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REDUCING AMBIGUITY IN THE FUNCTIONAL ASSESSMENT OF PROBLEM BEHAVIOR

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Abstract

Severe problem behavior (e.g., self-injury and aggression) remains among the most serious challenges for the habilitation of persons with intellectual disabilities and is a significant obstacle to community integration. The current standard of behavior analytic treatment for problem behavior in this population consists of a functional assessment and treatment model. Within that model, the first step is to assess the behavior–environment relations that give rise to and maintain problem behavior, a functional behavioral assessment. Conventional methods of assessing behavioral function include indirect, descriptive, and experimental assessments of problem behavior. Clinical investigators have produced a rich literature demonstrating the relative effectiveness for each method, but in clinical practice, each can produce ambiguous or difficult-to-interpret outcomes that may impede treatment development. This paper outlines potential sources of variability in assessment outcomes and then reviews the evidence on strategies for avoiding ambiguous outcomes and/or clarifying initially ambiguous results. The end result for each assessment method is a set of best practice guidelines, given the available evidence, for conducting the initial assessment.

Functional behavioral assessment (FBA) of challenging behavior is a process through which clinicians attempt to identify the variables that give rise to and maintain the target behavior. FBA can involve a wide variety of procedures that differ with respect to whether the individuals are directly observed or not, the conditions under which they are observed, and the extent to which the observation context is arranged by the clinician or researcher. For ease of interpretation, we here term methods that do not involve direct observation (i.e., require only that the clinician or researcher gathers information from informants) as *indirect assessment* (*IA*). Methods that involve direct observation but not manipulation of the

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environmental context are termed *descriptive assessment* (*DA*). Methods in which the clinician or experimenter directly manipulates the environmental context are termed *functional analysis* (*FA*).

The principal utility of FBA is to guide the development of interventions for challenging behavior. In general, three types of contingencies maintain challenging behavior. These contingencies include automatic reinforcement, social positive reinforcement, and social negative reinforcement. Automatic reinforcement may be in the form of positive or negative reinforcement (although this distinction may not be clear based on FBA results). Armed with information about the variables that evoke and reinforce target behavior, the intervention agent can then devise ways to disrupt the contingency between the target response and the putative reinforcer and/or arrange for delivery of that reinforcer through other means (e.g., contingent on an alternative and appropriate response). Functional behavioral assessment is a powerful tool for the assessment and treatment of severe problem behavior and an ethical requirement for clinical care (Hanley, 2012), but the outcomes of assessment are not always perfectly clear. Although several reviews and commentaries (e.g., Beavers, Iwata, & Lerman, 2013; Hanley, 2012; Hanley, Iwata, & McCord, 2003) touch upon ambiguity in FBA outcomes (see also Schlichenmeyer, Roscoe, Rooker, Wheeler, & Dube, 2013), none have focused exclusively on ambiguous FBA outcomes and strategies to deal with these outcomes.

When we speak of ambiguity in the assessment process, we refer to instances in which the assessment failed to provide a clear hypothesis regarding the relevant antecedents and consequences. *Ambiguous assessment outcomes* are an enormous impediment to effective intervention. If the clinician cannot derive clear hypotheses, the clinician is taking a wild guess. Developing treatments based on an incorrect hypothesis may cost the clinician weeks, perhaps months, evaluating an ineffective intervention. In some cases, treatments based upon incorrect hypotheses may even be counter-therapeutic (Iwata, Pace, Cowdery, & Miltenberger, 1994). Even properly derived interventions may fail to produce the desired outcome, but the tact one takes after such an outcome may differ. If one is reasonably certain that one's hypothesis was on target, then variations and minor modifications of the hypothesis driven intervention may ultimately succeed. However, if the functional assessment failed to yield a correct hypothesis in the first place, then it is possible that no amount of adjustment within a given line of intervention will succeed. The dilemma is one akin to the old carpenter's adage, 'Measure twice, cut once.'

Unfortunately, many factors can lead to ambiguity during FBA. This paper was therefore designed to describe the sort of processes that can lead to ambiguity during the major forms of assessment, then describe the sorts of recommendations and modifications derived from behavior analytic research that have been shown to clarify ambiguous outcomes. Three sections follow, each corresponding to one of the major forms of assessment: IA, DA, and FA. For IAs, ambiguous outcomes include the following: (i) a lack of strong endorsement for any hypothesis regarding problem behavior; (ii) strong endorsements for all hypotheses regarding problem behavior; (iii) conflicting endorsements of hypotheses regarding problem behavior across raters (raters generally agree, except about the specific hypotheses that maintain problem behavior); or (iv) overall poor agreement between raters (raters agree about the hypotheses regarding problem behavior in some but not all cases). For DAs, ambiguous outcomes include the following: (i) failure to observe the problem behavior, (ii) low levels of correlation between problem behavior and antecedent and consequent events; and (iii) high levels of correlation between problem behavior and all antecedent and consequent events. For FAs, ambiguous outcomes include the following: (i) little to no responding in the assessment; (ii) an undifferentiated pattern that is not indicative of automatic reinforcement; and (iii) responding in the control condition.

INDIRECT ASSESSMENT

Broadly, IA refers to the 'assessment of behavior that is removed in time and place from the actual occurrence of that behavior' (Gresham, Watson, & Skinner, 2001, p. 161). By definition, such a process already relies on the faithful recollection, rather than observation, of behavior and the events surrounding it. Despite this inherent weakness, IAs are frequently used with persons who engage in problem behavior (Desrochers, Hile, & Williams-Moseley, 1997; Ellingson, Miltenberger, & Long, 1999).

The vast majority of research on IAs has focused on the evaluation of the psycho-metric properties of varying interviews, rating scales, and questionnaires (e.g., Iwata, DeLeon, & Roscoe, 2013; Paclawskjy, Matson, Rush, Smalls, & Vollmer, 2000; Zaja, Moore, van Ingen, & Rojahn, 2011) and less on the circumstances under which such instruments provide information that ultimately leads to accurate hypotheses and effective intervention. As such, a relative lack of information exists about potential sources of ambiguity in IAs. In the section that follow, we identify some issues that may lead to uncertainty with regard to interpreting the results of IAs and some strategies to minimize ambiguity related to such measures.

Hypothesis Generation

Indirect assessments aid in generating hypotheses regarding the environmental variables commonly associated with problem behavior. Results of these assessments do not demonstrate a causal relation between those events and the behavior of interest. This necessarily leads to some ambiguity when interpreting the results. Even though function is not identified via IA, there may be some benefits to conducting such assessments. Commonly cited advantages include low cost in the generation of hypotheses regarding the variables maintaining problem behavior and little training and time to administer (e.g., Zaja *et al*., 2011). In addition, IAs may also be helpful in defining and determining the severity of the target behaviors and in identifying the optimal conditions in which one may observe problem behavior (Floyd, Phaneuf, & Wilczynski, 2005).

Perhaps, the most important means of clarifying the results of an IA is to seek convergent validity by supplementing the IA with a method based on direct observation. Several studies have attempted to assess the validity of various IAs by comparing the results obtained from those assessments with results obtained from DAs or FAs (e.g., Crawford, Brockel, Schauss, & Miltenberger, 1992; Cunningham & O'Neill, 2007; Durand & Crimmins, 1988; Hall, 2005; Paclawskyj, Matson, Rush, Smalls, & Vollmer, 2001; Toogood & Timlin, 1996; Wasano, Borrero, & Kohn, 2009). Results tend to vary across studies and across different

IAs. Two of the most extensively studied IAs include the Questions About Behavioral Function (QABF; Matson & Vollmer, 1995) and the Motivation Assessment Scale (MAS; Durand & Crimmins, 1988). In general, outcomes of studies assessing the convergent validity of the QABF and FAs have suggested more positive and consistent findings than those evaluating the validity of the MAS. However, researchers have not always observed perfect correspondence between outcomes obtained from the QABF and FAs either (e.g., Hall, 2005; Paclawskyj *et al*., 2001), providing further evidence that IAs should not be conducted in isolation. Rather, IA should inform the development of assessments based on direct observation.

