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INITIAL FUNCTIONAL ANALYSIS OUTCOMES AND MODIFICATIONS IN PURSUIT OF DIFFERENTIATION: A SUMMARY OF 176 INPATIENT CASES

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Abstract

The functional analysis (FA) described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) delineated not only a set of specific procedures, but also a model that involves the use of analogue conditions wherein antecedent and consequent variables are systematically manipulated. This consecutive case-series analysis describes FAs of 176 individuals with intellectual disabilities who had been admitted to an inpatient unit for severe problem behavior. Following an initial standardized FA, additional modifications were performed in pursuit of differentiation. Ultimately, a function was identified in 86.9% of the 176 cases and in 93.3% of the 161 cases for which the FA, if necessary, was modified up to 2 times. All modifications were documented and classified as involving changes to antecedents, consequences, or design (or some combination of these). Outcomes for each type of modification are reported. The results support the utility of ongoing hypothesis testing through individualized modifications to FA procedures, and provide information regarding how each type of modification affected results.

Keywords

functional analysis; undifferentiated; intellectual disabilities; self-injury; aggression

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) described a set of procedures for the functional analysis (FA) of self-injury in children and adolescents with intellectual and developmental disabilities (IDD). Review of the literature over the past three decades reveals that the contribution of this paper has extended far beyond the specific procedures it described. That is, it provided a model for the analysis of problem behavior that was experimentally rigorous and designed to understand behavior within the framework of the three-term contingency. As has been noted elsewhere (Mace, 1994), this paper played an important role in helping to usher in a shift from a technological to an analytical approach consistent with the basic tenets of applied behavior analysis (Baer, Wolf, & Risley, 1968). This FA model has been termed the *ABC model* by Hanley, Iwata, and McCord (2003) because it involves manipulation of both antecedent and consequent variables. The core elements of the ABC model include the use of test and control conditions, each of which

includes specific establishing operations (EOs), discriminative stimuli (S^D s), and programmed contingencies, designed to serve as analogues to situations in the natural environment. The use of analogue sessions conducted within the structure of an experimental design also permits interpretation of results through comparative analysis of the relative rates of responding across test and control conditions.

The ABC model is the most widely used model in the published literature, and its efficacy in identifying the function of behavior across a wide range of problem behaviors, ages, and settings is well established (Hanley et al., 2003). Numerous studies with small numbers of subjects have described FA procedures based on the ABC model, including studies that report using procedures very similar to those described by Iwata et al. (1982/1994), as well as a number of variations to those procedures (for reviews, see Hanley et al., 2003; Schlichenmeyer, Roscoe, Rooker, Wheeler, & Dube, 2013). For example, Schlichenmeyer et al. (2013) identified 42 articles published from 2001 to 2010 that described over 30 modifications to the FA procedures described by Iwata et al. Many of these studies described hypothesis-driven modifications based on information obtained from various sources, including within-session data patterns, parental reports, questionnaires, and anecdotal observations.

Modifications to FA procedures often can be classified broadly as involving changes to antecedent conditions (i.e., variables that reliably precede target behaviors), consequent events (i.e., variables that follow the occurrence of target behaviors), the design of the analysis, or some combination of these. For example, following inconclusive standard FAs, Mace, Page, Ivancic, and O'Brien (1986) added a divided attention condition to the FA of three individuals when initial FA results were inconclusive. Although the consequence remained the same as in the standard attention condition (e.g., brief statement of concern), the divided attention condition included an antecedent manipulation (i.e., a confederate conversing with the therapist). Other antecedent modifications include the use of more difficult tasks in the demand condition (Boelter et al., 2007) and supplemental condition-correlated stimuli (Conners et al., 2000). By contrast, consequent-event modifications have included provision of different forms of attention in addition to standard statements of concern (e.g., Kodak, Northup, & Kelley, 2007; Richman & Hagopian, 1999), as well as progressively placing behaviors on extinction to identify members of the same response class (Harding et al., 2001).

