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Functional Analysis of Problem Behavior: A Systematic Approach for Identifying Idiosyncratic Variables

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Abstract

When inconclusive functional analysis (FA) outcomes occur, a number of modifications have been made to enhance the putative establishing operation or consequence associated with behavioral maintenance. However, a systematic method for identifying relevant events to test during modified FAs has not been evaluated. The purpose of this study was to develop and evaluate a technology for systematically identifying events to test in a modified FA after an initial FA led to inconclusive outcomes. Six individuals whose initial FA showed little or no responding or high levels only in the control condition participated. An indirect assessment (IA) questionnaire developed for identifying idiosyncratic variables was administered, and a descriptive analysis (DA) was conducted. Results from the IA only or a combination of the IA and DA were used to inform modified FA test and control conditions. Conclusive FA outcomes were obtained with five of the six participants during the modified FA phase.

Keywords

descriptive analysis; functional analysis; idiosyncratic variables; indirect assessment

Functional analysis (FA; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) has had a substantial impact in the field of applied behavior analysis. By conducting an FA, variables maintaining problem behavior can be identified, permitting the development of effective function-based treatment. The utility of FA for informing successful intervention has been demonstrated across a wide range of behavioral functions and response topographies. Furthermore, research suggests that the increased use of a pretreatment FA has been associated with decreased use of punishment (Pelios, Morren, Tesch, & Axelrod, 1999).

An FA typically involves three or four standard test conditions, including alone or no interaction, attention, escape, and tangible, and a control condition, play. Each of these test conditions involves manipulation of commonly occurring antecedent events (e.g., low

attention, demand presentation) and consequent events (e.g., attention, escape from demands). These general test conditions have been shown to have clinical utility in that they are often associated with differentially higher levels of problem behavior relative to the control condition, resulting in the successful identification of behavioral function.

Although FA often yields clear and interpretable outcomes, inconclusive outcomes are sometimes reported. Patterns indicative of an inconclusive FA include (a) low rates of behavior across all conditions (e.g., Hagopian, Bruzek, Bowman, & Jennett, 2007), (b) differentially higher levels in the control condition relative to test conditions (e.g., Tiger, Fisher, Toussaint, & Kodak, 2009), or (c) inconsistently high levels of behavior in multiple test conditions (Kahng & Iwata, 1999). Although high and undifferentiated levels of responding across conditions may be equivocal, this pattern is often interpreted to indicate problem behavior maintained by nonsocial variables or by automatic reinforcement. When this pattern is observed, conducting multiple consecutive alone sessions can provide further clarification on behavior function (see Vollmer, Marcus, Ringdahl, & Roane, 1995). Therefore, an FA outcome pattern including high levels across conditions was not considered inconclusive during this study.

The number of inconclusive outcomes reported in large-scale analyses and literature reviews varies widely. For example, Kurtz et al. (2003) reported uninterpretable outcomes in three of 24 (12.5%) cases, whereas Hanley, Iwata, and McCord (2003) reported uninterpretable outcomes in 22 of 514 (4.2%) of functional analyses published between the years 1982 and 2000. In contrast, a recent study by Hagopian, Rooker, Jessel, and DeLeon (2013) reported inconclusive FA outcomes in 53% of 176 cases. This variability may be due to setting or population differences, FA methodology, or how inconclusive outcomes were defined. Regardless of the reason for the variability, it is likely that the number of cases is higher than the lowest prevalence estimate because publication contingencies likely would favor clear FA outcomes. Given that inconclusive FA outcomes can occur, there is a need for identifying a method for clarifying them so that behavioral function and effective treatment identification can be determined.

One explanation for uninterpretable outcomes is possible carryover effects that may result from rapid alternation of multiple conditions. One way to reduce this possibility is to modify either the experimental design used or the session duration. Hagopian et al. (2013) conducted a number of design modifications, including conducting an extended alone phase, increasing session duration, and conducting a pairwise experimental design. Hagopian et al. reported that these design manipulations resulted in clear outcomes for 33 (84.6%) of 39 cases. However, it was unclear which design modification was used most often or resulted in differentiated outcomes. It is also important to note that the authors' definition of undifferentiated included patterns suggestive of behavior maintained by automatic reinforcement, whereas the definition of inconclusive outcomes used in the current study does not.

A second likely explanation for uninterpretable FA outcomes is that the antecedent and consequent events manipulated were not functionally relevant to the target problem behavior. For example, in the commonly conducted attention condition, a therapist ignores

the participant while acting busy and delivers a reprimand contingent on problem behavior. However, for some individuals, a reprimand may not be the form of attention maintaining their problem behavior. Instead, conversation initiations (e.g., engaging in a reciprocal conversation with the individual about a specific topic) may be the maintaining form of attention. Therefore, the typical FA attention condition may not serve as an adequate test for individuals with problem behavior maintained by more idiosyncratic forms of attention.

Functional analysis is an analytic process by which behavioral function is identified. As such, when common and general classes of reinforcers are tested and do not yield clear outcomes, a number of modifications have been made to enhance the putative establishing operation or consequence during test conditions. In a recent review of published functional analyses between 2001 and 2010, Schlichenmeyer, Roscoe, Rooker, Wheeler, and Dube (2013) identified 42 studies that included idiosyncratic modifications to a standard FA. Ten articles (23.8% of the sample) included variations in the presentation style or type of task demand during the escape condition of the FA. For example, Call, Wacker, Ringdahl, Cooper-Brown, and Boelter (2004) showed that more difficult tasks (i.e., those associated with lower accuracy) and a longer duration of exposure to tasks evoked more problem behavior than did easier tasks and a shorter duration of task presentation. Seven articles (16.6% of the sample) evaluated modifications to the putative motivating operation for attention-maintained behavior. For example, instead of simply acting busy and diverting one's attention (as indicated in the typical FA attention condition), modifications such as diverting attention to another individual (Call, Wacker, Ringdahl, & Boelter, 2005) or leaving the room (Edwards, Magee, & Ellis, 2002) were used. These modifications apparently increased the value of attention, leading to interpretable FA outcomes. Eleven studies (26.1% of sample) conducted modifications to consequent events during the attention test condition. For example, after an initial FA resulted in little problem behavior, Roscoe, Kindle, and Pence (2010) conducted a modified FA that included a condition in which preferred conversational topics were delivered (e.g., talking about the zoo). Inclusion of this condition in a modified FA resulted in a differentiated outcome and the development of an effective function-based treatment.

Given the wide variety of stimulus parameters found to be functionally relevant during modified functional analyses, there is a need for a preassessment technology for identifying relevant antecedents and consequences to test in modified functional analyses. The most commonly reported forms of preassessment used for informing modified functional analyses include anecdotal report either alone or in combination with informal observation (i.e., reporting that interviews or observations were conducted without describing a systematic procedure or displaying the results through quantitative means; Schlichenmeyer et al., 2013). Several studies have shown that a functional analysis can be modified and result in clear outcomes by incorporating information obtained from an informal descriptive analysis (e.g., Bowman, Fisher, Thompson, & Piazza, 1997; Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998). In a book chapter on functional analysis, Betz and Fisher (2011) commented on the utility of interviewing caregivers and collecting descriptive analyses for generating and testing hypotheses about idiosyncratic events that may maintain problem behavior. However, because of the informal nature of these assessments, they were not described in sufficient detail to permit replication.

Previous research that has systematically evaluated indirect assessments and descriptive analyses has not done so for the purpose of informing a modified FA. Previously published indirect assessments and descriptive analyses typically include the same antecedent and consequent events as those tested during a FA (e.g., Durand & Crimmins, 1988; Iwata, DeLeon, & Roscoe, 2013). An exception was a study by Tiger, Hanley, and Bessette (2006), who conducted an open-ended descriptive analysis after an initial functional analysis of a participant's hand mouthing resulted in inconclusive outcomes. The descriptive analysis indicated the context (naptime) in which the behavior was most likely to occur. When stimuli associated with naptime were included in a subsequent series of functional analysis conditions, high levels of hand mouthing were observed across all conditions, suggesting maintenance by automatic reinforcement. A noteworthy feature of this study was that the authors conducted a systematic and open-ended descriptive analysis to inform the functional analysis. However, it is unclear whether this methodology would be useful for socially reinforced problem behavior. Furthermore, no study to date has empirically evaluated the utility of including a closed- and open-ended indirect assessment for identifying idiosyncratic events to test in a modified FA. To this end, the purpose of this study was to develop and evaluate a technology for systematically identifying events to test in a modified FA after an initial FA led to inconclusive outcomes.

Method

Participants and Setting

Six individuals with a diagnosis of an autism spectrum disorder participated in this study. Participants were identified by referral from their clinical teams as having problem behavior that interfered with their educational objectives, was resistant to current interventions, and had resulted in inconclusive FA outcomes. The first six referrals for whom the FA resulted in an inconclusive outcome were included in the study. Table 1 lists participant designations, ages, communication levels, Peabody Picture Vocabulary Test 4 mental age-equivalent scores (Dunn & Dunn, 2007), and target problem behavior definitions. Aggression and self-injury were recorded using a frequency measure and were summarized as responses per minute. Loud vocalizations were recorded using a continuous duration measure and were summarized as percentage of session (in seconds).