Iwata *et al*. (2013) conducted one of the largest comparative studies between IA and FA. They compared the Functional Analysis Screening Tool (a 16-item questionnaire) that was tailored to the common functions of problem behavior to the results of an FA in 69 cases. The authors found correspondence between the two measures in 44 (63.8%) cases. These data further suggest that there is not a high level of correspondence between IAs and FA results

Indirect Measure of Behavior

The quality of information gathered from IAs relies on the subjective recall of the informant and not on direct observation of the behavior itself. Such a reliance on the recollection of others can lead to obtaining ambiguous results, as raters may not agree on previous events or may have witnessed very different antecedent and consequent events in relation to problem behavior. For example, a few instances of a high-intensity behavior may result in the informant recalling the response as occurring more frequently than it actually does. In the previously mentioned study conducted by Iwata *et al*. (2013), there were three possible outcomes (social positive, social negative, or automatic); however, raters only agreed in 64.8% of cases. These data indicate that inter-rater agreement is difficult to obtain even with limited choices.

Indirect assessments may also be susceptible to biased responding that results from the tendency to be too lenient or to answer all questions using the middle of the scale regardless of level of behavior (Paclawskyj, Kurtz, & O'Connor, 2004). It may also be the case that different informants do not perceive the same behaviors as being problematic, resulting in unreliable assessment outcomes (Toogood & Timlin, 1996). Informants may lack sufficient training or knowledge regarding the variables that occasion and maintain problem behavior. This may lead to the informant attributing the problem behavior to irrelevant antecedents and consequences or to emotional states (Oliver, Hall, Hales, & Head, 1996). Ambiguous results may also be obtained if informants differ in their amount of exposure to the target individual (Borgmeier & Horner, 2006) or if they observe the target individual under very different conditions (Achenbach, McConaughy, & Howell, 1987). Thus, even if one chooses to supplement an IA with a method based on direct observation, the sheer number of potential problems that can arise because of a reliance on the recollection of an informant highlights the importance of researchers continuing to improve these measures.

To accomplish this goal, researchers over the past decade or so have begun to examine a number of variables that may contribute to obtaining accurate IA outcomes. Some of this research has suggested that perhaps one key to maximizing the potential utility of IA may be to choose informants wisely (e.g., Borgmeier & Horner, 2006; Yarbrough & Carr, 2000). Yarbrough and Carr suggested that the outcome of an IA was more likely to be accurate (i.e., to correspond with results obtained from an FA) if the informant believed a situation was highly likely to occasion problem behavior, as defined on a seven-point Likert scale. Borgmeier and Horner extended this line of research by assessing the informant's confidence in the hypothesized function, degree of contact with the participants, and knowledge of behavioral theory as variables that may affect the accuracy of IAs. Results suggested that informants whose responses led to the generation of accurate hypotheses and who were highly confident in their assessment of problem behavior had significantly higher levels of contact with target individual in his or her problem routine than those with low confidence in their assessment or high confidence but incorrect hypotheses.

Other research has suggested that features of the problem behavior itself may affect the accuracy of IA. For example, Matson and Wilkins (2008) found inter-rater reliability for the QABF better for high-rate aggression and self-injurious behavior (SIB) than when these behaviors occurred at low rates. Although limited, the results of studies assessing variables that may affect IA outcomes seem to suggest that it is important that the informant know the target individual for a sufficient amount of time and have an adequate sample of the person's behavior under relevant situations.

Assessing Relevant Antecedents and Consequences

Indirect assessment instruments can only provide information regarding outcomes about which they ask. In recent years, clinical researchers have identified a variety of 'idiosyncratic functions' of problem behavior that may not be adequately captured in the sorts of questions asked during an interview (see Beavers *et al*., 2013 and Hanley *et al*., 2003). Idiosyncratic variables are those that are related to the individual's particular reinforcement history and are specific to the individual in the sense that they are variables that occasion or maintain responding but do not belong to the broad classes of antecedent/consequent events that typically have been shown to occasion problem behavior. For this reason, it may be important for IAs to include open-ended questions that permit the informant to provide information beyond the very specific sorts of questions often found in an assessment instrument (Hanley, 2012). Hanley, Jin, Vanselow, and Hanratty (2014) compared the results of open-ended IAs with synthesized FA conditions (including multiple FA contingencies in one condition) for three individuals with autism. Results of the IA seem to be verified by synthesized FA conditions in two of three cases; however, a direct comparison cannot be made because of the combined conditions. Additionally, follow-up questions, such as asking the informant to rate his or her confidence in the hypotheses generated from completion of the assessment (Borgmeier & Horner, 2006; Yarbrough & Carr, 2000), may prove useful in enhancing the accuracy of results obtained from IAs.

Although data gathered from IAs alone cannot provide confirmation of the functional relation between environmental events and problem behavior, the results may prove useful with regard to guiding the development of further, more rigorous, objective assessments. IAs can therefore be an important tool in the assessment of problem behavior if clinicians take steps to ensure they provide accurate results.

DESCRIPTIVE ASSESSMENT

Descriptive assessment refers to the observation of interactions between organisms and environmental events that can result in information describing the **occurrence** of such interactions but not in the identification of a **functional relation** between events (Bijou, Peterson, & Ault, 1968). DA typically involves the observation and recording of both an individual's behavior and the behavior of those around him or her and an analysis of how often antecedent and consequent events co-occur with problem behavior and how often the same antecedent and consequent events occur without problem behavior. If antecedent and consequent events occur more often with problem behavior, there is a 'positive contingency' between these events and problem behavior. In practice, after a sample of behavior has been observed (see succeeding texts for more information on sufficient samples), the data sample is continuously coded for two events (the individual's behavior and the behavior of others). Following this, the conditional probability of problem behavior (PB) given the behavior of others (BO) is calculated [*p* (PB|BO)], and the unconditional probability of the problem behavior is also assessed to account for the background probability of events. Typically, events from some interval surrounding the problem behavior (e.g.,10-s prior to and following the problem behavior) will be compared with the number of times the event occurs in general [*p* (BO)]. If *p* (PB|BO) is greater than *p* (BO), then a relevant potential contingency will be assumed. The correlational nature of DA suggests that ambiguous results are a potential concern. However, DAs are often used in practice instead of analyses that could identify functional relations (Thompson & Borrero, 2011). Therefore, strategies to reduce ambiguity related to DAs are important (see Table 1 for a summary of sources of ambiguity in DA).

Correlational Nature of Descriptive Assessments

Descriptive assessments merely provide a correlational account of interactions between responses and environmental events. However, there may be some strategies that could help ensure the usefulness of the information in designing assessment and treatment plans, and possibly limit additional sources of ambiguity. In addition, as with IAs, there may be some benefits to conducting DAs. These may include but are not limited to the following: (i) identifying potential contingencies in naturalistic situations; (ii) capturing a naturalistic baseline by which to assess interventions; (iii) gathering useful information for designing experimental analyses; and (iv) evaluating basic behavioral processes in naturalistic situations (see Thompson & Borrero, 2011). Researchers have conducted DAs in combination with FAs to clarify possible ambiguities in descriptive data (e.g., Borrero & Borrero, 2008; Borrero & Vollmer, 2002; Mace & Lalli, 1991; Tiger, Hanley, & Bessette, 2006), and this is the only way to evaluate known reinforcers in descriptive data. Mace and Lalli conducted a DA with one individual who engaged in bizarre speech. Results of the analysis suggested that bizarre speech occurred most frequently in demand and low attention situations, and adult attention and termination of demands followed bizarre speech. An FA only partially confirmed the outcome of the DA; only attention was identified as a reinforcer.

