THE SIGNIFICANCE AND FUTURE OF FUNCTIONAL ANALYSIS METHODOLOGIES

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Iwata, Dorsey, Slifer, Bauman, and Richman (1982) presented the first comprehensive and standardized methodology for identifying operant functions of aberrant behavior. This essay discusses the significance functional analysis has had for applied behavior analysis. The methodology has lessened the field's reliance on default technologies and promoted analysis of environment–behavior interactions maintaining target responses as the basis for selecting treatments. It has also contributed to the integration of basic and applied research. Future directions for this research are suggested.

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The roots of functional analysis methodologies can be traced to the earliest years of applied behavior analysis (e.g., Ayllon & Michael, 1959; Bijou, Peterson, & Ault, 1968). However, the article by Iwata, Dorsey, Slifer, Bauman, and Richman (1982) (reprinted in this issue of *JABA*) built upon previous theoretical papers (e.g., Carr, 1977) and research methods (e.g., Bijou et al., 1968; Thomas, Becker, & Armstrong, 1968) to formulate the first comprehensive and standardized functional analysis methodology. This methodology, initially applied to the analysis of self-injurious behavior, was soon adapted to analyze environment–behavior interactions that maintained a wide variety of behavior disorders, such as aggression (Mace, Page, Ivancic, & O'Brien, 1986; Wacker et al., 1990), destructive behaviors (Slifer, Ivancic, Parrish, Page, & Burgio, 1986), disordered speech (Mace & Lalli, 1991; Mace, Webb, Sharkey, Mattson, & Rosen, 1988; Mace & West, 1986), stereotypy (Durand & Carr, 1987; Mace, Browder, & Lin, 1987; Wacker et al., 1990), pica (Mace & Knight, 1986), and tantrums (Carr & Newsom, 1985).

Since being introduced to functional analysis as an intern at the Kennedy Institute in 1982, I have always considered the methodology to be one of the most significant developments in applied behavior analysis. My objectives in this essay are to offer some perspectives on the importance of func-

tional analysis to applied behavioral science and technology development and to suggest some directions for the future evolution and refinement of functional analysis methodologies.

The Significance of Functional Analysis

Beyond behavior modification: A return to behavior analysis. An assumption common to most applications of learning theory aimed at modification of socially relevant human behavior is that both adaptive and aberrant behaviors are learned through a history of interactions between an individual and the environment (Baer, Wolf, & Risley, 1968; Bijou & Baer, 1961; Krasner & Ullmann, 1965; Skinner, 1953; Tharp & Wetzel, 1969). The vast majority of these interactions are believed to follow operant paradigms of positive and negative reinforcement. This history of reinforcement, in turn, influences how an individual responds to current environmental contingencies.

Before applied behavior analysts had a methodology to identify the conditions maintaining aberrant behavior, the reinforcement histories that gave rise to current behavior–environment interactions were largely ignored. Instead, existing repertoires were altered and new ones established by superimposing reinforcement contingencies, punishment contingencies, or both, onto the current environmental contingencies or unknown processes that maintained aberrant behavior. The approach was known generically as behavior modification. However, without the capacity to explicitly interrupt the events maintaining aberrant behavior, be-

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havioral interventions relied on potent reinforcers and/or punishers that could override the conditions that supported problem behavior. Although effective in many cases, this strategy of overriding the maintaining conditions led to concerns about the field's overreliance on the default technologies of contingent aversive stimulation and artificial positive reinforcement (Iwata, 1988; Johnston, 1991a, 1991b; Sherman, 1991).

Behavior modification has also come under fire for its approach to technology development and the treatment philosophies it has spawned (e.g., Dietz, 1978; Hayes, Rincover, & Solnick, 1980; Johnston, 1991a; Mace, 1994; Pierce & Epling, 1980). Technology is directly affected by the scope of research questions posed. Behavior modification research has generally limited itself to the following questions: "What procedures produce behavior change?" "What is the generality of these effects across subjects, behaviors, and settings?" "What are the long-term benefits of this procedure?" "What is the relative efficacy of various procedures in treating the same problem behavior?" Although these questions certainly have merit, their focus is limited to technical application *per se* without concern for discovery of the variables that control behavior under natural conditions (Morris, 1991). Thus, if a particular intervention fails to produce behavior change, it is unlikely to be subjected to the tests of generality, long-term benefits, and relative efficacy. Moreover, treatment failures are seldom analyzed to identify the conditions necessary and sufficient for a given class of procedures to result in behavior change. (For example, under what conditions will contingent praise positively reinforce social interaction and result in a concomitant reduction in aberrant behavior?)