Combined antecedent- and consequent-event modifications involve the alteration of both antecedent and consequent events within the FA. The term *idiosyncratic function* has been used often to refer to situations in which problem behavior is maintained by variables other than those examined in the standard test conditions (i.e., attention, escape from demands, tangible items, automatic reinforcement). A large number of idiosyncratic conditions have been identified in the literature (see Hanley et al., 2003, and Schlichenmeyer et al., 2013, for more detailed reviews). Examples of new conditions that involved both antecedent and consequent manipulations included a rituals condition in which the EO for rituals was present and problem behavior resulted in access to rituals (Hausman, Kahng, Farrell, & Mongeon, 2009), and escape from interaction condition in which problem behavior resulted in termination of interaction (Hagopian, Wilson, & Wilder, 2001).

Design modifications do not involve changing programmed antecedents or consequences within conditions but involve some other procedural change, such as the duration of the sessions or the experimental design of the analysis. For example, Vollmer, Iwata, Duncan, and Lerman (1993) identified a maintaining variable for three of four individuals by conducting the conditions in a reversal design when a multielement design failed to produce differentiated FA outcomes. Similarly, Iwata, Duncan, Zarcone, Lerman, and Shore (1994) compared a combination of reversal (comparison of test and control) and multielement designs to a pairwise comparison of conditions. The pairwise design involved a series of multielement comparisons of two conditions (test and control). This procedure was effective in clarifying ambiguous FA outcomes in two of three cases. Another prominent design manipulation has been the use of an extended alone condition in which several alone sessions are conducted sequentially (Vollmer, Marcus, Ringdahl, & Roane, 1995). The purpose of this condition is to examine whether responding persists in the absence of social contingencies, thus providing evidence that the behavior is maintained by automatic reinforcement.

Demonstrations of the utility of the ABC model also can be gleaned by summarizing FA outcomes obtained with a large number of participants and from studies that reviewed published FA data sets. In a study of 152 individuals with IDD and self-injury, Iwata, Pace, et al. (1994) identified at least one function for SIB in 94.6% of individuals. Kurtz et al. (2003) identified a function in 87.5% of FAs in a sample of 30 young children with severe problem behavior (e.g., self-injury or aggression). In a more recent study of 69 students (and 90 FAs) in which FAs were conducted in public school settings using the ABC model, Mueller, Nkosi, and Hine (2011) identified at least one function in 90% of cases. In a review of 277 studies that reported FA results for 536 individuals (in which the ABC model was used in 87% of cases), a function was identified in 95.9% of cases (Hanley et al., 2003). Collectively, these findings provide compelling evidence that FA using the ABC model effectively identified the function of behavior in the majority of cases (range, 87.5% to 94.6%).

It should be pointed out that these large-scale study outcomes of FAs often included variations to the specific procedures described by Iwata et al. (1982/1994). For example, in their analysis of FA outcomes obtained with 152 individuals, Iwata, Pace, et al. (1994) described a highly individualized hypothesis-testing approach that included the core elements of the ABC model as defined above (i.e., analogue conditions with specific EOs, S^Ds, and consequences). Across the sample of 152 cases, they reported using three to eight test and control conditions that contained individualized antecedent conditions, S^Ds, and consequences. In addition, they reported using three types of control conditions (fixed time, differential reinforcement of other behavior [DRO], or momentary DRO), two methods of sequencing sessions (randomized without replacement, or fixed order of sessions), and three types of designs (multielement, pairwise, and reversal). Kurtz et al. (2003) and Mueller et al. (2011) also reported individualized variations to FA procedures, although all FAs could be characterized as being consistent with the ABC model. In the Hanley et al. (2003) review of FAs described in 277 published studies, they noted that 241 studies used the ABC model but reported numerous procedural variations with regard to the type and number of test conditions, length of analysis, and the design across studies.

In summary, these four large-scale studies described FA outcomes obtained using what has been characterized as the ABC model of FA; however, all reported a large number of individualized modifications to the specific procedures described by Iwata et al. (1982/1994). One limitation of these studies is that they reported only the final FA outcomes obtained across participants, thus providing little information regarding how and when the procedural modifications were implemented, and what impact they had on the results. Therefore, it is not possible to determine which modifications were implemented at the outset of FA, which modifications were made after undifferentiated responding was observed, and which modifications were helpful in yielding differentiated results. Although individual studies have illustrated the hypothesis-testing process via modifications to standard FA procedures, a large-scale study describing these modifications and the outcomes obtained after initial FA results are undifferentiated has not been conducted. Thus, the purpose of the current study was to retrospectively describe FA procedures and outcomes obtained with a sample of 176 individuals with IDD. Participants were initially exposed to FA procedures similar to those described by Iwata et al., and then the FA was modified in pursuit of differentiation if needed.

