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Evaluating the utility of interview-informed synthesized contingency analyses in informing the treatment of problem behavior among children with autism spectrum disorder

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ABSTRACT

Although functional analysis is a widely researched tool for determining behavioral function, traditional formats are associated with limitations that often preclude their incorporation into practice. The interview-informed synthesized contingency analysis (IISCA) was developed to address such limitations. This study investigated the effectiveness and efficiency of the IISCA in determining the function of problem behavior for three non-vocal children with autism spectrum disorder and intellectual disabilities in a school setting. The effectiveness of the skill-based treatment process associated with the IISCA was also evaluated, as were the acceptability of these treatment procedures and the fidelity with which they were implemented. The IISCAs yielded differentiated outcomes immediately for two participants and following a secondary analysis for the third participant. Assessment results informed the design of treatments involving functional communication training and delay- and denial-tolerance training evaluated using a changing-criterion design. Implications and limitations are discussed and recommendations for future research are offered.

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by deficits in social communication and interaction, and restricted and repetitive behaviors (American Psychiatric Association, 2013). In addition to these core symptoms, problem behavior (PB) is common among children with ASD. PB is defined as "behavior . . . of such an intensity, frequency or duration as to threaten the quality of life and/or the physical safety of the individual or others and is likely to lead to responses that are restrictive, aversive or result in exclusion" (Banks et al., 2007, p. 10). Among a sample of 3- to 14-year-olds with ASD, McTiernan et al. (2011) reported that 93.7% of the children exhibited some form of PB. Almost half of these participants engaged in self-injurious behavior (SIB), while more than half engaged in aggression. Ninety-two percent engaged in stereotypy and all three topographies co-occurred for 35.6% of the sample. More

recently, aggression was reported to affect 25% of a large clinical sample of children with ASD (Presmanes Hill et al., 2014) and a comprehensive meta-analysis estimated SIB to be a concern for 42% of people with ASD (Steenfeldt-Kristensen et al., 2020).

PB has deleterious effects on the daily functioning and quality of life of the individual and his/her caregivers. The relationship between PB and psychological distress among parents whose children have ASD is well documented in the literature (Benson, 2014; Tomanik et al., 2004; Walsh et al., 2013). Topographies such as SIB are also associated with long-term consequences for the individual including soft tissue lacerations, contusions, permanent scars, and callus formation (Erturk et al., 2018). Given the social significance of PB, its treatment is an issue of paramount importance for practitioners in the area of service provision for children with ASD.

The behavioral approach to addressing this issue is based on the assumption that PB is a learned behavior that is maintained by environmental variables. As such, behavioral interventions aiming to eliminate PB focus on changing the relationship between target behaviors and the environments in which they occur. Identifying the variables that influence an individual's PB is therefore the first step towards precise and effective treatment. This process, known as functional behavior assessment (FBA), dignifies the treatment process by incorporating the individual's unique learning history into personally relevant treatment plans (Hanley, 2012).

There are a wide range of FBA strategies used in practice. These methods can be classified as either indirect (i.e., informant) assessments, descriptive (i.e., correlational) assessments, or experimental functional analyses (FAs; Oliver et al., 2015). Indirect approaches to FBA involve the use of interviews, rating scales, or questionnaires to gather information about the PB from the individual and/or others who are familiar with them. Although they are simple and quick to administer, these informant assessments have repeatedly been found to have poor reliability and validity (Alter et al., 2008; Dufrene et al., 2017; Hanley, 2012; Iwata et al., 2013). As indirect assessments rely on retrospective reports of environment-behavior relations (Oliver et al.) they can yield data that fail to endorse any hypothesis regarding behavioral function, strongly endorse all possible hypotheses, or indicate conflicting endorsements of hypotheses across raters (Rooker et al., 2015).

Descriptive assessments, on the other hand, are considered more scientific than indirect methods because they involve the direct observation of the target behavior and environmental variables as they naturally occur (Oliver et al., 2015). Yet despite the more objective nature of these assessments, they too have been criticized for their time-consuming nature and reliance on correlational data that highlight prevalent environmental events regardless of their relevance to PB (Hanley, 2012; Rooker et al., 2015). Functional relations are often inferred from correlational assessments, and the inconsistencies between these assessments and more robust experimental analyses are far from being unique in the literature (Lerman & Iwata, 1993; Pence et al., 2009; Tarbox et al., 2009).

The only FBA method that has the potential to demonstrate whether a functional relationship exists between PB and environmental variables is the experimental FA. First introduced in a landmark paper by Iwata et al., 1994, the FA systematically manipulates environmental variables within test and control conditions to determine whether PB is differentially affected across sessions. A functional relationship is demonstrated when the

behavior of concern is consistently elevated in one or more test conditions in comparison to the control condition. The experimental FA has repeatedly been shown to improve the efficacy of interventions aiming to eliminate PB. Function-based treatments that are guided by FA results have led to greater behavioral suppression than interventions that have not included an experimental FA (Campbell, 2003; Herzinger & Campbell, 2007; Heyvaert et al., 2014). As such, the FA has come to represent best practice and the "gold standard" for FBA (Delfs & Campbell, 2010, p. 5).

