused their experimental analysis on the *antecedent* stimuli that would likely control escape-maintained SIB. The study demonstrated that levels of SIB were high in demand situations (such as a classroom) and low in situations that did not contain demands (such as conversation or freeplay). In addition, they manipulated the occurrence of stimuli which had historically been paired with removal of demands, hypothesizing that SIB should decrease upon the onset of the stimulus correlated with the termination of demands. When the child, who was engaging in SIB, was presented with the vocal prompt "O.K., let's go," a cue that normally terminated the demand period, the child abruptly stopped the self-destructive behavior. In contrast, when a neutral vocal stimulus was presented to the child, such as "The sky is blue" (a cue that had never been paired with the termination of demands), the child's rate of SIB remained high. By manipulating antecedent events that should be correlated with escape-maintained behavior, and by demonstrating that the occurrence of the behavior varied in a predictable way with the manipulation, Carr provided a convincing early experimental demonstration of maladaptive behavior with a negative reinforcement function, albeit without yet manipulating the actual consequences of which the behavior was thought to be a function.

SIB was not the only behavior thought to serve an escape function. Carr et al. (1980) sought to identify the variables controlling severe aggressive behavior in two children. In a series of four experiments, aggression was frequent in demand conditions and rare in nondemand situations. Like SIB, aggression was shown to function sometimes as an escape response. While previous investigations had implied that aggression could serve the function of an escape response to terminate demands or other aversive stimuli (Ludwig, Marx, Hill, & Browning, 1969; Patterson et al., 1967), Carr et al. (1980) was the first experimental study to systematically investigate the possible role of escape factors in the maintenance of aggression.

Weeks and Gaylord-Ross (1981) examined the relationship between task characteristics and problem behavior and provided additional experimental support for the negative reinforcement hypothesis of aberrant behaviors. It was conceptualized that severely handicapped children, when presented with a difficult task, would emit aberrant responses to terminate the aversive stimulus. Three experimental conditions were created to test this possibility in which the students would be presented with difficult tasks, easy tasks, and no tasks. As predicted, the highest frequency of aberrant behavior was associated with difficult demands, and near-zero levels of problem behavior occurred in settings that were free of demands, thereby providing further support for the negative reinforcement hypothesis.

Automatic Reinforcement

The concept of automatic reinforcement has early roots in behavior analysis, dating back at least as far as Skinner's analysis of verbal behavior (1957). Automatic reinforcement is reinforcement that is produced automatically when a behavior occurs. That is, it is reinforcement that is *not* dependent on the behavior of someone else to deliver it. Automatic reinforcement is sometimes described as reinforcement that is inherent in the behavior itself. Everyday examples include the relief of the itching sensation that the behavior of scratching an insect bite produces or the

pleasant odor that the behavior of smelling a flower produces. It is also important to note that stereotyped behaviors, behaviors which occur repeatedly in the same manner, are often assumed to be automatically reinforced. For this reason, it is likely that stereotypy is often referred to as "self-stimulatory" behavior, a term that assumes that the behavior is maintained by automatic reinforcement. However, it is important to note that the topography of a behavior (e.g., stereotypy) does not necessarily indicate function (e.g., automatic reinforcement). It is for this reason that the term stereotypy is generally preferred over "self-stimulatory" or "self-stim" behavior.

Early animal research on automatically reinforced behaviors addressed stereotypy across several species (Berkson, Mason, & Saxon, 1963). Experiments in the 1960s examined the effects of environments that were "deprived" of stimulation. In particular, social isolation was studied in primates because "it is difficult or impossible to study scientifically the impacts of culturally produced social isolation at the human level" (Harlow, Dodsworth, & Harlow, 1965). Researchers noted that the same behavioral principles seemed to operate for both humans and primates and that "social conditions which produce abnormality in one species will have comparable effects on the other" (Harlow et al., 1965, p. 90). Behaviors such as thumb sucking, unusual limb postures, and self-clasping were observed as common primate stereotypies.

A study by Berkson et al. (1963) examined stimulus and situational factors affecting the stereotyped behaviors characteristic of primates raised without their mothers. They observed that the level of stereotypy was highest in an environment in which vision, locomotion, and opportunities to manipulate objects were restricted. The authors argued that it was very likely that the absence of environmental stimulation was an important factor in the presence of such behavior, as the stereotyped responses were reduced when alternative activities were evoked (Berkson et al., 1963). These early animal studies reflected a basic hypothesis that automatically reinforced behavior is more likely to occur when an organism is deprived of stimulation because the behavior may

be one of the only sources of environmental stimulation available to the organism.