METHOD

Participants and Settings

Participants consisted of 176 individuals (ranging in age from 3 to 39 years old) who had been diagnosed with IDD and had been admitted to an inpatient program for the treatment of severe problem behavior (see Table 1 for participant demographic information). A consecutive case-series design was used to minimize any potential selection bias favoring particular outcomes. That is, all cases for whom FAs were conducted were included if (a) the FA data included at least three series (a series defined as a full sequence of all conditions) if a function was determined, at least four series if no responding occurred across all sessions, or at least six series if no function was determined (to ensure that a reasonable effort to determine the function was attempted); and (b) sufficient interobserver agreement data were available. A faculty-level behavior analyst with extensive experience in conducting FAs supervised all sessions, which were conducted by a trained clinical staff member (henceforth referred to as a therapist). Although potentially dangerous responses were allowed to occur in FA sessions, risks were mitigated through the use of numerous safety measures including oversight and direct care from medical staff, criteria for response blocking or session termination, and the use of protective equipment.

Response Definitions

The topographical features of problem behavior were specific to the participants and were operationally defined on an individual basis. However, the most common forms of problem behavior included self-injury, aggression, and disruption. *Self-injury* (SIB) was defined as behavior that produced or had the potential to produce injury to oneself and included responses such as hitting parts of one's own body with an open hand or closed fist, head banging, self-biting, and self-scratching. *Aggression* was defined as behavior that produced or had the potential to produce injury to others and included responses such as hitting other people with an open hand or closed fist, scratching, kicking, pulling hair, and throwing

objects at other people. *Disruption* was defined as behavior that produced or had the potential to cause damage to property or disrupt the environment and included responses such as hitting objects, swiping items off a table, throwing objects, ripping things, and turning over furniture. Other forms of targeted problem behavior included elopement, pica, inappropriate social behavior, verbal aggression, cursing, food stealing, inappropriate sexual behavior, emesis, dropping, disrobing, breath holding, ritualistic behavior, and inappropriate vocalizations; each of these was individually defined for each participant. In the majority of cases (70.1%), multiple topographies of problem behavior were assessed concurrently within the same FA. That is, any targeted problem behavior that occurred (e.g., aggression, SIB, and disruption) resulted in delivery of the programmed consequence (see Table 1).

Data Collection and Interobserver Agreement

Functional analysis sessions—Trained observers recorded the target responses on laptop computers using frequency (converted to a response rate for analysis), duration, or interval recording depending on the nature of the target behavior. To assess interobserver agreement, two observers independently and simultaneously collected data during 20% to 82% ($M = 49\%$) of the total sessions conducted for each participant. Agreement was assessed using either exact or proportional measures. Across participants, interobserver agreement coefficients ranged from 75% to 99% across all behaviors.

Interpretation of functional analysis results—The initial FA for each individual was analyzed by the study authors for the purpose of the current investigation. FA data were depicted graphically and interpreted by the faculty-level behavior analyst in charge of the case (each of whom had extensive experience and training in FA). For the current study, the authors interpreted the FA results using criteria based on those described by Hagopian et al. (1997). Those criteria were designed for analyses with 10 data points per condition. Thus, to allow analyses of differing lengths, we modified the procedures in a manner similar to that described by Roane, Fisher, Kelley, Mevers, and Boussein (2013; specific procedures are available from the first author). Visual analysis involved consideration of stability, trends, and magnitude of effect observed in the test conditions relative to the control condition. Interobserver agreement for interpretation of FA outcomes was obtained for 33% of graphs. Exact agreement on the identified function was obtained in 97% of analyses. When disagreements occurred between interpretation of the FA graph by the original behavior analyst who oversaw the case and the first and third authors who scored the FAs, the authors reached a consensus on the determination of the function. An initial disagreement occurred in 8% of cases.