Despite empirical evidence supporting the utility of the FA model designed by Iwata et al., 1994, the standard procedure is associated with a number of limitations that may preclude its incorporation into clinical practice. This is illustrated by the finding that 63% of surveyed Board Certified Behavior Analysts (BCBAs®) have never or almost never conducted FAs (Oliver et al., 2015). Common limitations identified by practitioners include the time-consuming and resource-intensive nature of the FA, a lack of support from stakeholders, and the risks that are associated with evoking and reinforcing dangerous PB (Hanley, 2012; Iwata & Dozier, 2008; Oliver et al.). Concerns surrounding time and resources likely arise from the fact that multielement FAs take, on average, approximately two and a half hours to produce differentiated results (Saini et al., 2020). Even if a BCBA® has the time and resources to spend on these analyses, they may be reluctant to expose individuals to conditions designed to occasion PB for multiple hours given the short-term increases in the rate of PB and possible injuries that can occur during FAs (Kahng et al., 2014). Furthermore, researchers have suggested that traditional FA outcomes may not reflect the results that are typically obtained in clinical practice (Jessel, Hanley et al., 2020). For example, Hagopian et al. (2013) summarized the initial FA outcomes for 176 inpatients with severe PB and found that the standard FA yielded differentiated outcomes in only 46.6% of the cases, with subsequent modifications needed for differentiation in a further 40.3% of cases.

A number of modified FA procedures have been developed to compensate for these limitations (Lydon et al., 2012). While these analyses differ from the standard procedure in notable ways, the positive, negative, and automatic contingencies mirror the test conditions first described by Iwata et al., 1994. Another approach involves the use of idiosyncratic EOs and reinforcers within the test conditions rather than generic contingencies (e.g., attention, escape, alone; Hanley, 2012). The need for individualized conditions was highlighted by Schlichenmeyer et al. (2013), who identified more than 30 idiosyncratic variables across 42 studies. Hanley argued that by incorporating idiosyncratic contingencies into the FA design, practitioners can facilitate more efficient, ecologically valid, and clinically useful analyses.

In Hanley's (2012) model, an open-ended interview is first conducted to discover any potentially relevant environmental variables whose influence on PB may then be demonstrated in an individualized test-control analysis. This interview guides the development of a test condition that contains idiosyncratic EOs and reinforcers that are synthesized into a single contingency that is then compared to a matched control condition. This deviation from the standard FA, in which possible controlling contingencies are isolated in multiple standardized test conditions that are compared to an omnibus control condition, has precedent in the literature (DeLeon et al., 2003; Hagopian et al., 2007; Hanley et al., 2001; Slaton & Hanley, 2018), and has been found to control behavior when

isolated contingencies have yielded undifferentiated outcomes (Call et al., 2005; Dolezal & Kurtz, 2010; Mueller et al., 2005). This model is known as the interview-informed synthesized contingency analysis (IISCA).

The first successful application of the IISCA was demonstrated by Hanley et al. (2014). In this original study, open-ended interviews were conducted with the parents of three children with developmental disabilities to understand the context of their PB. These interviews were followed by brief observations during which the researcher recorded the language ability and PB of each participant while EOs were randomly manipulated. Finally, IISCAs were conducted to test the synthesized reinforcement contingencies that were apparent during the interviews and observations. Differentiated results were obtained during synthesized analyses for each participant. The resulting function-based treatments involved teaching functional communication responses (FCRs) of increasing complexity, teaching a response to reinforcement denial or delay, and thinning the schedule of reinforcement by chaining contextually appropriate behaviors. These interventions were reported to reduce PB to zero levels and increase functional communication, tolerance, and cooperation that persisted under intermittent schedules of reinforcement. Together, the IISCA and treatment process were found to be socially valid among parents.

Further evidence for the efficiency and effectiveness of the IISCA in identifying idiosyncratic contingencies and informing function-based treatments has continually been provided in the literature (Beaulieu et al., 2018; Boyle et al., 2020, 2019; Ferguson et al., 2020; Ghaemmaghami et al., 2016; Herman et al., 2018; Jessel et al., 2019; Jessel, Ingvarsson, Metras, Whipple et al., 2018; Rose & Beaulieu, 2019; Santiago et al., 2016; Slaton et al., 2017; Taylor et al., 2018). Coffey et al. (2020) reviewed this literature and reported the median analysis length to be 25 minutes, with 89% of analyses having strong experimental control and all IISCA-informed treatments producing 90–100% reductions in PB. However, the most convincing evidence for the utility of the IISCA can be found in the form of three large-scale studies conducted by Jessel and colleagues. In the first, Jessel et al. (2016) summarized 30 IISCAs that were conducted in an outpatient clinic with 27 participants of various ages and diagnoses. The IISCAs only required 25 minutes on average to complete and 22 of the 30 primary analyses yielded differentiated results. Secondary analyses were differentiated in seven cases and the remaining case required a tertiary analysis. The capacity of the IISCA to rapidly identify idiosyncratic variables influencing PB was further demonstrated by Jessel, Ingvarsson, Metras, Kirk et al. (2018). In this study, 25 additional applications of the IISCA were conducted with 24 children and adolescents with ASD and one with Tourette syndrome. All IISCAs yielded differentiated results, with the average analysis lasting 35.6 minutes. The resulting function-based treatments were socially valid and reduced PB by at least 90% within one week. More recently, Jessel, Metras et al. (2020) analyzed the outcomes of 26 IISCAs and determined that a majority of these analyses demonstrated differentiated results and strong functional control in sessions as short as 3 minutes. Together, these findings indicate that the IISCA is an efficient and effective model for obtaining clinically useful information regarding behavioral function that can lead to socially significant reductions in PB.