Residential facilities were conceptualized as one type of setting in which individuals with disabilities may be deprived of stimulation, and researchers began to conceptualize environmental deprivation as a factor that may contribute to the maintenance of automatically reinforced maladaptive behaviors in humans (Green, 1967; McKinney, 1962; Murphy, 1982). For example, early researchers noted several cases of problem behavior among children who were restricted to their cribs without toys (Dennis & Najarian, 1957). Collins (1965) treated head banging in an isolated, severely intellectually disabled adult by exposing the individual to a high level of sensory stimulation. The consequent decrease in SIB was attributed to the increased tactile and kinesthetic stimulation that was provided in treatment. Green (1967) was another researcher to propose that the stereotypy often seen in children living in institutional settings occurred as an adaptive response to a decreased level of environmental stimulation. He postulated that, in the overall absence of stimulation, operant responses, such as self-destructive behaviors, develop into persistent behavior as a function of the increased sensory input they provide.

Experimental investigations of the effects of noncontingent stimuli on stereotypies provided additional foundation for the hypothesis that some aberrant behaviors have an automatic reinforcement function. Early studies demonstrated that vibration significantly decreased the stereotyped behavior of intellectually disabled children (Bailey & Meyerson, 1969, 1970; Meyerson, Kerr, & Michael, 1967). Maisto, Baumeister, and Maisto (1978) noted that individuals who lacked adaptive modes of behavior or appropriate opportunities to increase stimulation often resorted to activities that involved direct contact or manipulation of the body.

Wolery (1978) assessed the effects of experimenter-applied sensory stimulation that was comparable to the child's stereotypic behavior. Results from this study demonstrated that contingent trainer-applied sensory stimulation (which duplicated the child's stereotypy) functioned as a

powerful positive reinforcer. An additional study conducted by Rincover (1978) investigated the self-stimulatory behavior of psychotic children in order to identify possible maintaining/supporting variables. The results showed that the self-stimulatory behavior was "reliably decreased when a certain sensory consequence was removed, then increased when that consequence was permitted" (p. 307), thereby supporting the notion that the behavior was maintained by operant reinforcement in the form of sensory stimulation. Furthermore, Rincover stated that then-current theories holding that stereotypy is a result of understimulation did "not easily account for these data, primarily because the suppressive effect of removing sensory consequences was specific to a particular sensory modality" (p. 307).

The First Comprehensive Experimental Functional Analysis

The studies described thus far provided ample evidence for three possible functions of challenging behavior: (1) socially mediated positive reinforcement (e.g., attention), (2) negative reinforcement (e.g., escape from nonpreferred tasks), and (3) automatic reinforcement. Substantial evidence existed to support each hypothesis, but little or no research had been published on attempts at evaluating more than one potential function for the same behavior of one individual. In addition, although a substantial amount of literature had been published which had implications for how to identify the functions of challenging behavior, no standard set of comprehensive functional analysis procedures had yet been proposed, and several researchers acknowledged the need for it (Carr, 1977; Weeks & Gaylord-Ross, 1981). In particular, Weeks and Gaylord-Ross (1981) wrote that "a useful contribution to the burgeoning field of behavioral assessment would be the development of clear criteria for determining whether aberrant behavior is maintained by positive reinforcement, negative reinforcement, or intrinsic reinforcement (self-stimulation)" (p. 461).

One year later, Iwata et al. published their seminal paper, "Toward a Functional Analysis of

Self-Injurious Behavior” (1982), which was reprinted in 1994 in the *Journal of Applied Behavior Analysis*. The study included nine children and adolescents with developmental disabilities and SIB. A randomized multielement design (rapid alternation between 15-min sessions of each condition) was used to compare the occurrence of SIB under four experimental conditions: (1) academic, (2) alone, (3) social disapproval, and (4) play. The first three conditions were selected to represent the three general functions of behavior that had been hypothesized up to that point (positive, negative, and automatic reinforcement) and the fourth served as a control condition.

In the academic condition (now usually referred to as the “demand” or “escape” condition), the experimenter and participant sat at a desk. The experimenter presented tasks to the participant, using a graduated “three-step” prompting sequence. The sequence began with the experimenter presenting the task vocally. If the participant did not respond within 5 s, the experimenter repeated the vocal instruction and provided a model prompt. If the participant did not respond appropriately after 5 s, the experimenter physically guided the participant to respond, after which the next task was presented vocally. If the participant responded appropriately, the experimenter responded with brief praise. If, at any time, the participant engaged in SIB, the experimenter turned away from the participant and ceased task demands for 30 s. This condition was designed to test for a negative reinforcement function because escape from demands was systematically presented, contingent on the occurrence of the target behavior.