Standardized Functional Analysis

Procedure—The standardized FA for each case was conducted with procedures similar to those described by Iwata et al. (1982/1994) and included three conditions (alone or ignore, attention, and demand) and one control condition (play). In most cases, a fourth test condition (tangible) also was included in the initial FA (although this was not classified as a modification). In the alone or ignore condition, the participant was either alone or with a therapist in a room. The room contained no toys or task materials, and no consequences were provided if the participant engaged in problem behavior. In the attention condition, the

participant and therapist were in a room with toys. If the participant engaged in problem behavior, the therapist provided brief verbal (e.g., “don’t do that”) and physical attention (e.g., touch to the shoulder). In the demand condition, the participant and therapist were in the room with task materials. The therapist presented tasks using a three-step prompting procedure (i.e., successive vocal, model, and physical prompts). If the participant engaged in the target behavior, the therapist removed all task materials for 30 s. In some cases (typically based on anecdotal observation or parent report) a tangible condition was included in the initial FA. In cases in which the tangible item was not included in the initial FA but was later added, it was considered to be additional manipulation. In the tangible condition, the participant and therapist were in a room with a highly preferred edible or leisure item (determined from a preference assessment). Typically, the participant received brief access to the item (e.g., 2 min) prior to the start of the session. At the start of the session, the therapist removed the item. Contingent on the target behavior, the therapist provided the toy for a fixed period of time (e.g., 30 s) or a small bite of an edible item. In the play condition, the participant had access to preferred materials, and the therapist interacted with the participant every 30 s, after 5 s of no problem behavior.

Classification of Modifications

For the purposes of the current study, any procedural or design variation to the standardized FA described above was characterized as a modification. Modifications to standardized FA procedures were broadly categorized as involving one or a combination of the following classes of manipulations: antecedent-event modifications (e.g., changing the type of demands used in the demand condition; Roscoe, Rooker, Pence, & Longworth, 2009); consequence-event modifications (e.g., not providing reinforcement for a particular behavior; Smith & Churchill, 2002); design modifications (e.g., using a pairwise design; Iwata, Duncan, et al., 1994); or some combination of these. It should be noted that the modifications likely exerted effects via different functional mechanisms, some of which may be difficult to determine.

Functional Analysis Modifications after an Undifferentiated, Standardized FA

If the standardized FA failed to produce a conclusive outcome (i.e., results were undifferentiated using the interpretation procedures described above), initial modifications were made for the purpose of identifying at least one function (the expert behavior analysts who supervised each case designed the modifications). In all cases included in the current analysis, the FA was discontinued if results remained inconclusive after the behavior analyst made two series of modifications. In general, if two manipulations of the same class were implemented at the same time, the manipulation was only counted once categorically (e.g., changing the task in the demand condition and changing the toy in the play condition at the same time was considered one antecedent manipulation). A complete list of the classes of manipulations and each specific manipulation used can be found in Appendices A and B. Broad types of modifications (antecedent, consequent, design) are summarized below and in Tables 2 and 3.

Antecedent manipulations—Antecedent manipulations were conducted in 27 cases and included (a) conducting sessions in a new location (e.g., bedroom), (b) removing protective

equipment prior to the session, and (c) changing either the demand tasks or the other stimuli presented in the other conditions. In one unique case, the therapist provided verbal rules about the in-session contingencies.

Consequent manipulations—Consequent manipulations alone were conducted in six cases and consisted of an extinction analysis designed to determine the presence of a response class hierarchy (as described by Richman, Wacker, Asmus, Casey, & Andelman, 1999). The target behaviors included in the FA were placed on extinction sequentially.

Design manipulations—Design manipulations were included in 39 cases and included (a) a pairwise design, (b) an extended alone, (c) an increase in session duration, and (d) a combination of (a) and (c). In one unique case, sessions were initiated based on the occurrence of problem behavior.

Combined manipulations—More than one manipulation was conducted in 34 cases. Antecedent and consequent manipulations were conducted in 10 cases and most often included the addition of a new condition (seven cases); antecedent and design manipulations were conducted in 15 cases, and most often included the use of a pairwise design and a modification to the antecedent events of an FA condition; consequent and design manipulations were conducted in one case and involved changes to the consequent event in the demand condition and an increase in the session duration; antecedent, consequent, and design manipulations were conducted in eight cases, and most often involved the introduction of a new condition in a pairwise design.