This approach to technology development also influences the philosophies used to guide treatment selection. For example, in the field of developmental disabilities, treatments for aberrant behavior are frequently selected following a least-to-most intrusive intervention model. Treatments designated as less intrusive are used first and, if ineffective, are followed by interventions that are considered to be progressively more intrusive. Treatments are gen-

erally judged to be effective or ineffective, but are rarely fine-tuned to improve their efficacy. This tendency to abandon initially ineffective treatments may be due to the absence of a rationale for matching a particular treatment to a given individual's behavior disorder (Iwata, Vollmer, Zarcone, & Rodgers, 1993). A number of studies have now shown that the inefficacy of some nonintrusive treatments may be due to the mismatch between operant function and treatment (Durand & Carr, 1987; Repp, Felce, & Barton, 1988) or to a change in operant function over time (Lerman, Iwata, Smith, Zarcone, & Vollmer, 1994) rather than an indication of the need for more intrusive procedures.

The advent of functional analysis methodologies led to significant shifts in intervention development and treatment philosophy. Although identification of the operant function of an individual's aberrant behavior does not guarantee successful treatment via procedures matched to that function (Iwata, 1988, 1991), over a decade of research has increased confidence in the effectiveness of this treatment model and encouraged its widespread endorsement (Axelrod, 1987; Iwata et al., 1993; Mace, Lalli, & Pinter-Lalli, 1991). For example, a panel convening a 1989 National Institutes of Health Consensus Conference on the treatment of destructive behaviors associated with developmental disabilities recommended that treatment of severe behavior disorders be based on the results of a pretreatment functional analysis (NIH, 1989).

Treatment matched to the operant function of aberrant behavior generally follows two interrelated strategies: (a) weakening the maintaining response-reinforcer relationship, and (b) establishing or strengthening a response-reinforcer relationship for an adaptive response class that replaces the function of the aberrant one. However, both strategies can take numerous forms and can be tailored to individual cases and circumstances. For example, three classes of procedures have been used to weaken response-reinforcer relationships: extinction, response-independent reinforcement, and punishment. In the case of extinction, there are numerous operations, both within and across maintaining functions, that can discontinue the reinforcement

contingency maintaining aberrant behavior (see Iwata, Pace, Cowdery, & Miltenberger, 1994). For instance, extinction of attention-maintained behavior may consist of planned ignoring (Repp et al., 1988) or time-out (Mace et al., 1986), whereas extinction of escape-maintained behavior may entail continuation of instruction (Mace et al., 1987) or guided compliance (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990).

The key point here is that numerous treatment options are available when treatment and operant function are matched. Because treatment components are selected based on their likelihood to disrupt maintaining contingencies or reinforce adaptive replacement behaviors, behavior analysts are encouraged to adjust parameters of reinforcement schedules and discriminative stimuli to achieve desired treatment outcomes before pursuing a different course of treatment altogether. The result is an analytic treatment model aimed at identification and manipulation of variables that control socially significant behavior under natural conditions.

Opportunities to apply advances in basic research. Functional analysis methods may also contribute to the integration of basic and applied research by permitting applied behavior analysts to incorporate advances in basic research into the analysis and treatment of behavior disorders (Mace et al., 1991; Neef, Mace, Shea, & Shade, 1992). Knowing the operant function of aberrant behavior opens the door for applied researchers to conceptualize related environment-behavior interactions as basic operant processes. Research that isolates the variables influencing these processes may then prove to be relevant to applied work (see essays by Hayes & Hayes, 1993; Hineline & Wacker, 1993; Iwata & Michael, 1994; Nevin & Mace, in press; Shull & Fuqua, 1993).

Of the numerous areas of basic research with potential for application, three are especially relevant to functional analysis work. Perhaps the most fundamental applied questions are, "Why does a given behavior problem occur?" and "Why does the behavior persist in the face of treatment procedures that should be effective?" Basic research on choice and conceptual analyses of establishing op-

erations are relevant to the first question, and basic studies on behavioral momentum or response strength apply to the second.