In the alone condition, the participant was placed in a therapy room alone, with no toys or items of any kind. This condition was designed to test for automatic reinforcement and mimicked the types of “deprived” environments hypothesized to contribute to automatically reinforced behavior that were discussed in earlier research on automatic reinforcement.

In the social disapproval condition (now usually referred to as the “attention” condition), the experimenter and the participant entered a

therapy room that was equipped with a variety of toys. The experimenter then told the participant to play with the toys while the experimenter “did some work.” Contingent on each occurrence of SIB, or burst of occurrences, the experimenter delivered brief statements of concern (e.g., “Don’t do that, you will hurt yourself”) while also delivering brief physical attention (e.g., patting the person on the shoulder). All other participant behaviors were ignored. The purpose of this condition was to test for a possible function of positive reinforcement in the form of access to attention from others.

In the play condition (sometimes referred to as the “toy play” or “control” condition), the therapy room was equipped with a variety of toys, and no demands were placed on the child. The experimenter delivered brief social and physical attention to the participant, contingent on the absence of SIB, at least every 30 s. SIB was ignored. This condition was included to serve as a control condition. It served as a suitable control condition for the attention condition because the antecedent for attention-maintained behavior was absent (i.e., the participant was not deprived of attention), and attention was not delivered as a consequence of SIB. Similarly, the play condition served as a suitable control condition for escape-maintained behavior because the relevant antecedent was not present (i.e., presentation of demands), nor was the putative maintaining consequence (escape was not delivered contingent on SIB). It is difficult to construct a control condition that withholds the consequence for automatically reinforced behavior because the consequence is automatically produced, but the relevant antecedent (general deprivation of stimulation) is not present.

The analysis continued to be conducted until (1) stability in the level of SIB was observed, (2) unstable levels of SIB continued for 5 days, or (3) sessions had been conducted for 12 days. No assessment lasted longer than 11 days, and the number of 15-min sessions that were required ranged from 24 to 53. The results demonstrated significant variability in responding, both across various conditions within each participant and across patterns of responding between participants. These results provided strong support for

the position that particular topographies of challenging behavior do not have singular causes but, rather, are learned behaviors that differ in their relationship to environmental events, depending on the unique learning history of each individual person. In particular, the results of some participants strongly suggested that their SIB was maintained by attention, while others appeared to be maintained by escape from demands, and still others appeared to be maintained by automatic reinforcement. Another important finding was that the function of the SIB did not appear to be correlated in any significant way with the rate or severity of the behavior. All of these results strongly supported the notion developed in the functional assessment literature that the function and topography of any given behavior are distinct and, more importantly, that clinicians cannot, therefore, assume a cause of behavior by simply looking at the topography or severity.

Another important contribution of the paper by Iwata et al. (2000) was that it set forth a simple format for experimentally investigating the function of any behavior. By pitting one or more test conditions, each of which tests one potential consequence as a reinforcer, against a single control condition that reverses or eliminates each of the contingencies being manipulated in the test conditions, multiple potential functions could be assessed during the course of a single assessment. Furthermore, the variety of potential functions that could be assessed within this format was limited only by the imagination and ability of the assessor to control environmental conditions. As we will see in the coming section of this chapter, this basic format has changed little in the last 30 years, but a considerable variety of different behaviors and functions have been assessed.

After 1982

The seminal 1982 paper by Iwata et al. offered an elegant yet powerful format for conducting experimental assessments of the function of maladaptive behaviors, and the three decades that have passed since its publication have seen the

basic format used across a variety of other populations, settings, and behaviors. In addition, alterations to the basic format have been researched in order to accommodate a variety of different behaviors, idiosyncratic environmental variables, and other behavioral functions, among others. A complete description of the history of experimental functional analysis research post-1982 would likely require several volumes in itself, and other chapters in the current volume provide additional details in multiple areas. In what follows, we provide descriptions of some of the major highlights in terms of how the basic experimental functional analysis format has been used to study many additional phenomena, as well as how it has been modified to expand its scope further, and we will conclude the chapter with a discussion of future directions for research.

The “standard” functional analysis methodology proposed by Iwata et al. (2000) has proven to be robust and widely applicable, as described above. Indeed, reviews of functional analysis methodology have suggested that functional analyses result in a determination of behavioral function in about 94% of the cases in which they are applied (Hanley, Iwata, & McCord, 2003; Iwata, Pace, et al., 1994). While some functional analyses may result in undifferentiated or ambiguous outcomes, this does not necessarily mean that the assessment process has failed or that the contingencies maintaining the problem behavior cannot be understood (Tiger, Fisher, Toussaint, & Kodak, 2009). Many authors have noted that the traditional functional analysis methods developed by Iwata et al. (1982) occasionally require modifications to assess behavioral function more accurately across distinct populations, response topographies, and settings, especially when an initial conventional functional analysis proves to be inconclusive (Bowman, Fisher, Thompson, & Piazza, 1997; Cooper, Wacker, Sasso, Reimers, & Donn, 1990; Tiger et al., 2009). In what follows, we review some of the highlights of studies that have sought to modify some aspect of the basic approach in order to experimentally assess the function of behavior that may be difficult to assess using the standard approach.