Additional research comparing the outcomes of DA and FAs has demonstrated that results from FAs often differ from those of DAs (e.g., Pence, Roscoe, Bourret, & Ahearn, 2009; Thompson & Iwata, 2007). For example, Thompson and Iwata compared the results of DAs and FAs for 12 individuals and found that attention was the consequence for problem behavior in 75% of cases during the DA, despite the fact that problem behavior was only maintained by attention in 16.7% of cases as determined by the FA. Attention may often be indicated in DAs because (i) attention is commonly delivered in many contexts irrespective of the occurrence of problem behavior; (ii) if injury occurs with problem behavior, attention may be the only ethical consequence; and (iii) some problem behavior (such as aggression) is impossible to ignore. Taken together, attention occurs at a high baseline level in contexts where individuals with intellectual and developmental disabilities receive services; therefore, DAs may often report attention as a consequence, irrespective of the role of attention in maintaining problem behavior.

This is not to say that DAs do not provide useful descriptions of child–caregiver interactions. For example, in a typical classroom situation, if Mace and Lalli (1991) had treated bizarre speech based on the DA results, they would have developed an intervention for attention (the functional reinforcer) and escape from demands. An intervention for escape from demands may not have been necessary, but one could argue that training a teacher *not* to remove demands following problem behavior (i.e., healthy classroom contingencies) would not likely be harmful. In addition, an FA may yield false-positive results (Jessel, Hausman, Schmidt, Darnell, & Kahng, 2014; Rooker, Iwata, Harper, Fahmie, & Camp, 2011; Shirley, Iwata, & Kahng, 1999), and having information from multiple assessments could provide further support for conclusions.

Reactivity during Descriptive Observations

An additional difficulty that may be associated with DAs is the potential for reactivity. Reactivity refers to changes in participant responding, due to the assessment procedure, that results in an inadequate sample of behavior, one that is not typical outside of the assessment conditions (i.e., in the natural environment).

Kazdin (1979) offered some suggestions to reduce the bias introduced by the observation itself, thereby reducing the likelihood of reactivity and thus the risk of ambiguous or inaccurate conclusions. Some strategies for reducing bias include the following: (i) contriving situations to make it less clear to participants that they are being observed (e.g., observe parent–child interactions during initial interviews); (ii) collecting data unobtrusively (e.g., videotapes and behind a one-way mirror); (iii) collecting data on response products; (iv) providing limited information to participants so they are not informed of the purpose of the observation; (v) conducting multiple assessments and comparing the results (see section on Correlational Nature of Descriptive Assessments); and (vi) collecting a large enough sample of behavior such that reactivity wanes over time. As Kazdin suggested, collecting data on response products, although unobtrusive, can be limiting and may not provide data on the primary behavior of interest. However, such data could provide some additional information to support conclusions drawn from the more biased sample of data.

It may be possible to incorporate some of these strategies when designing DAs to minimize reactivity, although, unfortunately, it is not likely always practical, or ethical, to observe clients in an unobtrusive manner. Perhaps, the easiest strategy to incorporate would be to conduct enough obtrusive observations (i.e., sitting in the room with the clients or informing them they are being observed) so that the clients habituate to the presence of the observer and reactivity decreases.

Collecting an Adequate Sample of Behavior

Although it may not be possible to avoid the correlational nature and potential for reactivity of DAs, reducing other sources of variability in DA methods is a potential strategy. One potential source of ambiguity may be that DAs are often conducted using different methods of observation (e.g., narrative recording vs. structured recording; see Lerman, Hovanetz, Strobel, & Tetrault, 2009), and there are no set rules for the amount of observation necessary to obtain an adequate sample of behavior. Often, individuals are observed in the setting in which the target behavior occurs (e.g., classroom) for varying durations, and then conclusions are drawn as to potential antecedents and consequences for the target behavior. It may be the case, however, that the target behavior is not observed or is minimally observed, which could presumably influence the results of subsequent data analysis (i.e., increasing ambiguity). An inadequate sample of naturalistic situations could result in ambiguous outcomes in several ways by not including a sufficient number of client or caregiver responses, situations, or interactions with others.

For example, if SIB is observed five times in 10 min, and attention was provided following SIB on four of the five occasions, then attention was provided following SIB 80% of the time. One might reach a conclusion that attention (potentially) is reinforcing SIB. In a different example, perhaps, SIB was observed 20 times in 60 min, and attention was provided following SIB on 4 of the 20 occasions. Attention is a consequence in 20% of the time in this example and less likely to be considered a potential reinforcer for SIB. A scenario such as this would suggest that the observations in the former example provide an inadequate sample of responding compared with the latter example. Similarly, not allowing enough opportunities to observe care-giver responses to target behavior or a variety of environmental situations (e.g., instructional times, periods of low attention, and transitions) could also make interpretation difficult and result in similarly ambiguous outcomes. One way to make sure an adequate sample of behavior is captured might be to standardize observation periods when conducting DAs.

A number of studies using DA methods have included observation procedures with pre-specified criteria for a minimum duration of observation and number of responses (e.g., Borrero & Borrero, 2008; McKerchar & Thompson, 2004; Thompson & Iwata, 2001). Thompson and Iwata conducted a relatively large-scale study to determine if situations typically evaluated during FAs of problem behavior were representative of settings that are more naturalistic. To ensure consistency across observations, the researchers pre-specified observation criteria to ensure that they collected a reasonable sample of naturalistic events.

For 27 participants, they collected descriptive data for a minimum of 1h and recorded 10 intervals of problem behavior using partial-interval recording. In addition, as the purpose of the study was to assess potential antecedent conditions, a minimum of 20 antecedent demands had to be recorded during observations before terminating the assessment. Similar guidelines were used in other DA studies (e. g., Borrero, Woods, Borrero, Masler, & Lesser, 2010).

One possible difficulty in practice could be that time constraints prevent adequate observation of events in natural settings. This is a valid concern, and other researchers have evaluated ways in which to expedite this process. For example, one may conduct a structured DA to program for specific antecedent events during the observation (Anderson & Long, 2002; Carr & Durand, 1985). In this procedure, trials are conducted where specific antecedent events are presented, and no consequences are provided for the occurrence of problem behavior. The antecedent events that occasion responding may be causally related to the occurrence of problem behavior. Anderson and Long (2002) conducted structured DAs and set up antecedent conditions (i.e., attention, task, play, and tangible) for observation. Although the antecedent conditions were structured, any potential consequences provided by caregivers were not structured, and more naturalistic subsequent events were observed. This research suggests two relatively simple ways to standardize the observations in DAs.

Target Responses and Analysis

Once procedures are in place to assist observers with collecting an adequate sample of environmental interactions and behavior, additional sources of ambiguity may come from the lack of scoring relevant target responses and analysis. It may be difficult in some situations to determine what to score and how to analyze data to maximize the contributions of the DA.

Collecting data in a way that allows for calculating conditional probability analyses may help identify potential contingencies in DAs (e.g., Borrero, Vollmer, Borrero, & Bourret, 2005; Borrero *et al*., 2010; Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). These studies and others using similar methods suggest two strategies. First, data collection should include not only the various topographies of target problem behavior but also forms of appropriate behavior, including requests for potential reinforcers and compliance with instructions. In addition, clinicians should collect data on caregiver behavior (e.g., the withholding and delivery of potential reinforcers). Very simply put, to identify a potential positive contingency, the conditional probability of an event needs to be greater than the unconditional probability of that event. An example of a potential positive contingency is an unconditional probability of attention of 0.33 and a conditional probability of attention following SIB of 0.95. A potential negative contingency occurs when the conditional probability is less than the unconditional probability of that event (e.g., the unconditional probability of escape is 0.88, and the conditional probability of escape following disruption is 0.33). Differential reinforcement of other behavior is an example of a negative contingency, as the individual is more likely to access the reinforcer when not engaging in the target behavior, as compared with when the individual engages in the target behavior.