Phase 1: Initial FA—Prior to the initial FA, an experimenter consulted with the participant's clinical team (i.e., the educational coordinator and clinical specialist) and asked them questions to determine the materials included during the play, tangible, and escape FA conditions. To identify items for use during the play and escape conditions, the experimenter consulted with the participant's educational coordinator, who was responsible for designing the participant's educational curriculum and worked with the participant in a 1:1 ratio at least 1 hr per day for (usually) 5 days per week.

The experimenter asked the coordinator to list at least eight items that the participant often selected or readily engaged with when given access to the item. These items were then included in a paired-stimulus preference assessment (similar to that described by Fisher et al., 1992) and those items ranked 2nd and 3rd were included in the play condition. For the

escape condition, the experimenter asked the educational coordinator to list demands that the participant regularly encountered and that frequently evoked problem behavior (i.e., putative establishing operations for escape-maintained problem behavior). Five demands, three academic (e.g., match to sample) and two daily living (e.g., tooth brushing) activities, were included in the FA escape condition. Table 2 shows the specific items included in the escape and play conditions for each participant.

Conditions were conducted in a fixed sequence of alone, attention, play, escape, and tangible. For participants who exhibited aggression, an alone condition was not conducted. A tangible condition was conducted only if the participant's clinical specialist reported that the problem behavior might be maintained by tangible reinforcement. The clinical specialist supervises direct care staff, assists the educational coordinator in revising curricula, and develops and reviews the participant's program for managing problem behavior. An experimenter asked the participant's clinical specialist, "Do you think that X's problem behavior is maintained by access to preferred items or activities?" If the specialist answered affirmatively, then a tangible condition was conducted, and the experimenter asked for more clarification regarding which items were encountered following problem behavior. For example, the experimenter asked the clinical specialist to list tangible items he or she had observed to follow problem behavior or evoke this behavior when these items were restricted or withdrawn. Table 2 shows the specific items included in the tangible conditions for those participants with whom this condition was conducted.

Sessions of 10-min duration were conducted in a 3×1.5 m room. FA sessions continued until one of the following criteria were met: (a) differential responding was observed during at least three series of conditions, (b) no target behavior was observed during six series of conditions, or (c) 10 sessions of each condition were conducted. An upcoming session was briefly delayed (no more than 5 min) if the participant continued to display a burst of problem behavior after the end of the previous session. At least one complete series of conditions was conducted within each testing day.

Alone: Prior to the start of this condition, the therapist told the participant, "You need to stay in here for a little while. I need to leave and will be back in 10 min." During the condition, the participant was alone in the room with no toys available. There were no programmed consequences in effect for problem behavior.

Attention: During this condition, the therapist told the participant, "I need to do some work and will not be available for 10 min" and then sat in a chair reading a magazine. As in the alone condition, there were no toys present in the room. Contingent on each occurrence of the target behavior, the therapist provided brief social attention and non-punitive physical contact (e.g., the therapist said, "Don't do that, you'll hurt yourself" while placing a hand on the participant's shoulder).

Play: During this condition, preferred toys identified from a paired-stimulus preference assessment (based on that described by Fisher et al., 1992) were continuously available. At the start of the session, the therapist stated, "We're going to play with some toys for a while." The therapist sat in a chair and did not prompt the participant to play with the toys or

present other requests or demands. No programmed consequences were in effect for the target behavior. If the participant initiated play or communication, the therapist interacted with the participant. If the participant did not initiate interaction, the therapist attended to the participant every 30 s by providing 5–10 s of attention and praise (e.g., “Nice playing with the toys,” “Good sitting!”).

Escape: Prior to this condition, five tasks that varied in response effort and skill domain were identified through caregiver interview and informal observation. At the start of the session, the therapist told the participant, “We are going to do some work for a while.” During each session, the therapist continuously presented instructional trials using a three-step graduated prompting procedure (verbal, gestural, physical prompts) and a 5-s inter-prompt interval. Each task was presented an equal number of times in a quasi-random order (i.e., all five tasks were presented once before any of them was presented a second time). Occurrences of target behavior during the demand sequence resulted in demand termination (therapist removed demand materials, stopped interacting with the participant, and turned away) for 30 s. After the 30-s escape period, the therapist presented a new demand. The therapist delivered praise for compliance following the vocal or gestural prompt.

Tangible: Prior to this condition, items reported by the clinical specialist to frequently follow problem behavior were identified and included in a preference assessment. Items identified as highly preferred from this preference assessment were included in this condition. Two minutes prior to the session, the participant was given access to the preferred item. At the end of this 2-min period and immediately prior to the start of the session, the therapist said, “I need [item name]. Please give me the [item name].” If the participant did not hand over the item, the therapist took the item from the participant without further prompting. After the session began, the therapist sat or stood in the room holding the item. Attention in the form of a brief vocal statement was delivered every 30 s, as long as target problem behavior had not occurred within 5 s. Contingent on occurrences of the target behavior, the therapist stated, “Okay,” and returned the item to the participant for 30 s. All other behavior was ignored. Noncontingent attention was included to help disentangle a tangible function from a potential attention function. If behavior were maintained by attention, a false positive outcome for maintenance by tangible reinforcement may have occurred, as the tangible delivery is a form of attention.

During the initial FA, interobserver agreement (IOA) data were collected on 38.4% of sessions for Bill, 44% of sessions for Daniel, 33.3% of sessions for Nate, 33.3% of sessions for Jack, 37.5% of sessions for Jim, and 33.3% of sessions for Dave. Mean IOA scores were for the initial FA were 98.7% (range, 85.5% to 100%) for Bill, 100% for Daniel, 94.5% (range, 78.2% to 100%) for Nate, 100% for Jack, 100% for Jim, and 100% for Dave.

Phase 2: Indirect Assessment and Descriptive Analysis

Indirect Assessment (IA) procedure: The purpose of this assessment was to identify potentially relevant idiosyncratic antecedent and consequent variables (i.e., those that occasioned or maintained problem behavior) that were not included in the initial FA. Two informants, who had interacted with the participant on nearly a daily basis for at least 6

months, were identified to complete the IA. Each informant for the IA worked with the participant for at least 1 hr per day, 5 days per week. He or she worked directly with the participant as the teacher in a 1:1 ratio across a variety of contexts including school, residential, and community settings. Informants had somewhat different levels of experience in the participant's school and graduate training: Bill's informants had 1–2 years of experience and neither was enrolled in a graduate program; both of Daniel's informants had 3 years of experience and were enrolled in a Master of Science in Education with Certificate in Severe Disabilities program; one of Nate's informants had 2 years of experience and was enrolled in a Master's of Applied Behavior Analysis program (MABA) and the other had 6 months of experience and was not enrolled in a graduate program; one of Jack's informants had 2 years of experience, one had 6 months of experience and neither informant was enrolled in a graduate program; informants for Jim and Dave had 2 years of experience and were enrolled in a MABA program.

The IA was conducted concurrently with the standard FA (i.e., on days between the first and last series of the initial FA) to enhance efficiency of the functional assessment process. Before administering the IA, the experimenter gave the informant a brief information sheet that (a) thanked them for taking the time to answer questions related to the participant's problem behavior, (b) reminded them that their participation was voluntary and that they could withdraw from answering questions at any time, and (c) that the information they provided would be kept confidential and would not impact evaluation of their job performance. Next, the informant was asked to complete the IA questionnaire.

The IA questionnaire included closed-ended and open-ended sections. IA respondents completed both open- and close-ended portions of the IA in an average of approximately 30 min; in all cases, the IA was completed in less than 60 min. The closed-ended section (see Supporting Information) contained 71 questions divided into three categories: events related to social-positive reinforcement contingencies, events related to social-negative reinforcement contingencies, and miscellaneous variables. Each category was divided into two subsections, one containing antecedent-based questions and one containing consequent-based questions. The first question of each of these subsections was a commonly used non-idiosyncratic question similar to those published in previous IAs (e.g., MAS, Durand & Crimmins, 1988; QABF, Matson & Vollmer, 1995; FAST, Iwata et al., 2013). All subsequent questions asked about potential idiosyncratic variables and were informed by previous FA modifications that have been reported. Specifically, we included questions regarding idiosyncratic variables described in reviews by Hanley et al. (2003) and Schlichenmeyer et al. (2013). We reviewed the references cited in these two publications and created questions from the independent variables that were determined to be relevant to behavioral function. The IA questions asked whether this potential event could function as a putative motivating operation or maintaining consequence for problem behavior. For example, based on the Mace, Page, Ivancic, and O'Brien (1986) study on the antecedent modification of diverted attention, we created the question, "How often does the problem behavior occur when you are attending to other individuals (e.g., staff or students)?" Based on research demonstrating that peer attention can be a functionally relevant event for problem behavior (e.g., Flood, Wilder, Flood, & Masuda, 2002; Skinner, Veerkamp, Kamps, & Andra, 2009), we developed the consequent-based question, "Does the following happen

immediately after the individual has the problem behavior – a peer delivers some form of attention?” For each question, the informant was asked to rate the frequency of the relation between the event and behavior on a scale of 1 to 5 (1 = almost never, 5 = almost always) or indicate that the event was not applicable (N/A).