Expansion Across Populations

The majority of functional analysis research has been conducted with individuals with developmental disabilities, which is not surprising, given the increased prevalence of challenging behaviors in this population (Hanley et al., 2003). Additionally, functional analysis methodology has been expanded to young children with challenging behavior. For example, Wacker et al. (1998) trained parents to conduct functional analyses and Functional Communication Training (FCT) for 28 children, ages 1–6, with developmental disabilities who displayed aberrant behavior. Results indicated that problem behavior served socially mediated functions for the majority of children. Twenty-one percent of participants exhibited problem behavior maintained by positive reinforcement, 46% exhibited aberrant behavior maintained by negative reinforcement, and 18% engaged in problem behavior that was multiply controlled. Kurtz et al. (2003) further extended functional analysis research by conducting functional analyses across 30 very young children (ages 10 months to 4 years and 11 months) with SIB and other forms of challenging behaviors. The mean age of emergence of SIB was 17 months, and head banging was the most common topography. Functional analyses succeeded in identifying a function in 87.5% of cases, and successful function-based treatments were implemented in most cases, as well.

In addition to expansion of functional analysis methodology to very young children with developmental disabilities, research has demonstrated its efficacy with a variety of other populations, including children with attention deficit hyperactivity disorder (DuPaul & Ervin, 1996) and typically developing children with conduct disorders (Cooper et al., 1990).

Expansion Across Behaviors

Multiple Topographies

Iwata et al.'s, 1982 article was able to build upon previous theoretical papers (e.g., Carr, 1977) and research methods (e.g., Bijou, Peterson, & Ault,

1968; Thomas et al., 1968) to formulate the first standardized functional analysis methodology. Although initially applied to the analysis of self-injurious behavior, the methodology was quickly adapted to analyze environment–behavior relationships that maintained a wide array of problem behaviors, such as aggression (Day, Horner, & O'Neill, 1994; Lalli & Casey, 1996; Mace, Page, Ivancic, & O'Brien, 1986; Wacker et al., 1990), destructive behavior (Bowman et al., 1997; Slifer, Ivancic, Parrish, Page, & Burgio, 1986), stereotypy (Durand & Carr, 1987; Mace, Browder, & Lin, 1987; Wacker et al., 1990), pica (Mace & Knight, 1986; Piazza et al., 1998), and tantrums (Carr & Newsom, 1985).

The majority of functional analyses conducted in the 1980s and early 1990s focused on single functions that maintained one or more aberrant responses (e.g., Carr & Durand, 1985; Iwata et al., 1982; Northup et al., 1991; Wacker et al., 1990). However, some researchers noted that, on occasion, multiple functions of distinct topographies of aberrant behavior interfered with the analysis of those behaviors (Derby et al., 1994). While many investigators noted the existence of different topographies of behavior serving different functions for a single client (e.g., Durand, 1982; Mace et al., 1986; Slifer et al., 1986; Smith, Iwata, Vollmer, & Pace, 1992; Sturmey, Carlsen, Crisp, & Newton, 1988), the majority of research conducted prior to 1994 combined separate topographies of problem behavior and conducted one functional analysis on an aggregate class of target behavior (e.g., Durand & Carr, 1991; Wacker et al., 1990). Conducting separate functional analyses for several distinct topographies presented huge time and cost constraints, leading researchers to develop alternative strategies to accurately and efficiently measure these separate topographies. Derby et al. (1994) suggested conducting a single functional analysis, initially graphing all presenting target behaviors in an aggregate fashion and subsequently analyzing each topography of behavior on separate graphs. This approach offered investigators the practical advantage of conducting a single functional analysis while still allowing them to separate each topography in order to generate specific

hypotheses about the function of each behavior (Derby et al., 1994). The results of this study demonstrated how separate functions could be hidden by an aggregate analysis but could be accurately identified when the results for each target behavior were plotted separately.