Despite the strength of the empirical evidence supporting the IISCA, some researchers have criticized this model for overemphasizing the importance of synthesis and discounting the roles of isolated contingencies in maintaining PB. For example, Fisher

et al. (2016) conducted the first comparison between the standard FA and the IISCA and found that both analyses produced equally differentiated results for four of five participants. It was argued that the IISCAs included functionally irrelevant contingencies that would have led to imprecise, complex, and cumbersome treatments. More recent comparative studies have suggested that false positives are likely following the IISCA (Greer et al., 2020; Holehan et al., 2020; Retzlaff et al., 2020), and the utility of synthesized contingencies was particularly scrutinized by Holehan and colleagues after they found interventions based on isolated and synthesized contingencies were similarly effective.

However, other researchers have opposed this perspective, as they found that the IISCA demonstrated more reliable control of PB than the standard FA (Slaton et al., 2017) and that IISCA-based interventions were more effective than treatments based on isolated contingencies (Anderson et al., 2019). Slaton and colleagues argued that the IISCA-based treatments were improved because the synthesized contingencies closely emulated the EOs and reinforcers that operated together in the natural environment. While these synthesized analyses could not identify the independent contribution of each isolated contingency, it may be the case that this information is of little practical benefit when developing interventions. Furthermore, although Fisher et al. (2016) predicted that the inclusion of potentially incidental stimuli would lead to more cumbersome treatments, it is possible that the ecological validity associated with synthesized treatments could enhance treatment fidelity and acceptability. Given that neither of these variables have been measured in the comparative studies to date, the question as to whether synthesized contingencies result in more cumbersome treatments remains unanswered.

On the basis of the evidence presented, it may be concluded that there is considerable empirical support for the utility of the IISCA in informing function-based treatments that are effective in reducing PB. However, there remain several important weaknesses in this literature to date. Only 1 of the 90 participants whose data were reviewed by Coffey et al. (2020) was reported to have an intellectual disability and 75% of these participants communicated vocally. The authors also highlighted that limited data had been published regarding critical treatment components such as treatment fidelity, treatment acceptability, and generalization of behavior change. The present study sought to address these issues and answer the following research questions: (1) Is the IISCA an efficient and effective model for determining the function of PB among children with ASD/intellectual disability who are non-vocal?; (2) Is the associated function-based treatment process effective?, and (3) Are these treatment procedures acceptable and implemented with fidelity?

Method

Participants

Participants were three children who received 28 hours of behavior-analytic intervention per week at a school for individuals with ASD and complex needs. All children engaged in severe forms of PB that produced tissue damage in themselves or others. Strategies aiming to address these behaviors included response blocking and redirection.

Alex

Alex was a 6-year-old boy who was diagnosed with ASD and mild intellectual disability who had been attending the school for two years. Although he used the Picture Exchange Communication System (PECS) to make simple requests, he required prompting to use his PECS book and it was unclear whether he could consistently discriminate between the pictures in the book. His Individual Education Plan (IEP) highlighted his proficiency in following directions. His social, imitation, toleration, matching, discrimination, self-care, and language skills were targeted for improvement. Alex engaged in high levels of motor and vocal stereotypy. He also engaged in aggression in the form of slapping, pinching, grabbing, scratching, kicking, and pulling hair and SIB in the form of hitting his hands against his face and head.

James

James was a 6-year-old boy who was diagnosed with ASD and co-occurring global developmental delay and moderate intellectual disability according to an independent psychological report. James had been attending the school for three and a half years. He used PECS to communicate and had recently begun imitating the vocal verbal behavior of others and spontaneously emitted vocal mands. His IEP highlighted strengths in the areas of following directions, imitation, matching, and following visual schedules. His toleration, sorting, play, social, self-care, and language skills were targeted for improvement. James engaged in aggression in the form of hitting, pinching, scratching, kicking, and pulling hair. He also engaged in SIB in the form of pinching himself, banging, hitting, scratching his head with his hands, and hitting his head against hard surfaces.

Reese

Reese was a 7-year-old boy diagnosed with ASD and co-occurring moderate intellectual disability who had been attending the school for three and a half years. He communicated using the Proloquo2Go app on an iPod touch. He also imitated the vocal verbal behavior of others on occasion. His IEP highlighted strengths in the areas of following directions and imitation. His toleration, discrimination, categorization, and language skills were targeted for improvement. Reese engaged in aggression in the form of pinching and biting and SIB in the form of hitting his head against hard surfaces, hitting his hand against his head, pinching himself, and biting his hands.