The open-ended IA section consisted of five general questions about antecedent and consequent events (Hanley, 2012, Appendix). Informants provided written answers. Questions included:

- (1) What is the context in which (*behavior*) occurs most consistently?
- (2) What is it about that context that seems to bring about or cause the behavior?
- (3) When (*behavior*) occurs, how do you or others typically respond?
- (4) When the individual exhibits (*behavior*), what do you or others do to help calm him or her?
- (5) What do you think he/she is trying to communicate or achieve with his/her (*behavior*), if anything?

After both informants completed the closed-ended and open-ended IA sections, the experimenter reviewed the answers and asked the informant clarification or follow-up questions if needed for items with high frequency and agreement scores (see below). To standardize the assessment and avoid influencing caregiver responses, clarification or follow-up questions were limited to two specific formats: “What do you mean by ___” and, “Can you give me an example of ___.” For example, if an informant’s response was not clear in the sense of definition of terms, then the experimenter asked for clarification (e.g., “What do you mean by the term bad time?” “... by a long break?”). If an informant’s response was a category name or a generic term, the experimenter asked the informant for specific examples for clarification (e.g., “Can you give me some examples of difficult tasks?” “...of noisy places?” etc.).

IA data analysis: For the closed-ended IA section, items for which both informants’ frequency ratings were 4 or greater were considered relevant for further analysis. Such scores indicated that (a) both informants rated the relation as occurring frequently and (b) both informants were in agreement within one rating point. These events were subsequently coded during the DA (see below).

For the open-ended IA section, the informant’s responses to each of the first two questions were combined and entered as the informant’s reported relevant antecedent event (e.g., a response of “classroom” for question 1 and “noisy and crowded” for question 2 were combined and summarized as “classroom when noisy and crowded”) as the relevant antecedent event. The informants’ responses to the last three questions were combined and entered as the reported relevant consequent event. If responses were combined, then the experimenter confirmed the written response with the informant by saying, “I’ve summarized your responses; is this correct?” while showing the informant the combined written statement (e.g., “classroom when noisy and crowded”). For each category, informants’ responses were compared and categorized as exact agreement, partial agreement, or non-agreement. An exact agreement required identical or equivalent responses. A partial agreement required some overlap in responses but allowed some disagreement also (e.g., if one informant listed “escape from social demands” as a potential

consequent event, and the other informant listed “escape from academic instruction”). A disagreement was scored for responses that had no overlap or similarity with one another.

Descriptive Analysis (DA) procedure: A DA was conducted to determine whether events identified in the IA occurred in the natural environment and if so, whether they were correlated with problem behavior. A handheld digital video camera was used to collect a series of 10-min video samples in settings in which the problem behavior was reported to occur. The observation time was distributed approximately equally across multiple locations or activities. Video recording continued until (a) there was at least 50 min of video and the sample included at least 20 target responses or (b) there was a total of 120 min of video. The minimum of 20 target responses approximated the lower end of the range for similar analyses in Vollmer, Borrero, Wright, Van Camp, and Lalli (2001, Table 1). If fewer than 20 target responses were recorded in 120 min, then the DA was not completed and only the IA was used to inform the modified FA. During recording, caregivers were informed that the video was being collected to gather information on the participant’s problem behavior and they were instructed to proceed with their regular activities.

DA data analysis: If the criteria for DA data collection were met, observers analyzed the video recordings. Specifically, observers scored problem behavior and the relevant antecedent and consequent events identified in the IA (as described above). Observers scored the occurrence and duration of events and problem behavior by pressing and releasing keys on a computer keyboard while watching the video. Computer software compiled a record of all 1-s intervals in which the target response or environmental event occurred. Conditional probabilities were calculated on the basis of a 10-s moving window (for details see Pence, Roscoe, Bourret, & Ahearn, 2009). For antecedent events, the conditional probability of the target response following the environmental event was compared to the unconditional probability of the target response. For consequent events, the conditional probability of the environmental event following problem behavior was compared to the unconditional probability of the environmental event. For both types of events, a positive contingency was indicated when the conditional probability was greater than the associated unconditional probability.

IOA was calculated for an average of 40% of the DA sessions for Bill, Daniel, and Nate (the DA data collection criteria were not met for the other participants). For Bill, mean IOA was 98.2% (range, 96.5% to 100%) for SIB, 96.7% (range, 93.4% to 100%) for difficult demands, 91.8% (range, 91.8% to 91.9%) for denied requests, and 87.3% (range, 85% to 89.6%) for attend then ignore. For Daniel, mean IOA was 99.1% (range, 98.3% to 100%) for aggression, 90% (range, 86.3% to 93.7%) for prevents motor activity, and 93.3% (range, 89.7% to 97%) for denied requests. For Nate, mean IOA was 83% (range, 82% to 84%) for loud vocals and 95.1% (range, 91.8% to 98.3%) for denied bathroom requests.

Phase 3: Modified FA—The modified FA included one or more conditions that incorporated the contingencies suggested by the IA and then verified as actually occurring by the DA. If multiple variables were verified on the DA, then they were all evaluated during the modified FA. Each modified FA series included the test condition and one or more control condition(s). The event that was delivered contingent on problem behavior in

the test condition was delivered noncontingently (with respect to problem behavior) during the control condition, either continuously or on a continuous reinforcement schedule when the tested variable was denial of requests and thus identification of the consequence required some specific request by the participant.

In three cases (Jack, Jim, and Dave) in which there were insufficient occurrences of target behavior within 120 min of video footage for descriptive analyses, modified FA conditions were informed solely from the IA. The decision rule for determining the order of events to test was that events reported on both the open-ended and closed-ended IA sections were tested first. If more than one event was reported on both, then the frequency scale (from highest to lowest) was used to determine the test order. If two or more items were rated equal in frequency, a clinical team member was asked to rank them.

During Phase 3 (modified FA), IOA was collected on 35.2% of sessions for Bill, 51.9% of sessions for Daniel, 40% of sessions for Nate, 37.5% of sessions for Jack, 44.4% of sessions for Jim, and 38.1% of sessions for Dave. Mean IOA scores for Phase 3 were 99.5% (range, 96.8% to 100%) for Bill, 98.7% (range, 87.8% to 100%) for Daniel, 98.9% (range, 95.6% to 100%) for Nate, 99.4% (97.8% to 100%) for Jack, 99.7% (range, 98.3% to 100%) for Jim, and 100% for Dave.

Results

Bill

Initial FA—The results for Bill's initial FA are depicted in the top panel of Figure 1. For the first three series, there was little or no responding across conditions. During the fourth through sixth series, elevated levels of self-injurious behavior (SIB) occurred during the escape condition. However, responding decreased to low levels for the last four series. Therefore, Bill's initial FA results for self-injury were uninterpretable.

IA—The results of Bill's IA are depicted in the upper part of Table 3. During the closed-ended portion of the assessment, there were a total of six events (all antecedents, no consequences) that were identified as potentially relevant (i.e., average score was at least 4). During the open-ended portion of the IA, four events were identified (two antecedents and two consequences) as potentially relevant.

DA—The results of Bill's DA are depicted in the top panel of Figure 2. Four of the events identified from the IA were observed during the DA: Two antecedent events (difficult demand and denied request) and two consequent events (give space; attend, then ignore). Positive contingencies (i.e., the conditional probability of the behavior given the event was higher than the unconditional probability of behavior) were observed only for the two antecedent events. Negative contingencies (i.e., the probability of the event given behavior was lower than the unconditional probability of the event) were observed for the two consequent events. That is, the consequences identified by informants were actually less likely to occur following the behavior than at other times. Therefore, difficult demands and denied requests were verified during the DA as potentially relevant antecedent events.

Modified FA—The results of the IA and DA informed the test and control conditions during the modified FA. Because difficult demands and denied requests were indicated as potentially relevant antecedent events during both the IA and DA, modified test conditions were developed that included these events and the putative consequence associated with them.

Escape (difficult demand) test: This condition was similar to the initial FA escape condition. The therapist continuously presented demands using a three-step prompting hierarchy, 30-s breaks were delivered following problem behavior, and praise was delivered for compliance before the physical guidance prompt. The modified feature of this condition was that a single challenging task was continuously presented, which was a fine motor task of putting on shoes that was identified in the IA and DA.

Escape (easy demand) control: This condition served as a control for the relevance of task difficulty as a putative motivating operation. This condition was identical to the escape (difficult demand) test condition, except that a demand associated with high levels of compliance and low levels of SIB during the initial FA escape condition, clap hands, was included.