Precursor Behaviors

Experimental Functional Analysis (EFA) of behavior disorders often produces temporary increases in problem behavior and has led to concerns over the potentially reinforcing consequences of evoking such behavior during the assessment procedures (Najdowski, Wallace, Ellsworth, MacAleese, & Cleveland, 2008). To reduce risk associated with an experimental functional analysis, some investigators have conducted a functional analysis of precursor behavior in order to *indirectly* infer the variables that maintain problem behavior (Najdowski et al., 2008; Smith & Churchill, 2002). Lalli, Mace, Wohn, and Livezey (1995) provided a foundation for this approach by showing that three problem behaviors displayed by a 15-year-old girl typically occurred in a predictable sequence (referred to as a response hierarchy), and when reinforcement contingencies were applied to the first of these responses, later ones in the sequence were suppressed. Based on this information, subsequent studies demonstrated that it was possible to infer the maintaining variables for more severe behaviors based on the outcomes of analyzing the more benign, precursor behavior (Smith & Churchill, 2002). Furthermore, interventions based on the outcomes of such analyses reduced precursor behavior and were associated with zero levels of severe problem behavior (Najdowski et al., 2008). These results represent a promising alternative to assessing the operant function of severe problem behavior directly.

Low-Rate Behaviors

Clinicians have often noted that high-frequency behavior appears to be easier to functionally assess than low-frequency behavior (Sprague & Horner, 1999). Since low-rate behavior occurs infrequently, it may be difficult to observe during descriptive analyses, and it may not occur at all during traditional experimental functional

analyses (Kahng, Abt, & Schonbachler, 2001). In an early study on functional analysis of low-rate behavior, Kahng et al. (2001) conducted a modified functional analysis of low-rate aggression, extending the session duration to 7 h per day and conducting sessions 5 days per week, with each day representing a different analogue condition. The modified functional analysis produced clear results, whereas a previous functional analysis with standard session durations did not. The Kahng et al. procedural modification succeeded in producing clear assessment results for low-rate behavior, but two possible limitations are of note. First, many may be uncomfortable with exposing participants to the experimental conditions for such extended periods of time (especially in the attention condition, which essentially amounted to ignoring appropriate behavior all day), and second, some organizations may have difficulty allocating the large number of highly trained staff that is needed for such an extended functional analysis.

Tarbox, Wallace, Tarbox, Landaburu, and Williams (2004) evaluated an additional modification to functional analysis methodology for assessing low-rate behavior. In particular, functional analysis sessions were initiated contingent upon the occurrence of challenging behavior. This modification resulted in clear results in three adults with intellectual disabilities and low-rate challenging behaviors who had not engaged in a sufficient amount of challenging behavior during prior standard functional analyses. Furthermore, treatment analyses were conducted on the basis of the functional analysis outcomes for the two participants who were available for treatment, and both resulted in successful reductions in challenging behavior.

Expansion Across Settings

The immediate success of functional analysis within hospital settings led researchers to work on transferring the use of the technology across other settings, and the results have been encouraging. A common misconception seems to remain that successful experimental functional analyses require a highly controlled hospital or university

setting, consisting of two or three staff members, laptop computers for data collection, and padded session rooms with one-way mirrors, but published research shows this is clearly not the case. A significant amount of research has demonstrated that functional analysis techniques are useful in less-controlled much shorter-term outpatient clinical settings (Derby et al., 1992; Wacker et al., 1990). A still-common misconception among educators is that functional analysis methodology is not appropriate or not practical for schools, and this notion is cited as justification for often implementing only indirect and descriptive assessments in school settings (Weber, Killu, Derby, & Barretto, 2005). However, a very substantial amount of research has been published on the successful application of functional analysis methodology within schools. Hanley et al. (2003) found that just over 31% of published research on experimental functional analyses was conducted in school settings. In addition, a small but significant amount of research has demonstrated the use of functional analysis methodology in homes. For example, Arndorfer, Miltenberger, Woster, Rortvedt, and Gaffaney (1994) conducted brief experimental functional analyses with six children in their homes and found conclusive results in each case. Finally, the large amount of research on functional analyses in schools and homes described above clearly shows that contrived settings are not necessary to produce clear results, but little research has directly compared contrived and naturalistic settings. One recent study by Lang et al. (2008) directly compared the results of functional analyses conducted in therapy rooms versus classrooms for two children with autism. The results were somewhat inconsistent, but generally speaking, clearer results were obtained in the therapy room. More research is needed which directly compares contrived versus natural settings.

Expansion to Other Functions of Behavior

It should not be surprising that the original article by Iwata et al. (2000), and the earlier

developments leading up to it, could not possibly have identified all possible operant functions for challenging behavior. From a purely operant standpoint, all functions can be classified under either positive or negative reinforcement and either automatic or socially mediated. However, a small but significant number of additional subdivisions of these categories have been identified in the past 30 years, the highlights of which are reviewed next.