RESULTS

Figure 1 shows the proportions of cases for which FAs were differentiated after the standardized FA, initial modifications, and second modifications. The standardized FA resulted in identification of a function in 82 of 176 cases (46.6%). Initial modifications were made for 82 of the 94 cases with initial inconclusive results (for the remaining 12 cases with undifferentiated outcomes, other nonexperimental assessments were conducted, e.g., descriptive assessment, or treatment was initiated based on other information). After initial modifications to the FA for those 82 cases, FA results were differentiated in 55 additional cases (67.1%), but remained inconclusive in 27 cases. Thus, functions were identified in 137 of 164 cases (83.5%) for which the initial FA was clear or initial modifications to the FA were made (and for 77.8% of the original sample of 176 cases). Of the 27 remaining cases with inconclusive outcomes, secondary modifications were made in 24 cases (the other three cases did not meet criteria for inclusion in this part of the study for reasons similar to those described above). Following the secondary modifications, FA results were differentiated in 16 of the 24 cases (66.7%), and eight remained undifferentiated. Thus, differentiated outcomes were obtained in 153 of 161 cases (93.3%) for which the FA, if necessary, was modified up to two times. For the original sample of 176 cases, differentiated outcomes ultimately were obtained for 86.9% of cases.

Table 2 provides data on how often each type of modification was implemented and a summary of results obtained with each type of modification. In total, antecedent

modifications were effective in identifying a function in 44.4% of participants for whom they were conducted (12 of 27 cases). Consequent manipulations were effective in identifying a function in 66.7% of cases (four of six). Design manipulations were effective in identifying a function in 84.6% of cases (33 of 39). Combined modifications involving changes to antecedent, consequent, and design variables were effective in 64.7% of cases (22 of 34). The number and type of various combinations of modifications are summarized in Table 3. Conclusions about the effectiveness of modifications used in combination are difficult to make because of the small number in each combined category. A detailed summary of all the specific manipulations are summarized in Appendices A and B.

The number and percentage of differentiated FAs across broad functional classes of reinforcement for the 176 cases are summarized in Table 4. These results indicate that multiple control was the most common finding, followed by social-positive reinforcement.

DISCUSSION

In the current study of 176 individuals hospitalized for the assessment and treatment of severe problem behavior, FAs based on an ABC model resulted in the identification of at least one function in 86.9% of total cases. Although this finding is consistent with other studies that have shown that the function of problem behavior can be identified in the majority of cases (Hanley et al., 2003; Iwata, Pace, et al., 1994; Kurtz et al., 2003; Mueller et al., 2011), results also illustrate how procedural modifications (in some cases, very simple ones) can affect outcomes favorably when initial results are inconclusive. Despite the failure to identify the function of problem behavior in more than 50% of cases using a standardized FA, initial modifications increased the percentage of cases with differentiated outcomes to 83.3% of 164 cases for which the initial FA was clear or initial modifications were made (and to 77.8% of the original 176 cases). Differentiated results were obtained in 93.3% of the 161 cases for which (a) the initial FA was clear, (b) initial modifications produced differentiated outcomes, or (c) the FA was modified a second time if needed. Differentiation was achieved in 86.9% of cases from the original sample of 176 cases (which includes the 12 undifferentiated cases for which only the standard FA was conducted, and the three undifferentiated cases for which only the initial modification was attempted). Although these findings support the utility of the ABC model and the benefit of individualized modifications, it must be noted that modification of the FA extends the analysis and should only be considered when risks to the participant can be managed. When possible, hypotheses regarding the function of problem behavior can be tested without extended assessment, for example, via additional analysis of existing data, and in some cases, in the context of a treatment analysis.

The findings also suggest that different types of modifications to the FA procedures described by Iwata et al. (1982/1994) may be more effective than others. Change to the design of the FA was the most effective type of initial modification, resulting in differentiation in 84.6% of cases (33 of 39). In particular, shifting from a multielement to a pairwise design was effective in 93.3% of cases (14 of 15), and the use of an extended alone phase was effective in 87.5% of cases (seven of eight). Consequent manipulations, all of which involved placing individual responses sequentially on extinction, were successful in

two thirds of cases (four of six). Similarly, combined manipulations were successful in approximately two thirds of cases (22 of 34); however, the varied types of combined manipulations prevented firm conclusions about any particular combination. Antecedent manipulations were employed often, but they were the least effective type of manipulation, producing differentiated responding in 12 of 27 cases (44.4%). Despite reports of idiosyncratic variables in several studies with small numbers of subjects (e.g., Carr, Yarbrough, & Langdon, 1997), these were identified in only 8 of 156 cases for which a function for problem behavior was determined.