Compliance with requests (edibles or escape) test: Bill frequently requested edibles and alone time by pointing to picture cards. Because Bill was denied access to his requests for these events most frequently during the descriptive analyses, his requests for these events (defined as pointing to one of two pictures on a laminated card) were denied in this condition. Prior to the start of the session, the therapist presented Bill with a laminated card with a picture of an edible and the printed words “Snack Foods,” and another picture of a person taking a break with the printed word “Alone.” These pictures were selected because they were used during his daily programming. The therapist complied with all of Bill’s requests for both of these events for 30 s. The laminated card remained present throughout the session. After 30 s, if Bill requested either of the items, the therapist said, “That’s not available right now.” Contingent on SIB, the therapist said, “Bill, what would you like?” and complied with his requests continuously for 30 s.

Compliance with requests (edibles or escape) control: The laminated card was continuously available as in the previous condition. At the start of the session, the therapist stated, “Tell me what you would like” and continuously complied with Bill’s requests for edibles and alone time throughout the session.

Modified FA results: The results of Bill’s modified FA are depicted in the top panel of Figure 1. Bill’s SIB occurred at higher levels in the escape (difficult demand) test relative to the escape (easy demand) control, and the compliance with requests test and control conditions. This outcome showed that escape from a specific difficult demand (i.e., the fine motor task of putting on shoes) maintained his problem behavior.

Daniel

Initial FA—The results for Daniel’s initial FA are depicted in the second panel of Figure 1. Little or no aggression was observed across attention, play, or escape conditions for six series. Therefore, Daniel’s initial FA results for aggression were uninterpretable.

IA—The results of Daniel’s IA are depicted in the middle part of Table 3. During the closed-ended IA section, two antecedent events were identified as relevant and no consequent events were identified as relevant. During the open-ended IA section, two antecedent events and one consequent event were identified as relevant. During follow up questions, the informants reported that aggression occurred when caregivers prevented Daniel from going on a walk specifically.

DA—The results of Daniel’s DA are depicted in the middle panel of Figure 2. Two antecedent events identified as relevant from the IA were observed during the DA: caregiver prevents individual from engaging in motor activity (walks) and caregiver denies requests for items or takes them away (snack foods). Positive contingencies for both events verified them as potentially relevant antecedent events.

Modified FA 1—The results of the IA and DA informed the test and control conditions during the modified FA. Two antecedent events, caregiver prevents the individual from engaging in motor activity (walks) and caregiver denies requests for items or takes them away (snack foods), were used to inform modified test conditions that included these antecedent events and the putative consequences associated with them.

Walks test: Prior to the start of the session, the therapist stated, “OK you can go for a walk now” and walked closely with Daniel on a specific route (up and down the hallway outside the research room) for 30 s. At the start of the session, the therapist walked Daniel back to the research room, guided him to sit in a chair, and said, “Walks are all done.” If Daniel stood up from the chair, the therapist redirected him using least-to-most prompting to sit back down. Contingent on aggression, the therapist said, “OK you can go for a walk now” and walked closely with Daniel in the hallway outside the research room for 30 s. The therapist used physical guidance as necessary to ensure that Daniel followed the specified walking route. All other behavior resulted in no programmed consequences.

Compliance with requests (edibles) test: Prior to the start of the session, the therapist presented Daniel with a laminated card that had a picture of edible items on it. Daniel requested edibles by pointing to the picture. The therapist complied with Daniel’s requests for edibles for 30 s. At the start of the session, the therapist said, “Snack foods are all done.” If Daniel requested an edible, the therapist said, “Snack foods aren’t available right now.” Contingent on aggression, the therapist said, “Daniel, what would you like?” and complied with his requests for edibles for 30 s.

Walks and compliance with requests (edibles) control: At the start of the session, the therapist stated, “Let’s go for a walk.” and continuously walked with Daniel in the hallway for the duration of the session. The laminated card with pictures of edibles was continuously

available, and the therapist complied with Daniel's requests for edibles throughout the session. Occurrences of aggression resulted in no programmed consequences.

Modified FA 1 results: The results of Daniel's modified FA are depicted in the second panel of Figure 1. High levels of aggression occurred in both the contingent walks test condition and the walks and compliance with requests (edibles) control condition. Because similarly high levels were observed in both the test and control conditions, we concluded that some event other than walks or edibles maintained Daniel's aggression. When reviewing the videos from the control sessions, we observed that Daniel frequently requested (by pointing) access to certain locations beyond the hallway where the walks were conducted. These additional locations were associated with particular activities (e.g., the cafeteria, the playground). After his requests for these locations and activities were denied, he often exhibited aggression.

Modified FA 2—We modified test conditions to determine whether Daniel's aggression was maintained not only by walks, but more specifically by compliance with his requests to walk to certain locations and the activities associated with them (e.g., eating snacks in the cafeteria, swinging on a playground swing, or spinning in a chair in an office).

Compliance with requests (walking locations, activities) test: For 1 min prior to the start of the session, the therapist complied with Daniel's requests for walking in any location he chose. In addition, Daniel was permitted to engage in whatever activities he initiated during the walk. At the start of the session, the therapist brought Daniel back to the session room and said, "X (the name of the activity he was engaging in) is all done." Moderately preferred leisure items were continuously available, and Daniel was required to sit in a chair for the duration of the session. Contingent on aggression, the therapist stated "Point to where you want to go," and complied with all of Daniel's walking requests for 1 min. During the 1 min, the therapist walked with Daniel to wherever he pointed (e.g., if Daniel exhibited aggression at second 8 of the session, all pointing resulted in walking to the requested location until second 68). In addition, the therapist permitted Daniel to engage in whatever activity that Daniel initiated (e.g., looking at the pool in a certain area of the building, riding on a swing in the playground, looking out a window in someone's office, spinning chairs in a meeting room, and sitting inside a van in the parking lot). After 1 min elapsed, the therapist said, "X is all done" and brought Daniel back to the research room.

Compliance with requests (walking locations, activities) control: At the start of the session, the therapist said, "Where would you like to go?" and complied with all of Daniel's requests for walking to specific locations. In addition, Daniel was permitted access to any leisure items or edibles he encountered throughout the session. No programmed consequences were in effect for aggression.

Walking locations and activities control: The purpose of this condition was to determine whether target behavior in the compliance with requests (walking locations, activities) test condition was maintained (a) by the tangible consequences of access to the requested locations and activities, or (b) by the social consequence of the therapist's compliance with Daniel's mands. To rule out maintenance by the locations and activities encountered during

the test condition, Daniel was given access to the same reinforcers on a response-independent schedule. If the locations and activities were the maintaining consequences, then the response-independent delivery of these events would function as an abolishing operation and result in low rates of aggression. If the maintaining consequence was the social act of compliance, however, then allowing Daniel to dictate specific locations and activities contingent upon aggression should result in high rates of aggression.

At the start of the session, the therapist said, “We’re going to walk this way,” while walking with Daniel to an area he had previously selected in the compliance with requests (walking locations, activities) test condition for 1 min. At the end of the 1 min interval, the therapist said, “We’re going to walk this way” and walked with Daniel to a different location that Daniel had previously selected in the test condition. The specific locations in the control condition were thus yoked to those encountered in the preceding test condition. Aggression resulted in compliance with Daniel’s requests for specific locations and activities for 1 min. That is, the therapist said, “Point to where you want to go” and walked with Daniel to wherever he pointed for 1 min. At the end of the 1 min, the therapist said, “We’re going to walk this way,” and continued walking with Daniel to locations that he had selected in the preceding test condition.

Modified FA 2 results: The middle panel of Figure 1 shows that higher levels of aggression were observed in the compliance with requests (locations, activities) test condition compared to the two control conditions, suggesting that access to specific locations of his walk and the activities associated with them maintained his problem behavior.

Nate

Initial FA—The results for Nate’s initial FA are depicted in the bottom panel of Figure 1. Loud vocalizations occurred primarily in the play condition, with low and variable levels in the attention and escape conditions. Although an undifferentiated pattern was observed after six series, we conducted an additional three series because a new therapist was introduced. Similarly uninterpretable outcomes were observed in the three series with the novel therapist.

IA—The results of Nate’s IA are depicted in the lower part of Table 3. During the closed-ended IA section, two antecedent events and no consequent events were identified as relevant. During the open-ended IA section, three antecedent events and three consequent events were identified as relevant. The caregivers indicated that loud vocalizations frequently occurred when requests for soda, a comfy chair, or the bathroom, were denied. When asked what they meant by the bathroom, caregivers responded that Nate requested the bathroom so that he could exhibit ritualistic behavior (pacing back and forth and clicking his heels against the wall).

DA—The results of Nate’s DA are depicted in the bottom panel of Figure 2. The only event identified on the IA that was observed during the DA was the antecedent event of caregivers denying requests for the bathroom. In addition, there was a positive contingency for this

event. Therefore, the results of the DA verified that denied requests for the bathroom was a potentially relevant antecedent event.

Modified FA—Because denied requests for the bathroom was indicated as a potentially relevant antecedent event during the IA and verified during the DA, a modified test condition was developed that included this event and the putative consequence associated with it.