Like most behavior, aberrant responses can be conceptualized as choice (Myerson & Hale, 1984). The choice is between allocating responses to the aberrant response class or to one or more concurrently available response alternatives. Over three decades of research based on Herrnstein's matching law (Herrnstein, 1961, 1970) has demonstrated that patterns of response allocation across concurrent alternatives are orderly and are a function of *relative* reinforcer rates and amounts, reinforcer quality, reinforcer delay, and response force or effort (Davison & McCarthy, 1988). When the effects of relative reinforcer deprivation and satiation are also considered (Iwata et al., 1993; Michael, 1982, 1993), it becomes apparent that aberrant responding is controlled by several factors that may be targets for manipulation in a treatment protocol (Mace, Lalli, & Shea, 1992; Mace & Shea, 1991). For example, a functional analysis may show that a child's aggressive behavior is maintained by parental reprimands delivered on a variable-ratio (VR) 8 schedule. To discourage allocation of behavior to aggression, a treatment could be designed that arranged high-rate (continuous reinforcement) and high-quality parental attention (affectionate praise) for appropriate social interaction, while discontinuing the contingency between aggression and attention (i.e., extinction). The intervention could be further strengthened by teaching appropriate social interaction following periods of low adult attention in order to increase the reinforcing value of parental attention (Vollmer & Iwata, 1991). The general treatment strategy illustrated in this example is to shift response-allocation patterns away from aberrant behavior and toward adaptive replacement responses through deliberate manipulation of establishing stimuli and the variables that affect choice.

However, even well-designed treatments may not rapidly reduce rates of aberrant behavior. Several basic research studies have shown that despite extinction, satiation, alternative reinforcement, distraction, and punishment, reinforced behavior persists or has momentum over time (Cohen, Riley,

& Weigle, 1993; Nevin, Mandel, & Atak, 1983; Nevin, Tota, Torquato, & Shull, 1990). A consistent finding across species and environmental challenges to the response–reinforcer relation is that behavior is more persistent under stimulus conditions that are correlated with higher baseline rates of reinforcement. Of particular significance to applied work is the fact that this effect occurs regardless of whether reinforcement is contingent on the target response, is delivered noncontingently, or is arranged for a concurrently available response (Nevin et al., 1990). This fundamental property of reinforced behavior seems to be relevant to the treatment of behavior disorders, especially when the maintaining reinforcer can be identified via functional analysis.

Several investigators have drawn upon Nevin's basic research on behavioral momentum to formulate novel treatments for noncompliance. By arranging high-rate reinforcement for a class of responses called "compliance" immediately before issuing a request to perform a task with a low-probability of compliance, clinicians were able to establish a "momentum" of compliant behavior that resisted the challenge of the low-probability requests (Davis, Brady, Williams, & Hamilton, 1992; Mace, Hock, et al., 1988; Singer, Singer, & Horner, 1987). However, when the persistence of a specific aberrant response, such as self-injury, is encountered during treatment, the traditional intervention of extinction plus alternative reinforcement may actually prove to be counterproductive if Nevin's findings with pigeons generalize to human behavior problems. That is, alternative reinforcement, when presented in a context correlated with the occurrence of self-injury, may actually increase the persistence of self-injury, requiring longer to reach treatment goals, even though the rate of self-injury may be reduced by the intervention (Mace, 1994; Nevin & Mace, in press). If this occurs, different treatment sequences may be used to avoid correlating aberrant behavior with high-rate alternative reinforcement. Of course, such hypotheses warrant rigorous examination by applied researchers before treatment practices are altered. However, the important message here is that func-

tional analysis permits investigation of research questions that could not be seriously considered only a decade ago.