Finally, a potential neutral contingency occurs when the conditional and unconditional probabilities are equal.

In addition to conditional probability analyses, lag sequential analyses (Emerson, Thompson, Reeves, Henderson, & Robertson, 1995) can be useful for describing the probability of responses for every second before and after an event. Lag sequential analyses identify conditional probabilities in DA (e.g., Samaha *et al*., 2009), precursors for severe problem behavior or members of a response class (e.g., Borrero & Borrero, 2008), and potential sources of reinforcement for caregivers (e.g., Addison & Lerman, 2009; Sloman *et al*., 2005; Woods, Borrero, Laud, & Borrero, 2010).

Although there will always be some ambiguity in conclusions derived from DAs, the assessments can be conducted in a more structured format to make the most of the results. However, as noted by Thompson and Borrero (2011), the more structure added to the observations, the less naturalistic they are. Clinicians should therefore evaluate the pros and cons at the individual level. Although much evidence exists in the literature to suggest that we should not use descriptive methods as the only assessment method, the lack of trained staff and time constraints in many settings may prevent more rigorous assessment methods. For this reason, the strategies described here can assist practitioners with conducting a more rigorous DA to make the most of the resources available.

FUNCTIONAL ANALYSIS

Best Practice in Functional Analysis

Functional analysis of problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) allows for the identification of the variables maintaining problem behavior. An FA involves manipulating environmental events while directly observing problem behavior. FA identifies maintaining variables across a wide range of problem behavior, including aggression, SIB, and stereotypy (Matson *et al*., 2011). The use of an FA allows clinicians and researchers to develop successful interventions (most notably extinction; Iwata *et al*., 1994). In addition, an FA allows clinicians to establish an appropriate baseline during a treatment analysis, a necessary component to determining treatment effects.

Although the procedures in a typical FA are based on those described by Iwata, Dorsey, *et al*. (1982/1994) and general guidelines for how to conduct an FA have been previously published (Hanley, 2012; Hanley *et al*., 2003), additional research has been conducted in subsequent years to determine the best practices for conducting the assessment (Table 2). The current best practice of FA will reduce ambiguous outcomes, so it is necessary to define these procedures. The first step in conducting an FA is to rule out any biological or medical reason that problem behavior may be occurring (O'Reilly, 1995). Immediately prior to the session, pre-session access to the consequences provided in the FA should be limited (McGinnis, Houchins-Juárez, McDaniel, & Kennedy, 2010; O'Reilly & Carey, 1996), and sessions should not occur immediately after exercise, as this may decrease the overall level of problem behavior (e.g., Kern, Koegel, Dyer, Blew, & Fenton, 1982). Several procedural variables also merit consideration. When selecting target behavior, conducting the FA on one form of behavior (e.g., only SIB or only aggression) at a time will limit false-positive results (finding a functional relation when one does not exist; Jessel *et al*., 2014) and false-negative results (not finding a functional relation when one exists; Asmus, Franzese, Conroy, & Dozier, 2003; Beavers & Iwata, 2011). In addition, FA sessions are typically rapidly alternated, using a multi-element design, to increase the efficiency of the procedure. Using a fixed sequence of conditions (Hammond, Iwata, Rooker, Fritz, & Bloom, 2013) and a unique discriminative stimulus in each condition can increase the motivation in some conditions while potentially facilitating discrimination between conditions (Conners *et al*., 2000). Finally, when problem behavior persists at the end of a session (e.g., emotional responding due to the aversive nature of task demands), insertion of a period of time without the occurrence of problem behavior as the criteria for beginning the next session should be considered (McGonigle, Rojahn, Dixon, & Strain, 1987).

Assessments prior to conducting an FA should also be conducted to determine the content of FA conditions and reduce the possibility of an ambiguous outcome. A preference assessment should be conducted to determine what items should and should not be used in the alone and attention conditions to prevent false-negative outcomes (Roscoe *et al*., 2008). Roscoe *et al*. found that free access to high-preference items may reduce responding in the FA alone and attention conditions through competition; therefore, no items should be included in the alone condition, and only moderately preferred items should be included in the attention condition. A demand assessment should be conducted to determine the task demands to include in the demand condition to prevent false-negative outcomes (Roscoe *et al*., 2009). Roscoe *et al*. found that using highly preferred demands did not occasion responding for individuals who otherwise had problem behavior maintained by access to escape; therefore, it is important to ensure that the tasks included in the demand condition motivate escape. A DA should be conducted to determine if a tangible condition is necessary and what items should be included in this condition to prevent false-positive outcomes (Rooker *et al*., 2011). Rooker *et al*. found that an arbitrary response with no history of reinforcement was maintained by access to tangible items and that problem behavior maintained by automatic reinforcement occurred at high levels in the tangible condition when edible items were provided. Therefore, a tangible condition should be included only when there is reason to suspect that problem behavior is maintained by tangibles (e.g., if a caregiver reports that denied access to tangibles precedes problem behavior). In addition, only tangibles that are reported or observed to follow problem behavior in the typical environment should be included in the FA. If there is reason to suspect that behavior is maintained by automatic reinforcement, an alone screen could be conducted (Querim *et al*., 2013). An alone screen involves conducting just three 5-min alone sessions. Querim *et al*. found that this abbreviated assessment identified behavior maintained by automatic reinforcement in 21 of 22 cases; therefore, an alone screen could be conducted to enhance efficiency when problem behavior is hypothesized to be maintained by automatic reinforcement. Conducting an alone screen may reduce the amount of time required to conduct the FA as well as limit the amount of exposure to FA conditions and hence the potential for a false positive (Jessel *et al*., 2014; Rooker *et al*.).

Patterns of Responding in Functional Analyses

When problem behavior is maintained by automatic reinforcement, it may occur at a greater level in the alone/ignore condition relative to the control or may occur during all FA conditions. When problem behavior is maintained by social positive reinforcement, it occurs at a greater level in the attention and/or the tangible condition relative to the control condition. Positive reinforcement involves the presentation of attention or tangible items contingent on problem behavior, and behavior increases or becomes more likely as a result. When problem behavior is maintained by social negative reinforcement, it occurs at a greater level in the demand condition relative to the control condition. Negative reinforcement involves the removal of aversive events (usually a task demand is removed), and problem behavior increases or becomes more likely as a result.

Differentiated FA outcomes, as noted earlier, often occur. For example, Hanley *et al*. (2003) reported differentiated FA outcomes in 95.9% (514 of 536) of FAs. However, this study reflects the rates of differentiated outcomes among published studies, which may exclude ambiguous FA outcomes due to publication bias. Hagopian, Rooker, Jessel, and DeLeon (2013) reviewed data from FA outcomes for individuals hospitalized for the treatment of problem behavior and found that a clear FA was identified in 93.3% of the cases for which the FA, if necessary, was modified up to two times. Similarly, Vollmer, Marcus, Ringdahl, and Roane (1995) conducted FAs on the problem behavior of 20 individuals where the authors progressed from brief to extended analysis and found that following an initial multi-element FA, FA results were differentiated in 10 of 20 cases (50%). Following more extended analysis, FA results remained undifferentiated for 3 (15%) of 20 cases. In these three cases, it is likely that the FA results were inconclusive because a necessary motivating operation (MO) was not present, a consequence for problem behavior was not present, or some procedural factor obscured the result. Finally, Kurtz *et al*. (2003) conducted FAs with 24 individuals who engaged in multiple forms of problem behavior and found inconclusive FA results in 3 of 24 (12.5%) cases. Although the review and experimental studies suggest a large range of inconclusive findings (4.1–15%), the difference in results is likely due to differences in FA procedures, methodology, or varying definitions of an unclear outcome across the studies.