Compliance with requests (bathroom) test: For 45 min prior to the start of the session, caregivers denied Nate’s requests for the bathroom. Immediately prior to the session, to permit Nate to use the bathroom for functional purposes, the therapist said, “Nate, if you want the bathroom, you can request it.” If Nate requested the bathroom, the therapist permitted him access to the bathroom for 1 min. While in the bathroom, Nate typically exhibited ritualistic behavior. Specifically, he moved laterally in a step-by-step fashion along the perimeter of the bathroom while his heels remained in contact with the wall.

After 1 min of access to the bathroom, the therapist presented a vocal prompt, “Nate, it’s time to go back to the classroom.” After Nate walked back to the classroom and sat down at his desk, the session started. Contingent on loud vocalizations, the therapist stated, “OK, Nate, if you want the bathroom, you can request it” and the therapist complied with Nate’s request for the bathroom for 30 s. Therefore, Nate had to request the bathroom to be granted access to the bathroom within the allotted 30 s. Bathroom access was provided for requests for the bathroom rather than loud vocalizations because this was the specific contingency reported to maintain his behavior in the IA. After 30 s, the therapist said, “OK Nate, it is time to go back to the classroom.” Nate always complied with this request. Appropriate requests for the bathroom and other non-target behavior were ignored. If Nate attempted to use the bathroom functionally (i.e., approached the toilet while pulling pants down), the therapist paused the session and the session was resumed following completion of functional bathroom use.

Compliance with requests (bathroom) control: At the start of the session, the therapist stated, “Nate, you can request the bathroom as much as you want.” Contingent on Nate’s requests for the bathroom, the therapist complied by providing him with access to the bathroom for 30 s. No consequences were in effect for loud vocalizations.

Modified FA results: Figure 1 shows that higher levels of loud vocalizations occurred during the test condition relative to the control condition, indicating that loud vocalizations were maintained by compliance with requests for the bathroom. It is unclear why Nate frequently requested the bathroom and why compliance with these requests maintained his problem behavior. One possibility is that being in the bathroom (alone) allowed him to avoid social situations. Another possibility is that being in the bathroom was associated with unrestricted access to ritualistic behavior (e.g., tapping his heels along the perimeter of the bathroom; cf. Rispoli, Camargo, Machalicek, Lang, & Sigafos, 2014).

Jack

Initial FA—The results for Jack’s initial FA are depicted in the top panel of Figure 3. SIB did not occur during the initial FA.

IA—The results of Jack’s IA are depicted in the upper part of Table 4. During the closed-ended IA section, two antecedent events and three consequent events were identified as relevant. During the open-ended IA section, two antecedent events and three consequent events were identified as relevant. The events identified on both the open- and closed-ended IA sections were (a) a caregiver does not comply with requests; (b) ending or denying access to preferred activities; and (c) trying to gain access to something. Caregivers were asked to clarify these events by providing examples. For denied requests that frequently preceded SIB, caregivers reported specific videos (Dr. Seuss™, Spy Foxx™, or YouTube™ videos) as examples. For examples of preferred activities, caregivers indicated using a computer, gym activities, and watching movies, particularly the movie credits. For examples of trying to gain access to something, caregivers reported the items already noted for the other events and access to private time (i.e., time alone in the bathroom to masturbate).

DA—The DA was not conducted because of insufficient data. A total of 120 minutes of video recording included no instances of Jack’s SIB.

Modified FA—Because denied access to specific videos and denied requests for specific videos were both indicated as potentially relevant antecedent events during the IA, we planned to conduct tests for both of these variables to determine whether therapist compliance with Jack’s requests for specific videos maintained his SIB. However, before conducting a modified condition that included denied requests, we first conducted a test condition to determine whether access to these items independent of compliance with his requests for these items maintained his SIB.

Specific videos test: This condition was identical to the tangible condition of the standard FA protocol, with the exception that Dr. Seuss, Spy Foxx, YouTube videos, and movie credits were delivered contingent on the occurrence of Jack’s SIB.

Specific videos control: During this condition, the items delivered contingent on SIB in the preceding test condition were now continuously available. SIB resulted in no programmed consequences.

Modified FA results: The results of Jack’s modified FA are depicted in the top panel of Figure 3. Moderate levels of SIB occurred in the specific videos test condition relative to the control condition, indicating that Jack’s SIB was maintained by access to these specific videos and movie credits. Because we did not test whether Jack’s SIB was maintained by other tangible items, it is possible that Jack’s SIB was maintained by other items in addition to those reported during the IA and tested in the modified FA tangible condition.

Jim

Initial FA—The results for Jim’s initial FA are depicted in the middle panel of Figure 3. Aggression did not occur during the initial FA.

IA—The results of Jim’s IA are depicted in middle part of Table 4. During the closed-ended IA section, three antecedent events and no consequent events were identified as relevant. During the open-ended IA section, three antecedent events and three consequent events were identified as relevant. The event identified on both open- and closed-ended IA sections was ending preferred activities while presenting a work task. Caregivers reported the computer as an example of a preferred item and academic tasks as the type of demand that typically interrupted the computer. For clarification on the meaning of running, they indicated that Jim often ran when teachers touched items that he was “fixing” (the “insistence on sameness” that is part of the diagnostic criteria for Autism Spectrum Disorder; American Psychiatric Association, 2013). For examples of items that he fixed, caregivers reported blinds, his tote bag, his backpack, and his token board. For clarification on their report that he engaged in aggression when in the classroom, they stated that he ran out of the classroom to fix things in another room or he continuously attempted to fix his work binder.

DA—The DA was not conducted because of insufficient data. A total of 120 minutes of video recording included only two instances of Jim’s aggression.

Modified FA 1—Because caregivers reported that Jim frequently exhibited aggression when demands were presented that interrupted his time at the computer, a modified test condition was conducted to test the relevance of escape from demands combined with access to the computer as maintaining variables for his aggression.

Escape plus computer test: Immediately prior to the start of each session, the therapist provided Jim with 30-s access to the computer. At the start of the session, the therapist interrupted the computer use by presenting an incompatible demand (a handwriting task) on a fixed-time 30-s schedule, using a three-step prompting hierarchy (vocal, model, physical). Contingent on aggression, the therapist removed the demand and permitted Jim to engage with the computer for 30 s.

Escape plus computer control: During this condition, no demands were presented, and Jim had continuous access to the computer. No programmed consequences were in effect for aggression.

Modified FA 1 results: The results of Jim’s first modified FA are depicted in the middle panel of Figure 3. No responding was observed during the test or control conditions of this phase, suggesting that Jim’s aggression was not maintained by escape from demands combined with access to the computer.

Modified FA 2—Because the event indicated as potentially relevant on both the open-ended and closed-ended portions of the IA did not maintain responding during the first modified FA, the IA results were reviewed to identify the next event to test. Because there were multiple events that were tied in terms of frequency scores, we asked the clinical team

to rank the tied items, and they reported that Jim most frequently exhibited aggression when running to fix things such as his tote bag, school bag, academic instruction book, and token board. We conducted a modified test condition to determine whether access to fixing these specific items maintained his aggression. In both the test and control condition, the specific items reported by caregivers were included as baited items in the research room.

Fixing test: Prior to the start of each session, the therapist provided Jim with 1 min access to the baited items. After 1 min, Jim was taken from the research room and a therapist returned any fixed items to their original state. During sessions, the therapist blocked attempts to fix items, but allowed Jim to fix one item as a consequence for aggression.

Fixing control: During this condition, Jim had continuous access to the baited items. The therapist did not rearrange the items during this condition. No programmed consequences were in effect for aggression.

Modified FA 2 Results: Differentially higher levels of aggression were observed in the fixing test condition relative to the control condition, indicating that aggression was maintained by access to fixing items.

Dave

Initial FA—The results for Dave’s initial FA are depicted in the bottom panel of Figure 3. SIB did not occur during this FA.

IA—The results of Dave’s IA are depicted in the bottom part of Table 4. During the closed-ended IA section, two antecedent events and one consequent event were identified as relevant. During the open-ended IA section, two antecedent events and one consequent event were identified as relevant. The events identified on both open- and closed-ended IA sections were (a) denied access to ritualistic behavior; and (b) denied access to individual’s requests. For examples of denied access to ritualistic behavior, the caregivers responded, “going back and forth between chairs, touching chairs.” When asked what they meant when they reported denied access to Dave’s requests, they responded that his SIB typically occurred when they denied his requests for preferred edibles or going on trips.

DA—The DA was not conducted because of insufficient data. A total of 120 minutes of video recording included no instances of Dave’s SIB.

Modified FA 1—Because caregivers reported that Dave frequently exhibited SIB when caregivers blocked his ritualistic behavior (repeatedly flipping light switches, moving back and forth between chairs or touching chairs, putting away puzzles in a particular order, and repeatedly removing clothing), a modified test condition was developed to test whether access to ritualistic behavior maintained his SIB. For both test and control conditions, materials (i.e., chairs, a picture activity book, and puzzles) were included, as these were the items he was reported to use when emitting ritualistic behavior.