Tangible

Perhaps the most substantial and enduring addition to the standard functional analysis methodology is the addition of a condition to assess for the “tangible” function, that is, maintenance of behavior by forms of positive reinforcement, such as food, toys, or other items or activities. The tangible condition amounts to a minor modification to the attention condition. That is, positive reinforcement is still addressed as a potential function of behavior, but the form of positive reinforcement delivered is some form of preferred item or activity, and no physical or verbal attention is delivered. Mace and West (1986) were the first to include an experimental condition that assessed the effects of tangible reinforcement on problem behavior. However, the condition which provided access to preferred items/activities contingent upon challenging behavior also provided simultaneous escape from demands as a consequence. The first study to isolate access to preferred items/activities as a consequence for behavior during an experimental functional analysis was conducted by Day, Rea, Schussler, Larsen, & Johnson, (1988). This study included a condition that provided only access to preferred items/activities for 20–30 s contingent on problem behavior and is, therefore, often cited as the earliest demonstration of behavioral maintenance by access to tangible items (Hanley et al., 2003). However, the Day et al. study also included participant peers present in the condition, which represents another possible antecedent variable which may set the occasion for challenging behavior. One of the earliest studies to implement what is now considered the “standard” tangible condition was conducted by Vollmer, Marcus, Ringdahl, and Roane (1995).

In this study, tangible sessions were preceded by a brief period of access to preferred items that caregivers reported were correlated with challenging behavior. At the start of the session, the preferred items were removed and returned to the participant for approximately 20 s, contingent on each occurrence of the target behavior.

It is also interesting to note that, although the term “tangible” implies that the reinforcer for problem behavior is a physical item that can be grasped, this is not always the case. Significant creativity and flexibility may be needed to accommodate the full range of items or activities that may serve as positive reinforcers for challenging behavior. For example, one recent study demonstrated that the opportunity to go for walks was the maintained reinforcer of behavior, a consequence that was initially overlooked when more conventional consequences were first evaluated (Ringdahl, Christensen, & Boelter, 2009).

The tangible condition has become common over the last two decades of functional analysis research, and it is generally considered a “standard” condition. Indeed, in their review, Hanley et al. (2003) found that 38% of articles included a tangible condition and that the problem behavior of 10% of participants was reported to have a tangible function (as opposed to 34% for escape and 25% for attention). However, many researchers caution against including a tangible condition in a functional analysis unless caregivers report that the target behavior is associated with a preferred item or activity, because of the potential for “shaping up” a false tangible function (Thompson & Iwata, 2001). Little research has suggested that functional analyses create false positive results, but Shirley, Iwata, and Kahng (1999) found that it is possible to unintentionally “create” or “shape up” a false function for challenging behavior in the tangible condition. The findings of Shirley and colleagues support the general practice of excluding the tangible condition unless caregivers provide information that may suggest a possible tangible function.

Control

The role of “control” in the maintenance of challenging behavior is a potential function that is

commonly discussed but has thus far been the subject of relatively little research. The general idea is that maintaining consequence of some challenging behavior is access to the opportunity to be in control. For example, a study by Bowman et al. (1997) demonstrated that the maintaining consequence of challenging behavior for children with developmental disabilities was the caregiver complying with the requests (i.e., “mands”) of the participant, regardless of what those requests were. This is to be distinguished from a standard tangible condition in that the particular item or activity being requested was not relevant as long as the request was fulfilled. Similar findings were replicated in a controlled case study by O’Connor, Sorensen-Burnworth, Rush, and Eidman (2003) in which the destructive behavior of a 14-year-old boy with developmental disabilities was found to be maintained by adult compliance with mands. More research is needed to identify exactly what “control” is from a behavioral perspective and how it participates in the maintenance of challenging behavior.

Access to Stereotypy

Preliminary research has documented challenging behaviors whose functions appear to be positive reinforcement in the form of the opportunity to engage in ritualistic behavior, routines of some sort, or to engage in stereotyped behavior of some kind. For example, Fisher, Lindauer, Alterson, and Thompson (1998) assessed the property destruction of two boys with intellectual disabilities and found that the behavior was maintained by the opportunity which it afforded to engage in stereotypy with the destroyed property. Specifically, the participants destroyed plastic items and then engaged in stereotypy with the broken pieces of the items. Treatments based on these results successfully reduced the property destruction.

Idiosyncratic Variables

Numerous studies have identified potential idiosyncratic antecedent variables that can affect the outcomes of functional analyses. O’Reilly (1996)

evaluated the influence of the location where a participant resided the night previous to the day in which functional analysis sessions were conducted. The participant was a 25-year-old man with moderate intellectual disabilities who exhibited intermittent SIB. The results of the analyses demonstrated clearly that SIB occurred on days following nights spent with respite care and did not occur on days following nights spent at home. A successful treatment for the behavior was designed in which an alternative respite placement was implemented.