Ambiguity in Functional Analyses

When ambiguous FA outcomes (sometimes also called inconclusive outcomes) occur, they can take a variety of patterns. Examples include the following: (i) little to no responding occurs across conditions; (ii) an undifferentiated pattern; and (iii) responding is differentially higher in the control condition. These different patterns may be a function of similar or different variables, but all three cases necessitate additional analysis. Figure 1 suggests how to proceed in these cases.

Little to No Responding Occurs Across Conditions—When little to no responding occurs across FA conditions, it is likely that the behavior is related to a biological or medical event, the problem behavior occurs infrequently outside of the FA, or relevant antecedents and consequences for problem behavior are not included in test conditions.

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Is the behavior occurring because of an ongoing medical condition?: When faced with little to no responding, a clinician should rule out whether an ongoing medical or biological event could be an occasioning problem behavior. One way to do this is to conduct a descriptive analysis to determine if the problem behavior occurs in a cyclical pattern (i.e., occurs for a period of time and then stops, or occurs only in certain stimulus contexts). For example, Taylor, Rush, Hetrick, and Sandman (1993) found that different rates of SIB occurred during different phases of a participant's menstrual cycle. Therefore, conducting an FA during a particular phase when SIB was least likely to occur would be likely to produce a low level of responding and, thus, an ambiguous outcome.

Similarly, but in the context of an FA, O'Reilly (1997) conducted a study with one individual who engaged in SIB only during periods of otitis media. During the initial FA, when the child did not have the infection, there was no problem behavior. Based on information developed during a structured interview with a parent and medical professional, the experimenter conducted the FA when the otitis media was occurring and found that problem behavior occurred whenever noise (a radio) was present. The conclusion was that SIB was maintained by automatic negative reinforcement (i.e., pain attenuation), as SIB decreased the aversiveness of the noise, and the noise was aversive only when the otitis media was occurring,

In addition, medication may also affect response rate, although the data are notably less clear. For example, Garcia and Smith (1999) examined the effects of Naltrexone on SIB during an FA. The authors found that Naltrexone reduced responding in FA conditions for one individual with SIB maintained by automatic reinforcement. Similarly, Hagopian and Caruso-Anderson (2010) noted that selective serotonin reuptake inhibitors may decrease stereotypy. It is possible that similar medications could decrease problem behavior to the point of producing little to no responding across conditions. These findings underscore the importance of proper communication between medical and behavioral staff and indicate that additional research is needed on the effects of pharmacological treatments on FA outcomes.

Does the behavior occur at a high level outside of the functional analysis conditions?: When little to no responding occurs in an FA, the clinician should ask if the behavior occurs at a high frequency outside of the FA conditions. If the behavior occurs at a low frequency outside of FA sessions, it is possible that the relevant antecedents and consequent events are present but that the behavior does not occur frequently enough to come in contact with these consequent events during time-limited FA sessions. That is, when problem behavior occurs at a low frequency throughout the day, it may be particularly difficult to assess because problem behavior may not occur during the relatively short FA sessions (5 to 15 min) that are typically used. Several studies have assessed procedures to determine the function of problem behavior when it did not occur in the FA and occurred infrequently outside of the FA. For example, Tarbox, Wallace, Tarbox, Landaburu, and Williams (2004) conducted a standard FA and an FA that was initiated contingent on a burst of responding with three individuals. The authors found that although the function of low-rate behavior could not be determined in the standard FA, the contingent FA was effective at determining the function of problem behavior in all three cases. When standard 10 min FA sessions failed to capture responding for one participant, Kahng, Abt, and Schonbachler (2001) conducted an FA throughout the day that resulted in a clear function for aggression.

If the behavior occurs at a low frequency during the FA but at a high frequency outside of FA sessions, it is likely that the relevant antecedent or consequent events are not present in the FA (e.g., Bowman, Fisher, Thompson, & Piazza, 1997; Carr, Yarbrough, & Langdon, 1997; DeLeon, Kahng, Rodriguez-Catter, Sviensdottir, & Sadler, 2003; Hagopian, Bruzek, Bowman, & Jennett, 2007; Hausman, Kahng, Farrell, & Mongeon, 2009). In this case, clinicians should assess idiosyncratic variables (see section on Assessing Idiosyncratic Variables). For example, Hagopian *et al*. conducted an FA where the results for three individuals were inconclusive because of low or uncharacteristically low rates of problem behavior. Based on therapist observations of problem behavior outside of the sessions, the researchers modified their FA to include conditions that interrupted free operant behavior. In these conditions, the experimenter delivered either ‘do’ requests (i.e., requests for the participant to engage in an activity that was incompatible with the ongoing activity) or ‘don’t’ requests (i.e., requests that the individual stop engaging in the ongoing activity). The occurrence of problem behavior in either of these conditions resulted in removal of the request. Following these modifications, the researchers observed differentially high levels of problem behavior in the interruption conditions. Similarly Fahmie, Iwata, Harper, and Querim (2013) found that responding occurred more often in a divided attention condition than in the FA attention condition. In the divided attention condition, two therapists were present and conversing with each other. When problem behavior occurred, attention was redirected to the patient. This procedure may be particularly useful when clinicians believe the patient cannot discriminate the contingency in the attention condition. In the divided attention condition, the therapist conversing with another individual may signal the availability of attention to the patient.

Undifferentiated Pattern—In some cases, an undifferentiated pattern may suggest problem behavior is maintained by automatic reinforcement. In these cases, responding is typically consistent across FA conditions and maintains in the absence of social contingencies. However, other types of undifferentiated patterns may suggest behavior is not maintained by automatic reinforcement, but rather that the results are ambiguous. This may occur when behavior occurs inconsistently over time (sometimes occurring, sometimes not occurring) across either particular conditions or all conditions. When an undifferentiated pattern of responding is observed across FA conditions, it is likely that there is a lack of stimulus control between FA conditions, or the relevant antecedents and consequences for problem behavior are not included in test conditions. Decisions for how to proceed in this case can be seen in the middle panel of Figure 1.

Do functional analysis design and procedures follow the clinical best practice?: The first question a clinician should ask when faced with an undifferentiated but not automatic pattern of responding is whether the current FA follows the best clinical practice. Lack of adherence to this standard may result in undifferentiated responding due to the effects outlined in Table 2.

If the FA design does follow the clinical best practice and the outcome is still undifferentiated, a lack of stimulus control may remain. In addition to including discriminative stimuli in each condition, another way to enhance discrimination in an FA is to limit the number of conditions included in the multi-element design or to use a different experimental design, such as a reversal or a pairwise (test vs. control) design. In a reversal design, several sessions of a single condition are conducted consecutively until stability is achieved. This design minimizes potential interaction effects that may occur across conditions because they are no longer alternated rapidly. For example, Vollmer, Iwata, Duncan, and Lerman (1993) obtained ambiguous FA results when an FA was conducted in a multi-element fashion but were able to determine a maintaining variable for three of four individuals by running the same conditions in a reversal design.

A pairwise design contains features of multi-element and reversal designs. Each test condition is evaluated in a different phase using a reversal design. Within each phase, the test condition is alternated with a generic control condition using a multi-element design. Iwata, Duncan, Zarcone, Lerman, and Shore (1994) evaluated a pairwise FA and found that it yielded clearer outcomes than the multi-element FA in two of five cases and was similar to the multi-element in three of five cases. In one of the similar cases, neither the pairwise nor the multi-element FA produced a clear FA outcome. In total, this procedure was effective in clarifying ambiguous FA outcomes in two of three cases. The pairwise FA has been conducted following an initial multi-element FA to clarify FA outcomes in several other studies (e.g., Piazza, Fisher, *et al*., 1997; Piazza, Hanley, *et al*., 1997).