Ritualistic behavior test: Prior to the start of the session, Dave had continuous access to the materials for ritualistic behavior for 2 min. The session proceeded only if Dave exhibited

ritualistic behavior prior to the session. At the start of the session, Dave was removed from the room while another experimenter rearranged the materials to their original positions. The therapist blocked all attempts to emit ritualistic behavior. Contingent on SIB, access to the materials for ritualistic behavior was provided for 30 s. After the 30 s, the therapist restored the environment to its original condition.

Tangible test condition: This condition was identical to the standard tangible condition of the initial FA. Contingent on SIB, the materials for ritualistic behavior described above and candy were presented for 30 s. However, ritualistic behavior with the materials was blocked.

Ritualistic behavior / tangible control: At the start of the session, the therapist stated, “Dave, I have some work to do. You can play over here,” while escorting David to the table. The therapist delivered edibles on a fixed-time 30-s schedule, and Dave had continuous access to the materials that he used for ritualistic behavior. No programmed consequences were in effect for SIB or ritualistic behavior.

Modified FA I Results: No SIB was observed, suggesting that access to materials for ritualistic behavior did not maintain Dave’s SIB.

Modified FA 2—During this phase, a test was developed to evaluate whether compliance with requests for specific items and activities maintained Dave’s SIB.

Compliance with requests (edibles, leisure items) test: Prior to the start of the session, Dave had continuous access to his communication book. The therapist complied with Dave’s requests (pointing to item in communication book or signing) for access to candy, puzzles, or toys for 2 min. At the end of the 2-min pre-session period, the therapist stated, “Dave, I am all done giving you things” and the session began. If Dave requested an item, the therapist stated, “That item is not available.” If Dave engaged in SIB, the therapist stated, “OK, you can have the item if you request it” and provided access to the item for 30 s contingent on his requests.

Compliance with requests (edibles, leisure items) control: The same items from the test condition were included in this condition and were delivered contingent on Dave’s requests. SIB resulted in no programmed consequences.

Modified FA 2 results: No SIB was observed during this phase, suggesting that compliance with requests for specific items and activities did not maintain Dave’s SIB.

Discussion

Six individuals with inconclusive FA outcomes participated in this study. Five of the six participants demonstrated little or no responding during the FA, similar to that reported by Hagopian et al. (2007). One participant, Nate, exhibited high but variable levels in the control condition relative to the test conditions. Both indirect assessments and descriptive analyses were used to inform modified FA test conditions for Bill, Daniel, and Nate, whereas only IAs were used to inform the modified FA for Jack, Jim, and Dave.

The initial FA included a number of best-practice recommendations that were conducted to minimize the likelihood of obtaining unclear outcomes. These include the use of a fixed sequence of FA conditions, the use of 10-min sessions, the absence of toys in the attention condition, and the use of visual inspection criteria. Furthermore, the addition of consecutive alone sessions aided in ruling out behavior that was high and undifferentiated due to maintenance by automatic reinforcement. These methodological details may have decreased the likelihood that inconclusive outcomes were due to design characteristics and increased the likelihood that they were due to the absence of idiosyncratic variables in the test conditions.

For Bill, Daniel, and Nate, the IA yielded 5 to 10 potentially relevant events for subsequent testing. The DA for each participant confirmed positive contingencies for one (Nate) or two (Bill and Daniel) of these events. For Bill and Nate, modified FA results incorporating these events identified one event for each participant that was functionally relevant to problem behavior. By contrast, Daniel's initial modified FA showed that neither of the events identified on the IA and DA were functionally related to problem behavior. However, observations of problem behavior during both test and control conditions for one of these events (contingent walks) provided additional information (about specific locations and activities encountered during walks) that led directly to a subsequent modification and a clear FA outcome.

For Jack, Jim, and Dave, the IA yielded six to ten potentially relevant events for subsequent testing. Because these participants did not exhibit sufficient occurrences of target behavior during DA data collection, however, the modified FAs were informed solely from the IA results. In Jack's case, an event reported on both the closed-ended and open-ended portions of the IA (access to specific videos) was confirmed to be functionally relevant to his problem behavior. In Jim's case, an event (presentation of demands combined with denied access to computer use) was identified on both the closed- and open-ended IA sections, but it was not found to be functionally relevant to his problem behavior during the subsequent modified FA. Rather, an event listed only on the open-ended IA section (running to "fix" items) was subsequently tested and shown to be functionally relevant. In Dave's case, two events were indicated as potentially relevant on both the closed- and open-ended IA sections (access to ritualistic behavior or tangible items), but modified FAs testing these events failed to confirm functional relations with problem behavior. Thus, modified FAs informed solely by IA results led to conclusive outcomes and the identification of behavioral function for two of three participants.

It remains unclear why a conclusive function was not identified for Dave. It is possible that his problem behavior was maintained by idiosyncratic test variables that were not identified by the IA. It is also possible that the antecedent events included in the modified FA functioned as establishing operations only when presented for longer durations (e.g., 30 min) or that combined consequences functioned as the reinforcer for problem behavior. Future researchers might consider extending session duration and combining antecedent and consequence events to assist in determining behavioral function.

The current study extended previous research by evaluating a systematic procedure for identifying potentially relevant variables to test during a modified FA. Although a variety of stimulus parameters have been previously determined to be functionally relevant during modified FAs, a systematic preassessment technology that included both IA and DA components for identifying relevant antecedents and consequences to include in modified FAs was not described. In addition, the IA used in this study offered a more comprehensive and systematic approach relative to anecdotal report alone or in combination with informal observation. Although there is extensive research examining the utility of IAs for informing the function of problem behavior using common reinforcers, there is not an evaluation of an IA tool that addresses potential idiosyncratic antecedent and consequent event variables that may be functionally relevant.

Three features of the IA used in this study offer advantages over previously used IA tools. First, unlike previously published closed-ended IAs, the closed-ended IA section in the current study contained questions regarding potential idiosyncratic variables. Because these questions were based on FA research that has demonstrated the relevance of these idiosyncratic variables, the potential utility for resolving inconclusive FAs may be greater than previously published IAs with questions regarding more general or typical motivating operations and consequences (e.g., Iwata et al., 2013; Matson & Vollmer, 1995). Second, the IA included follow-up questions for affirmative answers on the closed-ended IA section or general statements on the open-ended IA section. These follow-up questions, asking for definitions or examples, proved particularly useful for narrowing down the number of events to test, especially for those participants whose modified FA was informed solely by the IA. Third, by assigning testing priority to those events reported on both the closed-ended and open-ended IA sections, it seems likely that we reduced the overall duration of modified FA testing.

The rationale behind including an open-ended IA section was that the closed-ended section may not have contained a potentially relevant idiosyncratic event for some individuals. In any such cases, the open-ended section with more general questions may have provided information about a missed event from the closed-ended portion. Interestingly, similar outcomes were obtained across closed-ended and open-ended IA sections for four of six participants; exceptions were Jim's running to fix items, identified in only the open-ended IA, and Bill's putting on shoes, identified in only the closed-ended IA. Although the closed-ended portion of the IA was sufficient for identifying functionally relevant events for most of the participants, the functionally relevant event for Bill was missed by the closed-ended IA section. Therefore, it may be useful for clinicians to include an open-ended IA section in combination with a closed-ended IA. Because there was only one functionally relevant event missed by each of these sections, future research could evaluate whether there is value in including both sections or whether one of the sections could be omitted to enhance efficiency.

Although our study did not permit an evaluation of the independent utility of a DA for informing the modified FA, it did provide an independent evaluation of the IA in informing the modified conditions. For the three participants who received both an IA and a DA, the DA did not provide any additional information beyond that provided by the IA. However,

the DA was helpful in confirming the prevalence of informed events in the natural environment. In addition, it was helpful in reducing the number of events to test that were indicated by the IA method (e.g., consequences for Bill with negative contingencies). By narrowing potential test variables, we were able to avoid exposing participants to unnecessary FA sessions and enhance efficiency. However, there are some concerns with the use of a DA for informing an FA. First, there is the potential for false negative DA results. For example, there may be relevant events that occur with low frequency and thus do not occur within the limits of the DA sample. Future research could address this concern by testing variables informed by the IA that were associated with negative contingencies on the DA. Another concern with the DA is that results may be inaccurate predictors of behavioral function; DA results show events that are prevalent, but these events are not necessarily relevant. A limitation of the current study is that we did not evaluate the independent contribution of the IA and DA. Therefore, future research could focus on comparing the relative utility of these different assessments when they are both conducted independently and concurrently.