One potential limitation is that the sample of participants may not be representative of the larger population of individuals with severe problem behavior. Although the use of a consecutive case-series design ensures that the sample described is representative of individuals admitted to the inpatient unit where these data were obtained, all the cases included in the current study had a history of highly severe and treatment-resistant problem behavior that necessitated inpatient hospitalization. Admission to this program usually is not considered unless all other available treatment options have been exhausted. Thus, many of the individuals in this sample had been exposed to an FA (or functional behavioral assessment of some type) and behavioral treatment before their hospitalization.

Although ongoing modifications to FA procedures may effectively identify the function of problem behavior, it would be far better to design the initial FA to yield more differentiated results earlier. Arguably, there is sufficient research now to support the following modifications to the original FA described by Iwata et al. (1982/1994): (a) the use of condition-correlated stimuli during the FA to facilitate schedule or stimulus control (Conners et al., 2000), (b) selection of stimuli based on certain properties (e.g., preference) that will enhance the relevant EOs (Roscoe, Carreau, MacDonald, & Pence, 2008), and (c) the use of a fixed sequence of FA conditions so that MO effects may be maximized (e.g., conducting the alone session before the attention session may increase the MO for attention) and carryover effects may be minimized (Hammond, Iwata, Rooker, Fritz, & Bloom, 2013; Hanley et al., 2003; Iwata, Pace, et al., 1994). Additional research also should examine the utility of screening procedures to identify individual variables that may alter FA outcomes. This information, as well as information about individual sensitivities to reinforcement, may come from multiple sources, including indirect and descriptive methods. Although indirect and descriptive methods are not ideal for determining causal relations (Camp, Iwata, Hammond, & Bloom, 2009; Thompson & Iwata, 2007), they may be useful in identifying idiosyncratic stimuli that are not typically included in an FA (thus saving time within the assessment and allowing a quicker introduction of treatment).

Some caution should be taken when interpreting these findings, because they are retrospective and did not follow a formal sequence of procedures. The various analyses often involved a hypothesis development and testing model. Additional research is needed to better define this process, as well as to provide guidelines for how to determine when one should pursue additional analysis and which additional analysis should be conducted. Similarly, research aimed at identification of patterns of behavior predictive of the utility of specific additional analyses is warranted. Currently, decisions about when to modify analyses are left to the individual behavior analyst and are limited by his or her expertise,

resources, and time. Developing such a technology may prevent premature termination of assessments or unduly lengthy assessments that waste resources and increase risks to the individual. Although the ABC model is a well-established approach to the assessment of problem behavior, additional research is needed to identify the most efficient way to modify analyses when initial results are inconclusive.

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APPENDIX A Initial Modifications

Type of modification	Specific modification	Number of analyses	Percentage differentiated
Single modifications			
Antecedent	Changed session location	10	20
	Removed protective equipment	5	40
	Changed tasks in demand condition	3	33.3
	Changed baited items	1	100
	Changed tasks in the demand condition and removed toy from the play condition	1	100
	Provided competing stimuli in the play condition	1	100
	Provided continuous physical attention across conditions	1	100
	Explained the in-session contingencies (verbal rules)	1	0
	Added divided attention condition and noncontingent attention in play	1	100
Design	Pairwise design	15	93.3
	Conducted extended alone sessions	8	87.5
	Pairwise design and increased session duration	2	50
	Increased session duration	2	100
	Initiated sessions after problem behavior occurred	1	100
Consequent	Placed behaviors on extinction sequentially	3	33
Combined modifications			
Antecedent and design	Added divided attention condition; pairwise design	3	66.7
	Added noncontingent attention in play; pairwise design	2	100
	Changed session location; pairwise design	2	50
	Removed equipment; changed session location; conducted extended alone	2	100
	Reversal design; changed session location	2	50
	Changed tasks in the demand condition; pairwise design	1	100
	Pairwise design; conducted extended alone with and without toys	1	100
Antecedent and consequent	Added tangible condition	4	100
	Changed tasks in demand condition; changed target response	1	0
	Medical equipment used in the tangible condition; modified prompting in the demand	1	100