Setting and materials

Alex's initial FA and all sessions for James and Reese, were conducted at their desks in their regular classroom. Alex's secondary FA and treatment sessions began in the break area in the corner of the classroom, which contained a soft mat, a bean bag chair, and storage for toys and books. Some parts of these sessions were also conducted at his desk. For Alex and James, probes for generalization across stimuli were conducted in the school's gymnasium. Other students and tutors were typically present in both the classroom and the gymnasium as they followed their usual school routines. The educational

materials and preferred items used with each participant were identified by the open-ended interviews. For Alex and James, two sizes of picture card were used during the intervention phase: one measuring 10.2 cm x 10.2 cm and the other measuring 5.1 cm x 5.1 cm. The latter was attached to a wristband using Velcro.

Response definitions and measurement

Sessions were video recorded, which allowed the trained observers to score instances of PB, functional communication responses (FCRs), and tolerance responses using pen and paper recording. These data were collected during continuous 10-second intervals and summarized as number of responses per minute, with the total number of responses within each session being divided by the session duration in minutes.

PB for all participants included aggression and SIB. For Alex and James, aggression was defined as forceful contact of the participant's feet, legs, arms, or hands with another person's body. For Reese, aggression was defined as pinching any part of another person's body and any contact between the participant's teeth and another person's body or clothing. Alex's SIB was defined as forceful contact of the participant's hands with his own body. For James, SIB was defined as forceful contact of the participant's head, hands, or elbows with his own body or another object or surface. The definition of SIB for Reese was forceful contact of the participant's head with an object or surface, forceful contact of his hands with his own body, pinching his own body, and any contact between the participant's teeth and his own body or clothing. For all target behaviors, each discrete contact was counted as a single instance.

Alex's teacher and BCBA® recommended that he first be taught to emit an additional simple FCR due to the severity of his PB and the slower rate at which he acquired new responses. The first simple FCR that he was taught involved tapping a 10.2 cm x 10.2 cm picture card that read "my way" in the tutor's hand. Then, he was required to pick the card up directly in front of him and hand it to the tutor. Alex's complex FCR was defined as retrieving a 5.1 cm x 5.1 cm version of the picture card that was attached to a wristband using Velcro and handing it to the tutor. For James, the simple FCR involved picking up a 10.2 cm x 10.2 cm "my way" picture card directly in front of him and handing it to the tutor. His complex FCR was defined in the same way as Alex's. Reese's FCR involved pressing the "my way" icon on the home page of the Proloquo2Go app. The tolerance response for all three boys was defined as the participant placing his hands together on the desk or in his lap.

FCRs and tolerance responses were considered prompted if any vocal, gestural, or physical prompts were provided to aid the participant in emitting a correct and complete response. Only independent FCRs and tolerance responses are reported below.

Interobserver agreement (IOA)

A second trained observer independently collected data on target behaviors and treatment fidelity for at least 30% of sessions in each condition for each participant to obtain IOA. For target behaviors, total count IOA was calculated by dividing the smaller number of responses recorded in a session by the larger number and multiplying by 100. The mean IOA for Alex was 95.64% (range = 76.6–100%), for James 98.58%

(range = 70–100%) and for Reese 94.37% (range = 63–100%). For treatment fidelity, total count IOA was calculated by dividing the smaller score recorded for a session by the larger score and multiplying by 100. IOA for treatment fidelity averaged 96.7% (range = -87.5–100%) for Alex, 94.9% (range = 87.5–100%) for James, and 97.2% (range = 87.5–100%) for Reese.

Experimental design

A multielement design was used to compare the test and control conditions within each IISCA. Treatment evaluation followed a changing-criterion design, with functional control being demonstrated when levels of PB and alternative responses corresponded in the expected direction to successive changes in the reinforcement contingencies for those responses (see Hanley et al., 2014).

Procedure

Functional assessment
Interviews and observations. Open-ended interviews were conducted with the participants' class teacher to discover potential environmental variables influencing the participants' PB. Questions related to each participant's preferences, skills (e.g., "describe the child's language abilities"), topographies of PB (e.g., "what is the single most concerning PB?"), antecedents to PB (e.g., "under what conditions or situations is PB most likely to occur?"), and consequences following PB (e.g., "how do you and others react or respond to PB?"). Additional clarifying questions were asked as necessary. Each interview lasted approximately 10 minutes. The researcher then observed each participant in the classroom for 15 minutes, informally interacting with him and noting his language ability and instances of PB. The results of the interview and observation served to inform the condition to be tested in the FA, which included escape from academic demands to preferred tangible items.

Experimental analyses. All FAs were conducted by the experimenter who was the first author. A BCBA® who worked for the school supervised the analyses to ensure that they were conducted in accordance with best practice. The information obtained from the interviews and observations was used to design a single test condition for each participant's IISCA. Matched control conditions were designed from the test conditions, with the only difference between the two being the presence or absence of the suspected reinforcement contingency. During control sessions, which were conducted first, the participants had continuous and noncontingent access to all putative reinforcers. No programmed consequences followed PB in this condition. Test sessions began with the arrangement of EOs that were suspected of evoking PB for each participant. If PB occurred, the researcher immediately provided all putative reinforcers for 30 seconds before arranging the EOs again. PB during the reinforcement interval produced no programmed consequences. Both test and control sessions lasted 5 minutes.