Given the potential utility of the IA used in this study, one may question whether it should be used prior to initiating the FA process (i.e., prior to conducting a more standard set of conditions). Although the IA may prove useful in enhancing the efficiency of the FA process when problem behavior is maintained by idiosyncratic or somewhat unusual events or combinations of common events, it may be less useful for individuals whose problem behavior is maintained by the more typical sources of reinforcement frequently tested in a functional analysis (e.g., reprimands, escape from academic demands). Given the plethora of research demonstrating the utility of the standard set of conditions (similar to those used by Iwata et al., 1982/1994), the fact that these conditions often yield differentiated outcomes, and that problem behavior is often maintained by these common sources of reinforcement (Hanley et al., 2003), it seems premature to conduct idiosyncratic conditions before first evaluating more common sources of reinforcement. Therefore, the recommendation for best practice would be to conduct a standard set of conditions (attention, escape, alone, and play) prior to conducting modified conditions. However, if there is a strong reason to suspect that these conditions would not yield a conclusive outcome due to previous unsuccessful assessments or staff report, then an IA questionnaire for idiosyncratic events such as that used in the present study section (see Supporting Information) may be a useful starting point.

There are a number of limitations of the current study that deserve comment. First, we did not control for the training and background of the informants. Therefore, these variables may have influenced the outcomes of the IAs. Second, a tangible condition was not initially conducted with participants for whom access to a tangible or activity was found to maintain behavior in the modified FA. If a tangible condition had been conducted, it is possible that an additional FA would not have been needed. Third, the IA in this study was not fully evaluated because only those items or events that were endorsed on the IA and also observed in the DA for 3 of 6 participants were examined. Including only a subset of items indicated by the DA did not allow for an evaluation of the overall predictive validity of the IA. Therefore, future research could more fully examine the IA by including events that were

and were not observed in a DA. Fourth, Daniel's assessment process involved video review, which was unrelated to the IA/DA process.

In summary, we developed and evaluated a novel IA tool specifically for the purpose of identifying idiosyncratic variables to test during a modified FA. This IA tool proved useful in identifying a range of potentially relevant and reliable idiosyncratic events to test. For five of six participants, events functionally relevant to problem behavior were identified and the FA modifications produced conclusive outcomes. A potential concern is that the IA indicated many nonrelevant events or false positives. Therefore, future research could evaluate ways to refine or enhance the efficiency of this type of assessment tool.

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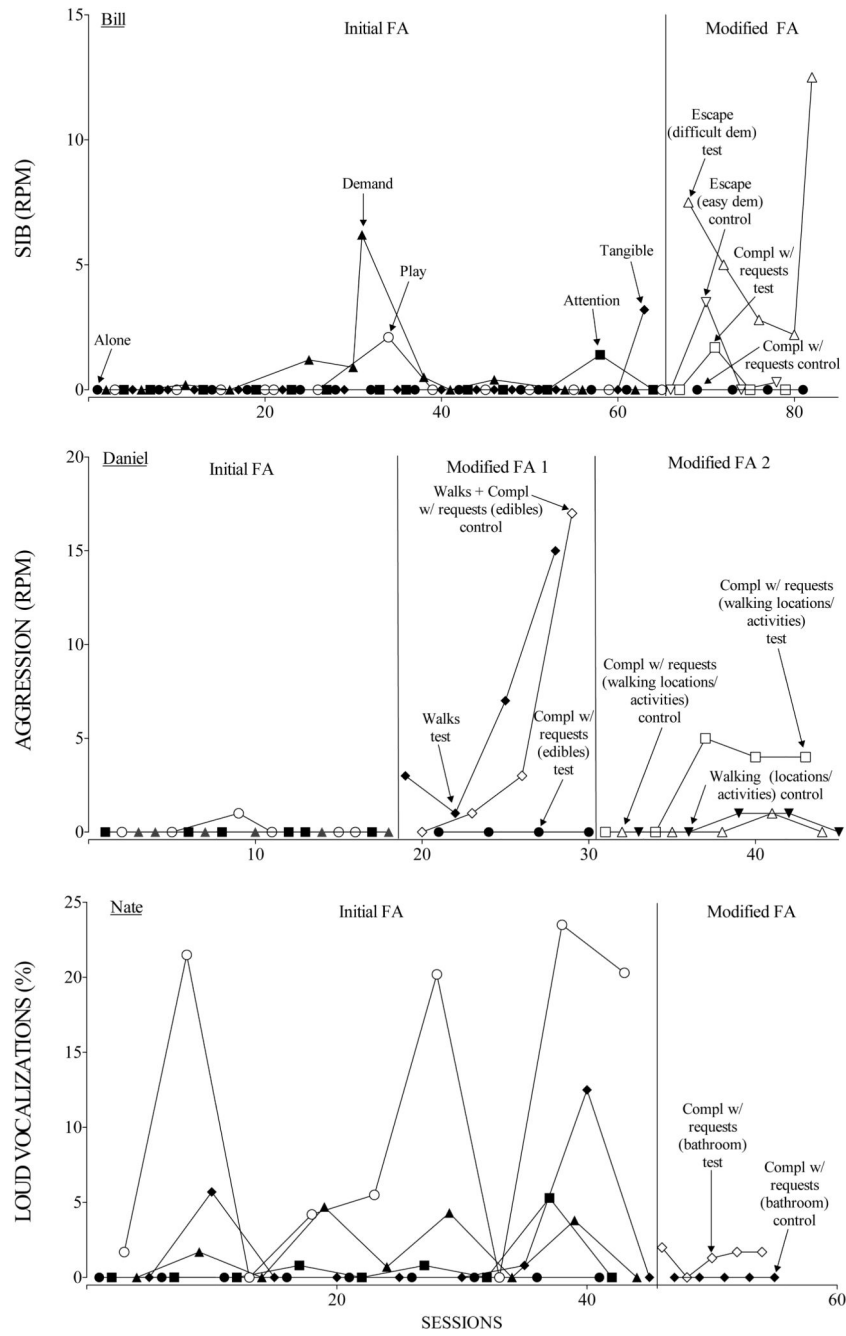


Figure 1.
Results of the functional analysis for Bill, Daniel, and Nate.

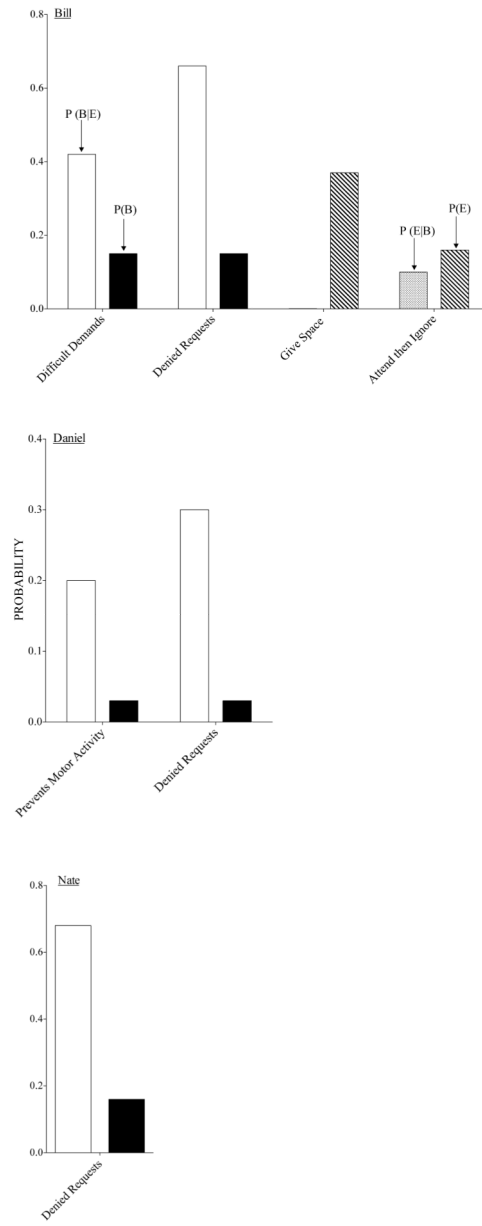


Figure 2.
Results of the descriptive analysis for Bill, Daniel, and Nate.