Type of modification	Specific modification	Number of analyses	Percentage differentiated
Consequent and design	condition; intense verbal and physical attention in the attention condition		
	Added an access to rituals condition	1	100
	Added an interruption condition	1	100
	Modified escape in the demand condition; increased session duration	1	100
	Antecedent, consequent, and design	1	100
Antecedent, consequent, and design	Changed tasks in the demand condition; used food in the tangible condition; pairwise design	1	100
	Changed session location; added tangible condition; pairwise design	1	0
	Added mands condition; pairwise design	1	0
	Added tangible condition; reversal design	1	0
	Changed therapist; reversal design	1	100

APPENDIX B Subsequent Modifications

Type of modification	Specific modification	Number of analyses	Percentage differentiated
Single modifications			
Antecedent	Provided competing stimuli during all conditions	1	100
	Removed protective equipment	1	100
	Changed session location	1	100
Consequent	Placed behaviors on extinction sequentially (i.e., extinction analysis)	3	66.7
	Design		
Design	Pairwise design	5	60
	Increased session duration	4	75
	Increased session duration; pairwise design	1	100
	Limited access to attention prior to the session	1	100
Combined modifications			
Antecedent and consequent	Added mands condition	1	100
	Increased session duration; changed therapist	1	0
Antecedent and design	Conducted an extended alone condition; conducted a divided attention condition; changed session location	1	0
	Removed protective equipment; pairwise design	1	0
Antecedent, consequent, and design	Changed session location; pairwise design; added social	1	100

Type of modification	Specific modification	Number of analyses	Percentage differentiated
	avoidance condition; changed therapist		
	Pairwise design; changed therapist	1	100
	Restricted access to reinforcement prior to the session; increased the reinforcement interval; removed competing stimuli in play and attention conditions	1	0

Figure 1.
Summary of FA results.

Table 1Participant Characteristics ($N = 176$)

Participant variable	Number of participants
Age	
Children (3 to 12 years)	89
Adolescents (13 to 18 years)	69
Adults (> 18 years)	18
Autism spectrum disorder	
Yes	97
No	79
Level of intellectual disability	
Borderline	2
Mild	9
Moderate	47
Severe	37
Profound	13
Unspecified	68
Problem behavior targeted during FA	
Aggression	7
Disruption	4
Self-injury	23
Other	18
Multiple behaviors targeted	124

Table 2

Summary of Initial and Subsequent Modifications and Outcomes of the FAs

Type of modification	Employed	Cases differentiated	Percentage differentiated
Initial modifications			
Antecedent	24	9	37.5
Consequent	3	2	66.7
Design	28	25	89.3
Combination	27	19	70.4
Total	82	55	67.1
Subsequent modifications			
Antecedent	3	3	100
Consequent	3	2	66.7
Design	11	8	72.7
Combination	7	3	42.9
Total	24	16	66.7
Total modifications			
Antecedent	27	12	44.4
Consequent	6	4	66.7
Design	39	33	84.6
Combination	34	22	64.7
Total	106	71	67

Table 3

Summary of Combined Initial and Subsequent Modifications and FA Outcomes

Type of modification	Employed	Cases differentiated	Percentage differentiated
Initial modifications			
Antecedent and consequent	8	7	87.5
Antecedent and design	13	9	69.2
Consequent and design	1	1	100
Antecedent, consequent, and design	5	2	40
Total	27	19	70.4
Subsequent modifications			
Antecedent and consequent	2	1	50
Antecedent and design	2	0	0
Antecedent, consequent, and design	3	2	66.7
Total	7	3	42.9
Total modifications			
Antecedent and consequent	10	8	80
Antecedent and design	15	9	60
Consequent and design	1	1	100
Antecedent, consequent, and design	8	4	50
Total	34	22	64.7

Table 4

Summary of FA Outcomes

Analysis	Social positive	Automatic	Social negative	Multiple	Total
Standardized FA	27	16	13	26	82
Initial modifications	16	13	8	18	55
Subsequent modifications	4	1	5	6	16
Total	48	30	28	51	153