During the control condition of Alex's first analysis, he was given uninterrupted access to highly preferred items at his desk. The experimenter refrained from entering the instructional area, presenting demands, or blocking his stereotypy. In the test condition,

the experimenter entered the instructional area and removed Alex's access to the items. She blocked his motor stereotypy by gently lowering his hands and said "OK Alex, it's time for work" while presenting educational materials and tasks. A combination of verbal, gestural, and physical prompts were used as needed to promote cooperation. If PB occurred, the experimenter was to stop issuing demands and blocking Alex's stereotypy, provide access to the highly preferred items, and remove herself and all educational materials from the instructional area. However, no PB was evoked in two consecutive test sessions during this initial analysis so a secondary analysis was necessary.

Alex's tutors reported that he most often engaged in PB when access to tangible items in the classroom's break area was terminated. As such, the secondary analysis involved a control condition in which Alex had uninterrupted access to the same tangible items in the break area. The experimenter refrained from entering the break area, presenting demands, or blocking his stereotypy. During the test condition, the experimenter entered the break area, removed Alex's access to the items, and began to block his motor stereotypy. She said "OK Alex, it's time for work" and put his shoes and socks on before guiding him to stand up and transition to the instructional area, where she presented educational materials and tasks. A combination of verbal, gestural, and physical prompts were used as needed to promote cooperation. If Alex engaged in PB, the experimenter immediately stopped issuing demands and removed all educational materials. She guided Alex to the break area, where she removed his shoes and socks as his preference and provided access to the highly preferred items before removing herself from the area.

The control condition for James consisted of uninterrupted access to highly preferred items at his desk. The experimenter refrained from entering the instructional area or presenting demands. During the test condition, she entered the instructional area and removed James' access to the items. She said "OK James, toys and books are finished. It's time for work" before presenting educational materials and tasks. A combination of verbal, gestural, and physical prompts were used as needed to promote cooperation. If James engaged in PB, the experimenter stopped issuing demands, provided access to the highly preferred items, and removed herself and all educational materials from the instructional area.

Reese's analysis followed the same procedures as those reported for James.

Treatment

Treatment for PB was based on the procedures described by Hanley et al. (2014). Sessions consisted of 10 trials and were conducted four to five days per week, with three sessions per day during the initial phases of treatment, and two sessions per day during the reinforcement thinning phase.

Treatment sessions were conducted by the experimenter and four tutors who had accumulated extensive training and experience in implementing behavioral interventions and collecting data. The experimenter trained the tutors to implement each phase of the intervention by providing instructions, modeling the procedure, observing practice sessions, and providing feedback. Each trial began when the tutor arranged the synthesized EO that had been shown to evoke PB in the differentiated FAs. Participants were taught to emit each target response in each phase using most-to-least prompting. Tutors initially provided full physical prompts and faded to partial physical and gestural prompts within and across sessions as the participant began to respond more independently. The

reinforcers from the differentiated FAs were provided for 30 seconds following the target response before a new trial began. If PB occurred at any time during a session, reinforcement was withheld for 5 seconds. The participant was prompted to emit the target response and all reinforcers were immediately reinstated contingent on this response.

Baseline. Data collected during the test sessions of the differentiated FAs served as baselines for the treatment evaluations.

Simple functional communication training (FCT). Alex and James were taught to emit simple FCRs following the arrangement of the synthesized EOs that had been shown to evoke PB in their differentiated FAs. The criterion for this phase was three consecutive sessions with 100% independent responding in the absence of PB.

Complex FCT. Each participant was taught to emit a complex FCR following the arrangement of the synthesized EO. Simple FCRs were placed on extinction for Alex and James. The criterion for this phase was two consecutive sessions with 100% independent responding in the absence of PB.

Delay- and denial-tolerance training. At the beginning of this phase, two of every five complex FCRs that were emitted, following the arrangement of the synthesized EO, produced immediate reinforcement. The tutor responded to the remaining complex FCRs by issuing cues of reinforcement denial or delay (e.g., "not right now"). Each participant was taught to emit the tolerance response following these cues. Reinforcement was initially provided immediately following the tolerance response. After three consecutive sessions with 100% independent responding in the absence of PB, the delay to reinforcement was gradually increased.

The participants were exposed to a chained schedule using differential reinforcement of alternative behavior during reinforcement thinning. One of every five complex FCRs still produced immediate reinforcement and the tolerance response was also reinforced immediately in one of every five trials. Participants were required to engage in contextually appropriate responses that varied in difficulty and number following the remaining tolerance responses (i.e., in 60% of trials). Simple contextually appropriate responses consisted of educational tasks that the participants had mastered. Tasks that had not yet been mastered were selected as the more difficult contextually appropriate responses. If PB occurred during the delay, the number of responses required was reset. The difficulty and number of responses increased each time the participant met the criterion of two consecutive sessions with 100% independent responding in the absence of PB.