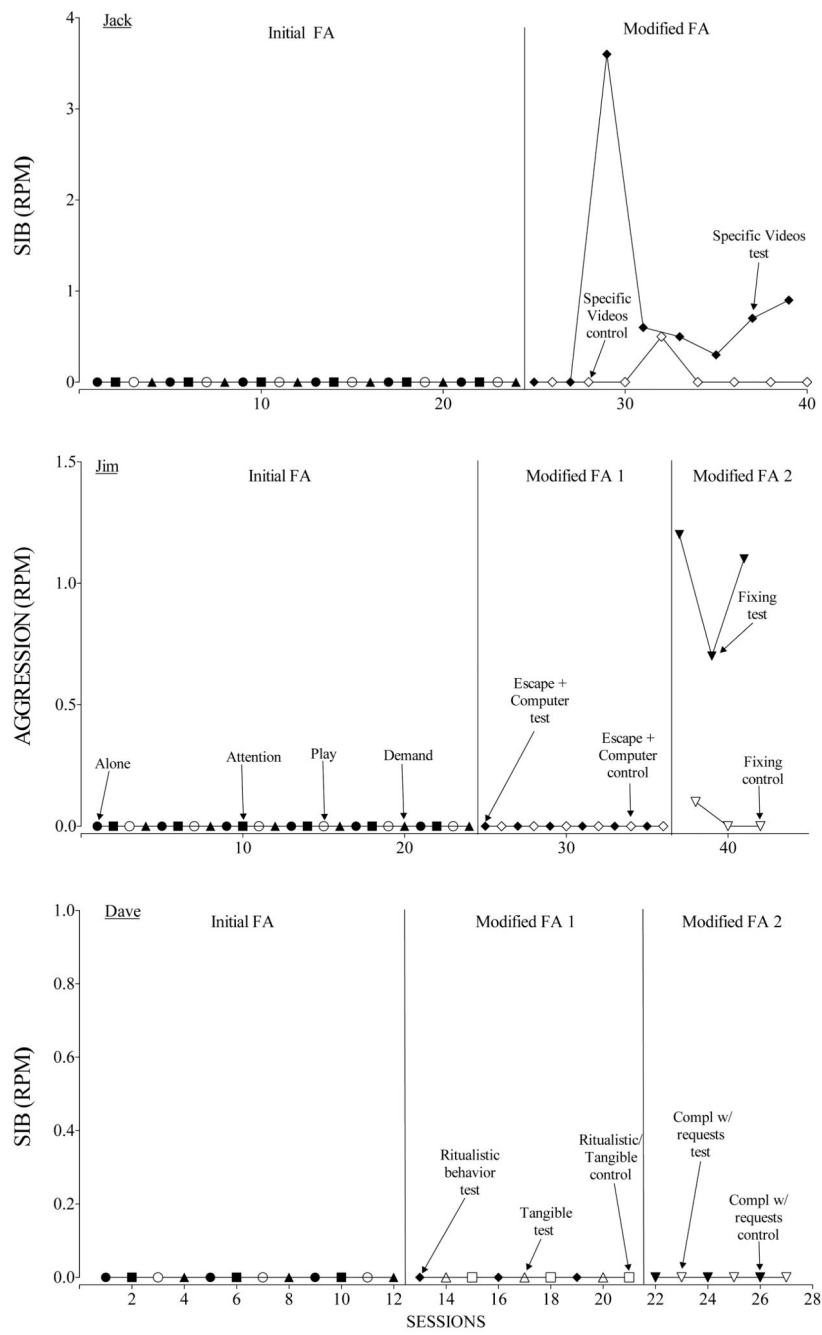


Figure 3. Results of the functional analysis for Jack, Jim, and Dave.

Table 1

Participant Characteristics

Name	Age (Yr)	Communication	PPVT MAE (Yr:Mo)	Target Behavior
Bill	15	Non-vocal; requested objects by pointing to pictures	Untestable (non-compliant)	Self-injurious behavior: Forcible contact between hand and head, or head and a stationary object
Daniel	12	Non-vocal; requested objects by pointing to pictures	Untestable (no basal score)	Aggression: Forcible contact between any portion of Daniel's body and any portion of the therapist's body, including open handed slaps, head butts, punches, and grabs
Nate	13	Vocal; spoke in full sentences	3:2	Loud vocalization: Vocalization louder than conversational level
Jack	13	Vocal; spoke in full sentences	3:6	Self-injurious behavior: Forcible contact between hand and head with a closed fist
Jim	19	Vocal; spoke in approximations to full sentences	3:0	Aggression: Forcible contact between any portion of Jim's body and the therapist's body, including open handed slaps and charging the therapist
Dave	8	Non-vocal; used a picture exchange communication system.	1:10	Self-injurious behavior: Forcible contact between hand and any body part, including open and closed handed hits to the head, legs, or chest

Note. PPVT MAE is the Peabody Picture Vocabulary Test (4th Ed.) Mental Age Equivalent score.

Table 2

Items Included in Phase 1, Initial FA Escape, Tangible, and Play Conditions.

Participant	Demands for Escape	Tangible Items	Play Items
Bill	Number ID (Point to indicated number), clap hands, put on coat, put foot on ball and give high five, one step instructions (stand up/sit down)	Edibles (olives)	Balloon, Play Doh™
Daniel	Sit down, do puzzle (basic jigsaw, put one piece in proper place), identity matching of pictures, gross motor imitation ("Do this" - pat belly), receptive identification of objects (pick up ball or pick up toothbrush)	N/A	Wiggles™ car that made music and engine noises, small rubber octopus
Nate	Set table (put plastic cup next to plate), sort silverware (fork, knife spoon put into bins), staple paper, paper clip paper, put paper in sheet protector	iPod Touch™	iPod Touch™, small rubber frog
Jack	Handwriting (copy sentences), addition (double digit numbers, e.g., 11+10), do sit-ups, respond to basic questions (e.g., what school do you go to, what is your birthday, what's your dad's name, what's your sister's name, what's your name), Jumping Jacks	N/A	Ball, Lincoln Logs™
Jim	Brush teeth, complete single digit math problems, trace objects, write name on paper, complete single insert puzzle	Oreo™ cookies	DVD Player, string (any kind)
Dave	Match objects to actions, count blocks, receptive identification of pictures, punch hole in paper using hole punch	N/A	Puzzles, Lite Brite™ (toy)

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Table 3

Indirect Assessment Results for Bill, Daniel, and Nate. Information in parentheses was obtained on follow-up and clarification questions. Items in italics were identified on both open- and closed-ended assessments. Asterisks indicate events tested in modified FA.

Bill	
Closed-ended	Average Rank
Caregiver does not comply with requests (edibles, time alone)*	4
<i>Caregiver asks individual to perform challenging task (putting on shoes)*(stringing beads)</i>	4
Caregiver asks individual to perform an activity of daily living or a physical education objective	4
Caregiver restricts access to preferred item for long duration	4
Caregiver asks individual to perform task or activity for long durations	4
Transitions occur, such as changing from one activity to another	4
Open-ended	Agreement
Denied access to liquids or water	Partial
<i>Starting non-preferred task</i>	Partial
Attend then ignore	Partial
Wait and give space	Partial
Daniel	
Closed-ended	Average Rank
<i>Caregiver prevents individual from engaging in motor activity (walks)*</i>	5
<i>Caregiver denies requests for items or takes them away (snack foods)*</i>	4.5
Open-ended	Agreement
<i>Denied access to a walk/walking*</i>	Exact
[Staff] Evade and block / evade and deflect	Partial
Wants something/item	Partial
Nate	
Closed-ended	Average Rank
<i>Denied requests for preferred items and activities and takes these away (bathroom for ritualistic behavior of pacing and clicking heels against the wall)* (soda, comfy chair)</i>	4.5
Restricted access to tangible provided by individual other than caregiver (soda, comfy chair)	4
Open ended	Agreement
Work	Exact
<i>Denied or interrupted access to preferred items or activities such as the bathroom (for ritualistic behavior of pacing and clicking heels against the wall)*</i>	Exact
Respond to first vocal with reminder to have a quiet voice	Exact
To get what he wants	Exact
Denied access (soda, comfy chair)	Partial
When agitated ignore or provide space	Partial

Table 4

Indirect Assessment Results for Jack, Jim, and Dave. Information in parentheses was obtained on follow-up and clarification questions. Items in italics were identified on both open- and closed-ended assessments. Asterisks indicate events tested in modified FA.

Jack	
Closed-ended	Average Rank
<i>Caregiver does not comply with requests (for access to specific videos*)</i>	5
Caregiver delivers a long break	5
Caregiver delivers break from their attention	5
Caregiver asks individual to perform non-preferred task / selected by caregiver	4
Caregiver delivers some form of attention	4
Open-ended	Agreement
Work/play periods	Exact
Non-exclusionary time out	Exact
Verbal reminders	Exact
<i>Trying to gain access to something (specific videos*)</i>	Exact
<i>Ending/denied access to preferred activities (specific videos*)</i>	Partial
Jim	
Closed-ended	Average Rank
<i>Denies requests for preferred items and activities and takes these away (computer)*</i>	4.5
<i>Caregiver presents a demand during a preferred activity (computer)*</i>	4
Caregiver presents a restraint	4
Open ended	Agreement
<i>Ending preferred activities (computer) to begin work in classroom*</i>	Exact
Running (to "fix" items such as token board, tote bag, school bag)	Exact
Classroom	Exact
Time out	Exact
Remind him of what he is earning	Exact
Likes physical attention	Partial
Dave	
Closed-ended	Average Rank
<i>Caregiver denies the individual's requests for preferred items or activities/takes items away (edibles, leisure items, ritualistic behavior)*</i>	4.5
<i>Caregiver tells individual to stop doing something (ritualistic behavior)*</i>	4
<i>Caregiver does not comply w/ the individual's requests (edibles) (going on trips)</i>	4
Open-ended	Agreement
<i>Denied access to ritualistic behavior (light switches, chairs)*</i>	Exact
<i>Attempting to gain access to denied items/activities (edibles, leisure items, ritualistic behavior)*</i>	Exact
Presenting blocking pad and PECs book following SIB	Exact