If the outcome remains undifferentiated following modifications to the experimental design, it is likely that the idiosyncratic antecedent or consequent events are affecting responding in the FA. In this case, clinicians should assess idiosyncratic variables (see section on Assessing Idiosyncratic Variables).

Responding in the Control Condition—Results of an FA may be ambiguous because responding occurs at high levels in the control condition, which may occur for two reasons. First, behavior could be maintained by social avoidance; second, idiosyncratic antecedents may be present in the control condition. Decisions for how to proceed in this case can be seen in the right panel of Figure 1.

Does behavior occur in the demand condition?: When responding occurs in the control condition, the first question a clinician should ask is whether responding also occurs in the demand condition. If so, it is possible that behavior is maintained by social avoidance. For example, Frea and Hughes (1997) compared an attention condition, a demand condition, and a social avoidance condition for two individuals. In the social avoidance condition, the therapist continuously conversed with the participant, and problem behavior resulted in termination of the conversation. For one of the two subjects in the study, problem behavior was maintained by access to attention; for the other, problem behavior was maintained by escape from the conversation. Similarly, Taylor, Ekdahl, Romanczyk, and Miller (1994) exposed four children to both task stimuli and social stimuli and found that two students engaged in problem behavior in the presence of task stimuli and two students engaged in problem behavior in the presence of social stimuli. Similar results were also found by

Hagopian, Wilson, and Wilder (2001) and Harper, Iwata, and Camp (2013) for one and three individuals, respectively.

If behavior does not occur in the demand condition, it is likely that some idiosyncratic variable is affecting responding in the control condition. In this case, clinicians should assess idiosyncratic variables (see section on Assessing Idiosyncratic Variables). For example, Van Camp *et al*. (2000) observed differentially higher levels of problem behavior in the FA control condition. The authors conducted additional analyses of various antecedents that might have occasioned problem behavior in the control condition. For one individual, this antecedent was a vibrating toy ball (specifically the vibration), and for the other, this was a specific toy paired with attention.

Assessing Idiosyncratic Variables—As noted earlier, when idiosyncratic stimuli affect responding in an FA, there are a number of ways to identify those stimuli. These methods include anecdotal report, IA, informal observation, DA within an FA, and DA outside of the FA. Schlichenmeyer *et al*. (2013) recently reviewed all published reports of idiosyncratic variables affecting FA outcomes in the preceding 10 years. The authors found that all of these methods for identifying idiosyncratic stimuli were effective, but they were used to different extents. Informal observation was used the most often (29.3% of studies), followed by anecdotal report (26.8% of studies), DA (19.5% of studies), observing behavior in experimental contexts (17.1% of studies), and finally IA (7.3% of studies). However, it is likely that the use of a more complex IA that includes a greater range of variables (e.g., Roscoe, Schlichenmeyer, & Dube, in press) or includes open-ended questions might be more effective and more efficient than probing multiple antecedents and consequences within the FA for identification of idiosyncratic variables (Hagopian, Dozier, Rooker, & Jones, 2013). Additionally, future research should examine what method is best for examining idiosyncratic variables.

Methods of Reinterpreting Functional Analysis Data—In addition to modifying the FA design or the FA conditions, it is also possible that additional post-hoc analyses may clarify FA results (Table 2). For example, after conducting an FA on combined response topographies, Derby *et al*. (1994) graphed each topography separately. When response topographies were graphed separately, clearer outcomes were obtained, and functions were identified that were masked when FA data were depicted in the aggregate. Therefore, graphing each topography separately may aid in identification of a functional relation.

Additionally, assessing FA data on a within-session basis may clarify an FA outcome. Fisher, Piazza, and Chiang (1996) noted that reinforcer durations in the attention (3–5 s) and escape (30 s) conditions differed and that this difference might account for increased responding in the attention condition, showing a false-positive effect. These authors indicated that it is important to examine when responding is occurring. That is, responding that is occurring when the MO is present (e.g., demands are presented) is related to that experimental condition; however, responding that is occurring in the absence of the MO (e.g., in the escape interval) may not be related to that experimental condition. Roane *et al*. (1999) graphed the occurrence of problem behavior when an MO was both present and absent. For two of the five individuals in the study, within-session analysis identified the same reinforcer for problem behavior as between-session analysis did but in a shorter amount of time. The authors found that when behavior was maintained by automatic reinforcement or by multiple reinforcers, within-session analysis of responding was a more efficient strategy than conducting an extended alone to determine the variables maintaining problem behavior. Responding in the absence of the relevant MO is nonfunctional. Therefore, discounting data occurring outside the MO (i.e., when the putative reinforcer is present) may lead to more interpretable results.

Additionally, within-session analysis may prove useful because it provides a more molecular view of patterns of responding that occur during a transitional state. That is, the rapid alternation of conditions in a multi-element design may obscure clear FA results on a between-session basis, but the additional information provided by within-session analysis may clarify these FAs. For example, if responding is only occurring in the initial minute of each session following the demand condition, within-session analysis might indicate carryover from the previous session.

Finally, some researchers have conducted additional analyses to determine statistical methods for determining FA outcomes. Hagopian *et al*. (1997) and Roane *et al*. (2013) both used similar quantitative procedures to interpret FA outcomes. These procedures allow for standard criteria for interpreting results that may reduce ambiguity by setting a standard for particular outcomes.

When interpreting FA data, it is important to compare each test condition to the control condition rather than each test condition to each other. Because a number of features (including rate, quality, and magnitude of reinforcement) are not constant across test conditions, comparison of rates of responding between test conditions is invalid.

Functional Analysis Modifications for High-Risk Behavior

The procedures described earlier are referred to as the ABC FA (Hanley, Iwata, & Smith, 2002), because both antecedents are provided and there are programmed consequences provided following problem behavior. However, a lack of staff, resources, and/or a desire to limit the amount of problem behavior or contact with consequences that occurs because of potential for patient or staff injury may make an ABC FA difficult or undesirable to conduct. To address some of these concerns, several different types of FAs have been developed, each with varying levels of effectiveness. These include the following: (i) providing only the MO, but not the consequence for problem behavior (AB FA); (ii) reducing the number of FA sessions (brief FA); (iii) using protective equipment during the FA; (iv) conducting the FA on precursors of problem behavior (precursor FA); (v) measuring the latency to problem behavior (latency FA); (vi) conducting the FA in a trial-based format; and (vii) screening for automatic reinforcement prior to the FA.

The AB FA was first described by Carr and Durand (1985). In this FA, the MO to engage in problem behavior is present (similar to the ABC FA); however, there are no programmed consequences for problem behavior. This AB FA may be a desirable alternative when clinicians want to limit exposure of problem behavior to contingencies that are designed to increase or maintain that behavior. However, direct comparisons of the effectiveness of

ABC and AB FAs have demonstrated that the AB FA fails to identify the function of problem behavior in some cases (Potoczak, Carr, & Michael, 2007). In a more recent study, Call, Zangrillo, Delfs, and Findley (2013) found that the when comparing the results of AB and ABC FAs using a brief procedure (the brief FA described later), the same function was determined in 14 of 15 cases. These results seem much more promising; however, the results in Call *et al*. were not compared against the results of the standard ABC FA as in the Potoczak *et al*. study. Therefore, it is unclear how effective the AB FA is in a large number of cases. The failure of the AB FA may be due to a lack of stimulus control between conditions. For example, Fischer *et al*. (1997) evaluated an AB FA attention condition that included no antecedent attention and no programmed consequences (i.e., a condition identical to the alone condition of a typical FA). For five individuals with attention-maintained SIB, this condition produced marginal increases in SIB relative to the control, indicating that an AB FA for individuals with attention-maintained problem behavior would result in false negatives in 86.1% of these cases.