Given that this phase of the treatment centered around the intermittent and unpredictable reinforcement of communication, tolerance, and contextually appropriate behavior, a random number generator was used to determine which target response would be reinforced during each trial. Participants were exposed to all possible outcomes following an FCR before any outcome was repeated.

If a participant failed to emit either an FCR or a tolerance response during a delay- and denial-tolerance training trial, the appropriate response was prompted before the procedure continued as normal. For example, if a participant did not emit an FCR in response to the arrangement of the synthesized EO the tutor prompted him to emit this response before presenting a denial cue.

Treatment extension. Maintenance of treatment effects was assessed after a four-week break, with the experimenter conducting one session with each participant according to the terminal treatment procedures. A novel tutor who had no experience working with the participants then conducted one session with each participant to assess for generalization of the treatment outcomes across people. Probes for generalization across stimuli were also conducted for each participant. The experimenter terminated access to novel preferred stimuli (the school's gymnasium for Alex and James and kinetic sand for Reese) and reinstated access contingent on functional communication and tolerance responses.

Treatment fidelity. Treatment fidelity was measured during all treatment sessions for each participant. Trained observers recorded what percentage of the steps involved in the procedure was implemented as prescribed using checklists that were specific to each phase of the treatment.

Treatment acceptability. Treatment acceptability was measured using the Treatment Acceptability Rating Form-Revised (TARF-R; Reimers et al., 1992), which was administered to all four tutors who had implemented the intervention. The TARF-R is a self-report measure comprising 20 questions, each accompanied by an anchor point descriptor to which raters respond on a six-point Likert-type scale. The items pertain to treatment acceptability, severity of the PB, and understanding of the intervention. Total acceptability scores can range from 17 to 119, with higher scores indicating greater treatment acceptability.

Results

### Functional assessments

Open-ended interviews

No precursors to the topographies of PB defined above were identified during the open-ended interviews. The teacher's responses suggested that all participants were likely to engage in PB when access to preferred items was restricted and when academic demands were presented. It was reported that tutors sometimes restricted access to preferred items and presented academic demands simultaneously, but these types of antecedents were also reported to occur in isolation. Although tutors attempted to follow through when PB occurred after they had removed or denied access to items and/or presented academic demands, the teacher recognized that it was sometimes necessary to "give in" in order to protect the students from harming themselves or others. It was hypothesized that escape from academic demands to preferred tangible items was a synthesized contingency that contributed to the maintenance of PB for all participants.

FAs

Results of the FAs are presented in Figure 1. No PB was observed during the initial analysis for Alex. PB was also at zero levels during the first test session of his secondary analysis. However, high levels of PB occurred during the subsequent three test sessions of this analysis and there was no PB in either control session. In James' FA, PB occurred at zero or near-zero levels during control sessions and at high levels with some variability during test sessions. There was no overlap between test and control conditions, indicating that his PB was sensitive to at least one of the contingencies included in the synthesized test condition. Similarly, Reese engaged in PB at high levels with some variability during test sessions and at zero levels during control sessions. Taken together, results of the FAs supported the findings from the open-ended interviews and implicated escape from academic demands to preferred tangible items in the maintenance of PB for all participants.
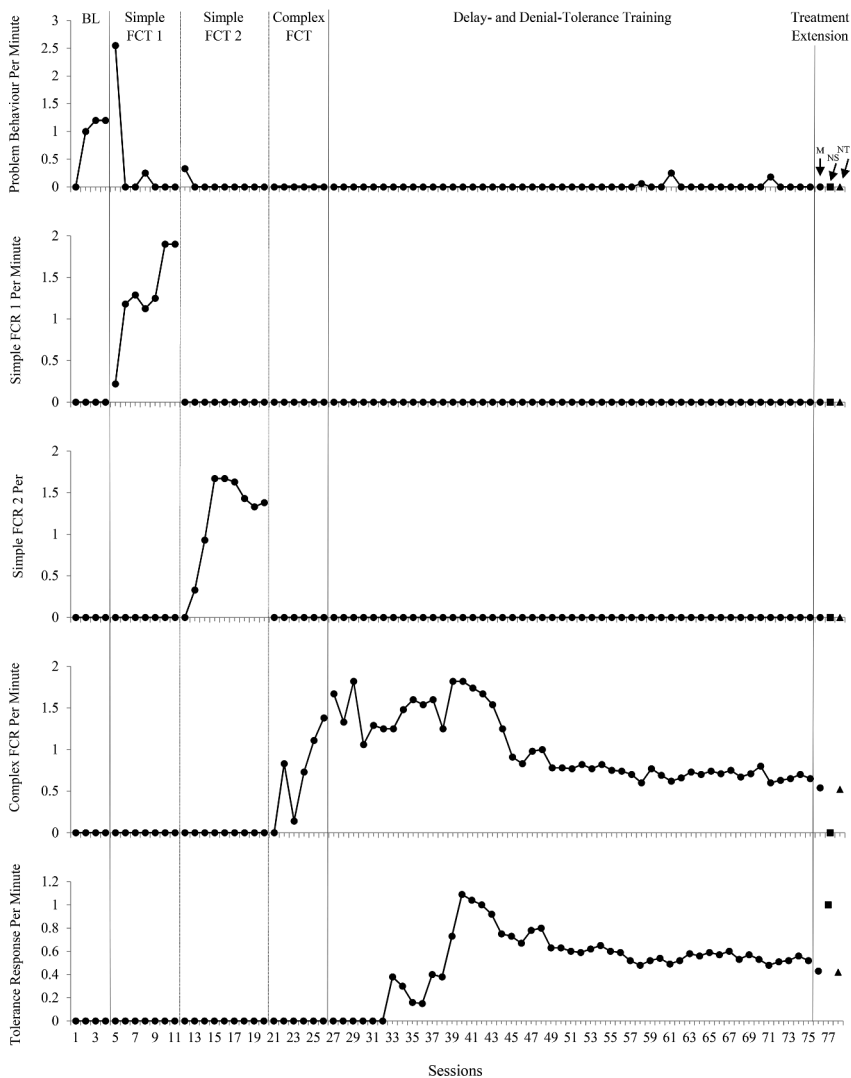
Treatment evaluation