Carr, Yarbrough, and Langdon (1997) evaluated the effects of idiosyncratic variables on functional analysis outcomes in three individuals with developmental disabilities. In each case, the presence or absence of highly idiosyncratic stimuli (large vs. small balls, magazines, and puzzles) determined whether the target behavior occurred during assessment conditions, regardless of the particular programmed consequence for the condition.

Ringdahl and Sellers (2000) examined the differential effects on problem behavior of caregivers and inpatient staff members as therapists, finding that aberrant behavior varied not only as a function of environmental contingencies but also as a function of therapist. Specifically, the aberrant behavior was more prevalent when the caregiver served as therapist during a functional analysis than when a staff member implemented the same procedures.

The effects of a multitude of other idiosyncratic variables have been studied as well, including the number of therapists present during the attention condition (Taylor, Sisson, McKelvey, & Trefelner, 1993), quality of attention delivered contingent on behavior (Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996), and establishment of operations for escape-maintained behavior (McComas, Hoch, Paone, & El-Roy, 2000), among many others. Taken together, these studies further reinforce the basic philosophical assumptions behind functional analysis, specifically, that it is a general format which is useful for identifying behavior/environment relations at the level of the individual client and that these relations are assumed to vary, as each individual is unique.

Functional analysis, no matter how well developed, still requires the “analysis” component; it is not a universal cookbook approach to assessment, nor was it ever intended to be.

Experimental Designs

The functional analyses in the 1982 paper by Iwata et al. were carried out in the context of multielement experimental designs, and this design remains the most prevalent (Hanley et al., 2003). However, several alternatives have been shown to be effective. One such alternative is to match one test condition with the control condition in a “pair-wise” fashion in order to minimize potential carryover effects that may result from alternating multiple test conditions at once (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). The reversal design has also been used in favor of the multielement design in several studies, also with the intention of minimizing carryover effects (Vollmer et al., 1995). Finally, multiple studies have conducted what has come to be known as an “extended alone” condition in which multiple successive sessions of the alone condition are conducted for behaviors that are suspected to be maintained by automatic reinforcement (Vollmer et al., 1995).

Functional Analysis Duration

A commonly stated potential limitation to experimental functional analyses is that they are said to require lengthy durations of time to complete. There is little research to suggest that other equally reliable functional assessment options exist that require less time; however, maximizing efficiency of any clinical procedure is always valuable. A significant amount of research has been done on ways to shorten the overall duration of time required for functional analyses. One option for shortening the time required for a functional analysis is to shorten the duration of each session, from the usual 10–15 to 1–5 min. Wallace and Iwata (1999) retrospectively evaluated the effects of analyzing only the first 10 min, versus

the first 5 min, versus the entire 15-min duration of functional analysis sessions, and found that 5-min session durations produced clear results in a majority of cases. A 90-min assessment, based on Iwata et al.'s (1982) model, has been developed for use in brief outpatient clinic visits. In this model, usually referred to as the "brief functional analysis," only one or two sessions of each condition are conducted, followed by a brief treatment assessment in which a replacement communication response is usually trained. The brief nature of the assessment does not always allow the target behavior to be observed successfully, but the model can be useful nonetheless (Cooper et al., 1990; Derby et al., 1992; Northup et al., 1991).

Interpreting Functional Analysis Data

Iwata et al.'s original functional analysis paper (1982) utilized visual inspection, without any formal criterion, to interpret data produced by the assessment. Visual inspection is the standard in single-case experimental design (Kazdin, 2010) and continues to be adequate in the vast majority of functional analyses. However, some researchers have expressed concern about the potential for subjectivity in the interpretation of functional analysis results, particularly in less-controlled settings. In order to increase both the validity and reliability of visual inspection for interpreting functional analysis results, Hagopian et al. (1997) developed a set of structured criteria and trained individuals to apply these rules when analyzing functional analysis data. The results suggested that, when applied correctly, the criteria improved the reliability of interpretations of functional analysis results.