A more thoroughly studied procedure is the brief FA (Derby *et al*., 1992; Kahng & Iwata, 1999). The procedures of the brief FA are generally identical to those of the ABC FA; however, one to two sessions of each condition are conducted. In a typical FA, sessions continue until differentiation is observed (usually a minimum of three sessions with differentiation between test and control conditions, but see Hagopian *et al*., 1997, for the use of structured criteria for interpreting FA outcomes). Large-scale analyses of the brief FA find that brief FAs identify a behavioral function that corresponds to a full-length FA in approximately two-thirds of cases (Kahng & Iwata, 1999). Similar to the AB FA, the failure of this procedure to identify a behavioral function is likely due to insufficient contact with the contingencies leading a lack of stimulus control.

The inclusion of protective equipment has also been assessed during the FA when severe problem behavior has the potential for immediate harm to the patient or clinicians. Unfortunately, the continuous application of protective equipment may result in undifferentiated responding, limiting identification of a maintaining variable (Borrero, Vollmer, Wright, Lerman, & Kelley, 2002; Le & Smith, 2002). For example, Borrero *et al*. and Le and Smith were unable to determine the function of SIB for participants who were wearing protective equipment during an FA. When they subsequently conducted an FA without protective equipment, behavioral functions were identified for each participant. However, in other cases, the use of blocking and protective equipment may reveal masked functions (Contrucci-Kuhn & Triggs, 2009; McKerchar, Kahng, Casioppo, & Wilson, 2001). For example, Kuhn, DeLeon, and Fisher (1999) conducted an initial FA that indicated an individual’s SIB was maintained by escape from demands and automatic reinforcement. The authors then compared sensory extinction (i.e., continuous protective equipment application), escape extinction, and the combination of these treatments. The authors found sensory extinction completely suppressed SIB but that escape extinction had no effect on responding. These results suggested that SIB was maintained solely by automatic reinforcement and that SIB was occurring in the demand condition because of a relatively impoverished environment. A noteworthy feature of this study was that the continuous application of protective equipment clarified the FA outcome. However, given these mixed outcomes regarding the use of protective equipment, one should proceed with caution when considering their use during FAs.

Another procedure used to determine the function of severe problem behavior is to conduct the FA on precursors of the problem behavior. In this procedure, a reliable predictor of problem behavior is identified through conditional probability analyses obtained through descriptive assessments. These analyses allow one to identify behaviors that reliably precede problem behavior (the precursor; e.g., crying, whining, and vocal protests). The FA is then conducted on the identified precursor(s). Several studies using this procedure have identified the same function in the FA of the precursor and of the target behavior (Borrero & Borrero, 2008; Fritz, Iwata, Hammond, & Bloom, 2013; Smith & Churchill, 2002). These results suggest that precursor FAs may be equally likely as FAs of problem behavior to produce clear or ambiguous outcomes.

A recent variation of FA methodology is the use latency as the index of problem behavior. In this procedure, the ABC model of FA is employed. However, rather than having a fixed session time, sessions are terminated when problem behavior occurs or at some fixed point if problem behavior never occurs (Neidert, Iwata, Dempsey, & Thomason-Sassi, 2013). Thomason-Sassi, Iwata, Neidert, and Roscoe (2011) compared outcomes from the latency FA with an ABC FA and found that the same function was identified in 90% of cases. Thus, similar to the precursor FA, conducting a latency-based FA seems equally likely as a standard FA to produce clear or ambiguous FA outcomes.

Another procedure that may be useful when resources to conduct an FA are scarce or to limit the occurrence of problem behavior is the trial-based FA (Bloom, Iwata, Fritz, Roscoe, & Carreau, 2011; Bloom, Lambert, Dayton, & Samaha, 2013; Kodak, Fisher, Paden, & Dickes, 2013; Sigafoos & Saggers, 1995). In this procedure, the presentation of FA conditions occurs during several brief 2-min trials. This allows for a large number of brief presentations of the MO and consequence in the classroom. No studies with a large number of cases of trial-based FAs compared with the ABC FA have been conducted. However, results are promising in the limited number of studies that have used this procedure.

CONCLUSIONS

Ambiguity in functional assessment results may come from a number of sources. For IAs, the largest sources of ambiguity are poor inter-rater agreement and reliance on recall of events to determine the contexts in which behavior has occurred. For DAs, the largest sources of ambiguity are the correlational nature of DAs, reactivity, lack of an adequate sample, and difficulty in identifying appropriate data collection targets. For FAs, the largest sources of ambiguity come from not adhering to the best practices (Table 2), the presence of other medical or biological conditions, low rates of behavior in FA conditions, indiscriminate responding in FA conditions, responding in the control condition, or an idiosyncratic variable (Figure 1).

Although we have summarized IAs, DAs, and FAs separately, in reality, these procedures should be used in conjunction. The effectiveness of using all three procedures is evidenced in assessing idiosyncratic variables; in including all three types of assessments, valuable information can be garnered in each stage of analysis when moving from an IA to DA to FA.

The assessments and their weaknesses summarized here present the current state of research on functional assessment; however, that is not to imply that this model cannot be further refined to make procedures more effective and efficient. Indeed, several questions about assessment procedures remain. For example, although the IAs have not been found to be particularly accurate at identifying the function of problem behavior assessed in a typical FA, this assessment may prove useful in identifying idiosyncratic variables (Schlichenmeyer *et al*., 2013). Therefore, further research on IA and its utility in identifying idiosyncratic variables is warranted (for a recent application of IA toward this goal, see Roscoe *et al*., in press).

Additionally, we have recommended only assessing behaviors that are in the same response class to limit the potential for false-positive and false-negative outcomes. However, no research has successfully demonstrated a method for determining what behaviors are in the same or different classes. Assessing multiple behaviors is sometimes more efficient (Derby *et al*., 1994) but also may obscure outcomes (Asmus *et al*., 2004) or, worse, teach new functions for problem behavior

(Jessel *et al*., 2014). Therefore, additional research is needed in identifying behaviors that are in the same class prior to conducting an FA, and this might be accomplished through IA or DA.

Similarly, the role of breaks between FA sessions should be assessed. We have suggested that it is best to wait until problem behavior subsides until the next FA condition begins; however, we do not provide recommendations for what should be happening during this inter-session time. Responding in inter-session time may become problematic if (i) responding occasioned in one condition continues into the next irrespective of the change in contingencies, (ii) conditions that occasion behavior are present in the period between FA conditions, or (iii) the individuals recognize the pattern of session–break–session as a multiple schedule and engage in behavior to avoid the next session. Therefore, it seems appropriate to assess the best inter-session procedures to reduce ambiguity and promote accurate responding in subsequent test conditions.

One goal of research on functional assessment of problem behavior should be to decrease sources of ambiguity and develop the most effective and efficient tests to determine the ‘causes’ of behavior. Therefore, the research summarized here can be viewed as increasing the magnification of our microscope to better understand the underlying functions of problem behavior, whether those functions are generic or idiosyncratic. Accomplishing this, the best methods can be selected for use by the clinician.