The results of Alex's treatment evaluation are presented in Figure 2. Although he engaged in approximately twice as much PB during his first simple FCT session than during baseline, PB was below baseline levels for the remaining 70 treatment sessions and at zero levels for 64 of these. All FCRs and tolerance responses increased when and only when the reinforcement contingency was assigned to them, demonstrating functional control of the treatment. As additional responses were being chained to the tolerance response, complex FCRs and tolerance responses maintained at optimal levels despite being reinforced only 20% of the time. Note that fewer complex FCRs and tolerance responses were emitted per minute as the duration of the delay and sessions increased with the progression of reinforcement thinning. The terminal task requirement for Alex was 13 instructions. During treatment extension, Alex emitted the complex FCR and tolerance
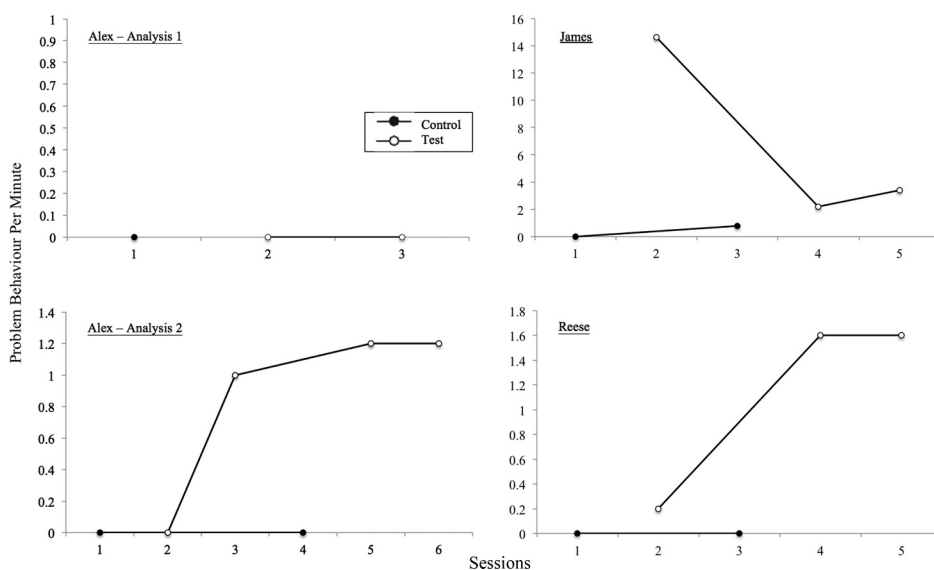
Figure 1. Results of the functional analyses conducted with Alex, James, and Reese.

response at optimal rates and in the absence of PB after a four-week break and in the session that was conducted by the novel tutor. However, he did not emit an independent FCR when access to the school's gymnasium was terminated. This response was prompted and a denial cue was provided, following which Alex emitted an independent tolerance response.

Similar positive results were observed during James' treatment evaluation (see Figure 3). His PB was high and variable during baseline, decreased immediately when simple FCT was introduced, and remained below baseline levels for the remainder of the study. Both FCRs were acquired immediately when they began to produce the reinforcers

Figure 2. Results of the treatment evaluation for Alex. BL = Baseline; FCT = Functional Communication Training; FCR = Functional Communication Response; M = Maintenance; NS = Novel Stimulus; NT = Novel Tutor.

identified during the IISCA, with the complex FCR persisting throughout delay- and denial-tolerance training. Eleven sessions were required for James to begin emitting the tolerance response independently. This response also persisted during reinforcement thinning. When the evaluation was terminated, PB was at zero, complex FCRs and tolerance responses persisted despite being reinforced only 20% of the time, and James was complying with up to 10 consecutive instructions before access to reinforcement was reinstated. He emitted the complex FCR and tolerance response at optimal levels during the sessions that were conducted after a four-week break and by the novel tutor. Low rates of PB were observed during these sessions. Although no PB occurred during the generalization across stimuli probe, James did not emit an independent FCR when access to the school's gymnasium was terminated. This response was prompted and a denial cue was provided, following which he emitted an independent tolerance response.