Future Directions for Functional Analysis

Numerous functional analysis methodologies have been reported in the literature, each with its attendant strengths and limitations. *Indirect methods*, such as rating scales completed by a client's care provider (e.g., Motivational Assessment Scale; Durand & Crimmins, 1988), are convenient to administer and have the potential to assess the function of aberrant behavior in the natural environment. The principal and significant limitation of ratings scales is that the findings are unreliable when compared to direct and detailed assessments of behavior (Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991). *Descriptive methods* use direct observations of client behavior and environmental events in natural settings to formulate data-based hypotheses about the operant function of aberrant behavior. Although descriptive analysis can provide information about the idiosyncratic reactions of care providers to problem behavior and provide estimates of natural schedules of reinforcement, the data collection methods are difficult to standardize, and the resulting data are correlational by nature and, therefore, must be interpreted with considerable caution (Lerman & Iwata, 1993; Mace & Lalli, 1991). Finally, *experimental methods* isolate and control contingencies that may maintain an individual's aberrant behavior using standardized procedures that are analogues of naturally occurring situations. They provide a direct and reliable means of identifying functional relations. The major limitations of experimental analyses are that they may overlook important variables that operate in the client's natural setting, and, hence, the results may not generalize outside the analogue conditions (Halle & Spradlin, 1993; Lerman & Iwata, 1993; Mace & Shea, 1991).

Given the respective strengths and limitations of available functional analysis methods, in what direction should the methodology evolve toward the goal of identifying the operant function of naturally

occurring aberrant behavior? I believe there are two answers to this question. First, the operant function of many cases of aberrant behavior can be accurately identified with existing methodologies. Moreover, several investigators have shown that brief and simplified methods of functional analysis can be useful for selecting effective treatments. For example, Wacker and his colleagues (Cooper, Wacker, Sasso, Reimers, & Donn, 1990; Derby et al., 1992; Northrup et al., 1991) have developed a 90-min assessment for use in outpatient clinics based on Iwata et al.'s (1982) model. Clients are presented with different analogue conditions in 10-min sessions to assess whether their aberrant or appropriate behavior is sensitive to one or more environmental contingencies. Preliminary studies have reported moderate correspondence between results of brief functional assessments and extended experimental analyses (Rodgers, Zarcone, & Iwata, 1990). Another efficient approach to functional analysis and treatment of behavior disorders has been to implement multiple treatments matched to different possible functions of the aberrant target response (e.g., escape and attention). If the aberrant behavior is responsive to one but not the other treatments, it may be reasonable to infer the operant function of the behavior based on the differential effectiveness of the treatments (Repp et al., 1988; Lalli, Browder, Mace, & Brown, 1993). Using either strategy, the acid test is the effectiveness of analysis-based treatments. If these efficient and abbreviated functional assessments can lead to effective treatment, there may be little reason to conduct more extensive and comprehensive forms of functional analysis.

The second answer to the question of which direction functional analysis methodologies should evolve concerns strategies for use with individuals with difficult-to-treat behavior disorders. It may be reasonable to conclude that, if treatment based on the results of an abbreviated functional analysis proves to be ineffective, the analysis lacked internal or external validity. That is, an operant function was not identified by the assessment (internal validity), or the operant function detected in the assessment did not hold in the individual's natural environment (external validity). In such circum-

stances, the behavior analyst has the option of conducting an extended experimental analysis characteristic of the Iwata et al. (1982) model or combining descriptive and experimental methods to design individualized assessment conditions (Mace & Lalli, 1991). With the latter approach, the naturally occurring consequences for target behaviors and the schedules in which these consequences are arranged are incorporated into the design of analogue experimental conditions. The goal is to increase the external validity of the experimental analysis, thereby increasing confidence that the results will generalize outside the experimental setting. Although the combination of descriptive and experimental methods has certain advantages, it can also be time consuming and complicated to execute—particularly the data collection and data analysis portions of the descriptive analysis. Additional work is needed to standardize descriptive analysis methods and make them easier to use on a wide-scale basis. In any case, whether experimental methods are used alone or in combination with descriptive assessments, our greatest confidence should rest on the findings from the experimental analysis. This is especially true when descriptive and experimental findings correspond. However, when no naturalistic observations are available or when descriptive and experimental findings are discordant, conclusions about the operant function of a behavior problem under natural conditions are best tempered, at least until treatments based on the analysis prove to be effective.

I want to observe, in conclusion, that the functional analysis of aberrant behavior has made tremendous advances since and because of the Iwata et al. (1982) publication. It has revolutionized how behavior analysts conceptualize and treat behavior disorders. Perhaps more significantly, it has renewed the analytic spirit in applied behavioral psychology and has contributed to closer connections between the basic and applied analysis of behavior. Evolution of functional analysis methodologies is inevitable and is to be encouraged. We can be confident that the next decade will provide us with improved technologies to identify the operant function of a wide range of behavior disorders.

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