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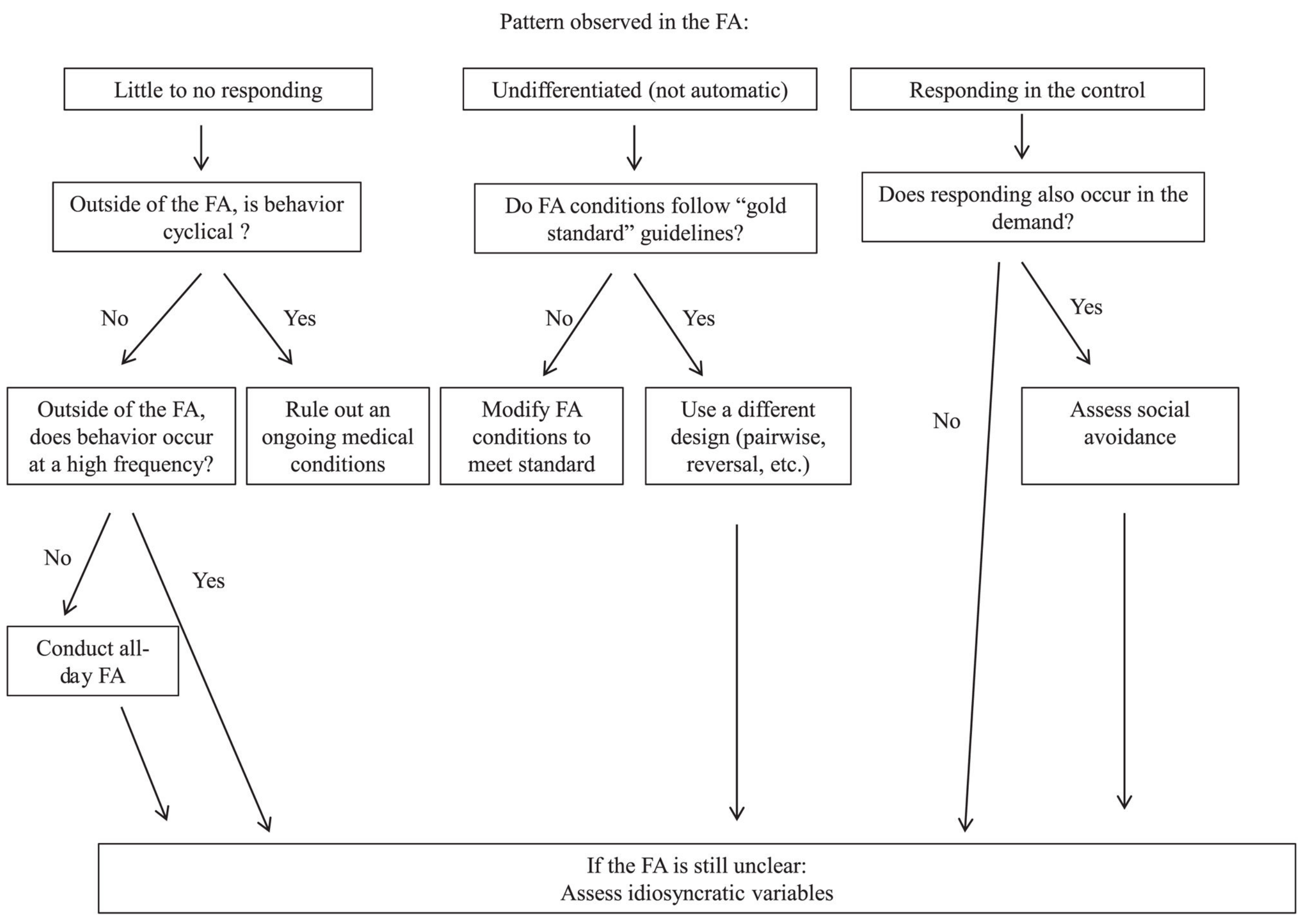

Figure 1.

Flow chart of ambiguous functional analysis (FA) outcomes and strategies.

Table 1

Summary of sources of ambiguity in descriptive assessment.

Source of ambiguity in descriptive assessment	Potential difficulty	Strategies to reduce ambiguity
Correlational nature of descriptive assessment	Conclusions cannot be drawn as to function of behavior or contingencies in place	Cannot eliminate source Conduct additional assessments to help clarify outcomes
Reactivity	Assessment outcomes will be based on client–caregiver interactions that are not typical	Contrive observation situations Use unobtrusive measures for data collection Collect data using response products Provide limited information to clients regarding purpose of observation Conduct multiple assessments and compare outcomes Collect large sample of responses over multiple observations
Inadequate sample of data	Assessment outcomes will be based on naturalistic observations that are not typical	Include minimum duration for data collection Include minimum number of responses and events to be observed
Inadequate data collection	May not have adequate information to conduct thorough analyses of client–caregiver interactions	Client target behavior (all topographies scored separately) Client appropriate behavior (requests for potential reinforcers and compliance with instructions) Potential antecedents Potential consequences/reinforcers
Lack of data analysis	May not be able to identify potential contingencies in data	Conditional probability analyses Unconditional probability Evaluate various parameters of reinforcement Lag sequential analyses

Table 2

Summary of guidelines for best practice functional analysis (FA).

Recommendation	Reason	Effect	Evidence
Prior to FA implementation			
Rule out biological/medical events	May negate assessment and treatment	• Ensures results are not related to a biological process	Kennedy and Meyer (1996) O'Reilly (1995)
Limit access to reinforcers outside of the FA	May abolish responding	• Increase responding • Limit false negative	McGinnis et al. (2010) O'Reilly et al. (2009)
Limit the number of target behaviors	Responses that contact reinforcement may abolish motivation for other responses	• Increase responding • Limit false positive • Limit false negative	Asmus et al. (2003) Jessel et al. (2014) Beavers and Iwata (2011)
Prescreen for automatic reinforcement (when suspected)	May reduce ambiguity and make FA more efficient	• Determines if behavior is maintained by automatic reinforcement	Querim et al. (2013)
During FA implementation			
Use a fixed sequence	Limits potential carryover effects by providing control condition immediately following test	• Enhance discrimination	Hammond et al. (2013) Iwata, Dorsey, et al. (1982/1994)
Use different S^Ds in each FA condition	Limits potential carryover effects by signaling the current condition	• Enhance discrimination	Conners et al. (2000)
Allow problem behavior to subside before beginning the next session	Limits potential carryover effects	• Enhance discrimination	McGonigle et al. (1987)
Use low preferred toys or no toys in the attention condition	Toys may compete with attention	• Increase responding • Limit false negative	Roscoe, Carreau, MacDonald, and Pence (2008)
Use attention form typically used	Ensures attention is relevant	• Increase responding • Limit false negative	Kodak, Northup, and Kelley (2007) Piazza et al. (1999)
Conduct demand assessment to identify tasks to include in the demand condition	Ensures demands are aversive	• Increase responding • Limit false negative	Call, Pabico, and Lomas (2009) Roscoe, Rooker, Pence, and Longworth (2009)
Include tasks typically used	Ensures demands are aversive	• Increase responding • Limit false negative	Asmus et al. (1999) Iwata, Pace, Kalsher, Cowdery, and Cataldo (1990) McCord, Iwata, Galensky, Ellingson, and Thomson (2001) McComas, Hoch, Paone, and El-Roy (2000), Smith, Iwata, Goh, and Shore (1995)
Use descriptive assessment to determine items in tangible condition	Ensure that tangible item is similar to delivery outside of the FA	• Increase responding • Limit false negative or positive	Rooker et al. (2011)
Use people as therapists who usually provide the consequence	Ensures that appropriate S^Ds and reinforcers are present	• Increase responding • Limit false negative	English and Anderson (2004) McAdam, DiCesare, Murphy, and Marshall (2004)

Recommendation	Reason	Effect	Evidence
			Thomason-Sassi, Iwata, and Fritz (2013)
Post-session			
Graph all target behavior separately	Ensures responding is related to the relevant stimulus conditions	• Differentiation may be easier to observe	Derby et al. (1994)
Designate appropriate control conditions	Makes analysis easier	• Differentiation may be easier to observe	Fischer, Iwata, and Worsdell (1997) Kahng and Iwata (1998)
Graph responding occurring when the motivational operation is present	Ensures responding is related to the relevant motivation	• Differentiation may be easier to observe	Roane, Lerman, Kelley, and Van Camp (1999)
Use statistical guidelines for visual analysis	Ensures consistency in FA outcomes	• Differentiation may be easier to observe	Hagopian et al. (1997) Roane, Fisher, Kelley, and Mevers (2013)