Antecedent-Only Functional Analysis

An early study on experimental functional analysis by Carr and Durand (1985) used a methodology in which only the antecedents of challenging behavior were experimentally manipulated between conditions, whereas no programmed

consequences were delivered for challenging behavior in any conditions. That is, there was no contingency between target behavior and consequence, and therefore the target behavior was putatively on extinction throughout the assessment. Carr and Durand (1985) and many subsequent studies have obtained clear results using this methodology. Indeed, the review by Hanley et al. (2003) cited 56 studies which had been published using this antecedent-only methodology. A major potential limitation to this model is that, since challenging behavior is on extinction during the assessment, it may decrease before clear results are obtained. However, a major potential strength of the approach is that many caregivers (e.g., teachers, parents, etc.) who are not familiar with standard functional analysis methodology may not approve of the idea of intentionally reinforcing challenging behavior during assessment. In any case, the antecedent-only model is a significant contribution to the traditional model and should be considered as one possible alternative.

Training Others to Conduct Functional Analyses

One criticism of traditional functional analysis methodology is that the precision required to conduct such an analysis necessitates extensive training and clinical expertise (Wallace, Doney, Mintz-Resudek, & Tarbox, 2004). However, recent studies have demonstrated that individuals with no prior experience with functional analysis procedures could be trained to implement functional analyses with a high degree of fidelity (Iwata et al., 2000; Moore et al., 2002; Wallace et al., 2004). With the use of a training package that included reading materials, watching a videotaped simulation, passing a written test, and receiving feedback, Iwata et al. (2000) effectively trained undergraduate students to implement three functional analysis conditions (attention, demand, and play). Moore and colleagues (Moore et al., 2002; Moore & Fisher, 2007) trained individuals through video modeling. Recent studies have demonstrated that, using video modeling, undergraduate students and teachers could be

trained to implement functional analysis procedures with high fidelity (Iwata et al., 2000; Moore et al., 2002; Wallace et al., 2004).

Nonexperimental Methods for Functional Assessment

Experimental functional analysis has become one of the most widely used technologies in ABA research on assessment and treatment of challenging behavior. However, the vast majority of clinical and educational settings do not conduct experimental analyses prior to treatment. Based upon the most commonly described methods for conducting an EFA (e.g., Iwata, Dorsey et al., 1994), determining the clear function of a target behavior may take several weeks to complete, depending on how many sessions can be conducted per day. As noted previously, researchers have made efforts to create abbreviated analyses (e.g., Northup et al., 1991). However, as discussed, these procedures have a number of limitations such as lower probability of observing the target behavior during the shortened observation time. Another limitation of EFA procedures is that several trained staff members are required to conduct the analysis, again adding to the resources required to conduct the analysis. Most clinical and educational settings simply do not have the staff available to conduct EFAs. In addition, many have concerns regarding the practice of intentionally reinforcing challenging behavior during EFAs.

Despite the large amount of research demonstrating the reliability of EFAs, one must wonder why the procedure has not been adopted on a wide scale in real-life clinical and educational settings. Although there is no simple answer to this question, it seems likely that all the potential limitations described above play a part. Based upon these limitations, a large amount of research has been done on nonexperimental methods for functional assessment. These methods are commonly classified as either indirect or descriptive assessment (Tarbox et al., 2009). Indirect assessments consist of interviewing caregivers who have previously observed the target behavior. Interviews may be open-ended or structured. Major advantages of indirect assessments are that

they are rapid, easy to administer, and do not require direct observation of the target behavior. Further, most require less than an hour to conduct. Descriptive assessments involve direct observation and measurement of the target behavior as well as environmental variables that are presumed to be functionally related (Cooper et al., 2007). In light of the resource-intensive nature of EFA, it is not surprising that Desrochers et al. (1997) found that clinicians reported indirect and descriptive assessments as more useful than experimental assessments. In cases where resources (e.g., availability of trained staff) do not permit experimental analyses, or the low-rate of severe behavior requires an inordinate amount of time to observe the behavior within an analogue setting, a significant amount of research has demonstrated that various indirect and descriptive methods of functional assessment can yield useful information.

A more thorough review of indirect and descriptive methods is outside of the scope of this chapter. Readers are advised to see the chapter titled, "Scaling Methods of Functional Assessment," in this volume for a thorough treatment of the topic.

Concerns and Future Directions

Ecological Validity

Over the years, some studies have focused on a descriptive analysis under natural settings (e.g., Bijou et al., 1968), while others have emphasized the experimental analysis of aberrant behavior within controlled laboratory conditions (e.g., Iwata et al., 1982). Throughout this time, researchers have questioned the ecological validity of the procedures employed in functional analyses, arguing that the results of such assessments are not reflective of the types of functional relationships operating in an individual's natural setting (Emerson, 1992).

While experimental functional analyses help ensure careful control over the environment, critics have raised questions regarding the ecological validity of the procedures employed (Emerson, 1992). The requirement of demonstrating

experimental control over a problem behavior may lead to artificial situations in which results are not reflective of the types of functional relationships operating in an individual's natural settings (Emerson, 1992).

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