As illustrated in Figure 4, Reese's PB appeared to be insensitive to the introduction of FCT. Although three consecutive sessions with no PB satisfied the criterion for beginning delay- and denial-tolerance training, PB remained highly variable throughout the treatment evaluation and often overlapped with baseline levels. However, elevated rates of the FCR and tolerance response were observed when the reinforcement contingency began to support these responses. Reese began to emit the FCR independently during the first FCT session and acquired the tolerance response after 13 teaching sessions. Both were occurring at optimal levels at the end of the study. Given that no PB occurred during the final treatment sessions, Reese's behavior met the criterion for beginning reinforcement thinning before the evaluation was terminated. Independent FCRs and tolerance responses occurred at optimal rates during the sessions that were conducted after a four-week break and by the novel tutor. PB was observed during the latter session. When access to kinetic sand was terminated during the probe for generalization across stimuli, Reese used the Proloquo2Go app to mand for "sand" rather than "My way" and emitted an independent tolerance response following the denial cue.

Treatment fidelity evaluation

Treatment fidelity scores were generally high during all phases across all participants. The average treatment fidelity score during simple FCT was 94.5% (range = 66–100%). Scores averaged 92.77% (range = 70–100%) during complex FCT. During delay- and denial-tolerance training, treatment fidelity was 96.55% on average (range = 87.5–100%).

Treatment acceptability evaluation

Results from the TARF-R (Reimers et al., 1992) indicated that the treatment procedures were rated as highly acceptable by all four tutors who had implemented them ($M = 105$). They reported the procedures to be acceptable and effective, agreeing that they were willing to adapt their classroom routines to facilitate continued delivery of the intervention.

Discussion

The functional assessment process described by Hanley et al. (2014) implicated the synthesis of escape from academic demands and access to preferred items in the maintenance of PB for three non-vocal boys with ASD and intellectual disabilities in a school
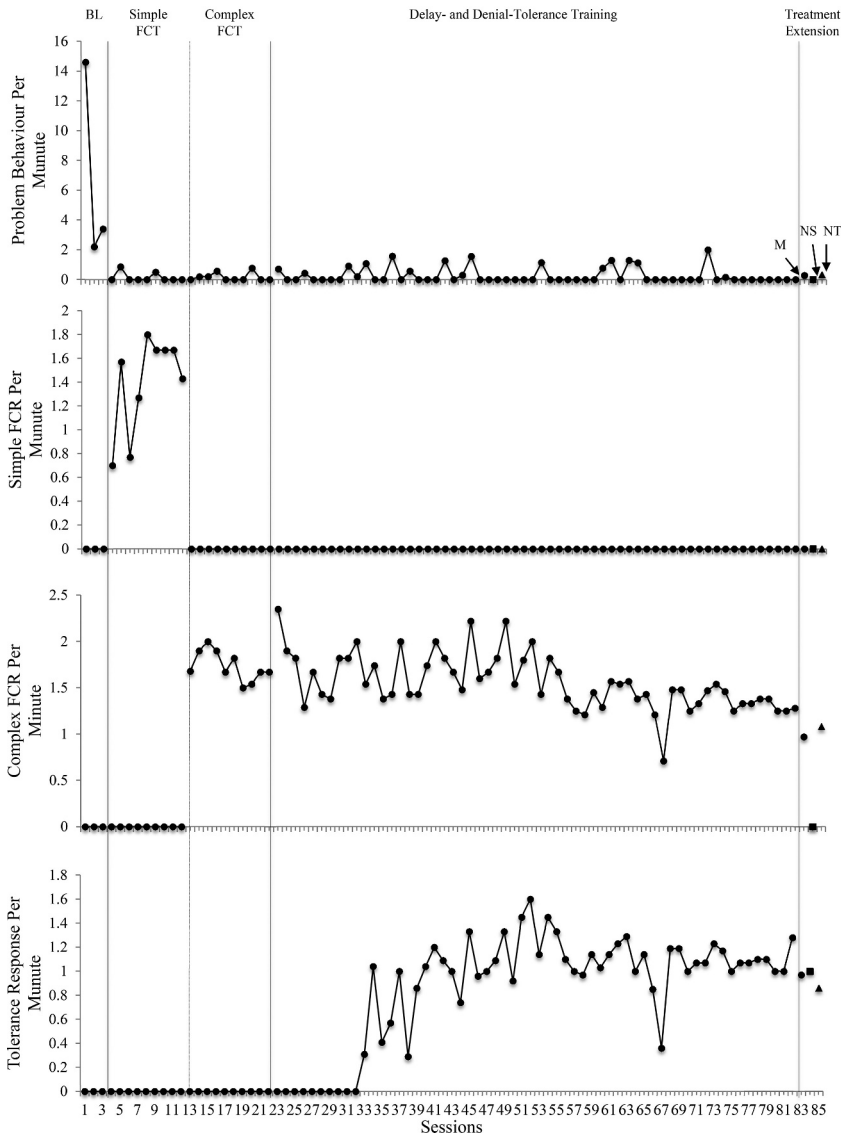
Figure 3. Results of the treatment evaluation for James. BL = Baseline; FCT = Functional Communication Training; FCR = Functional Communication Response; M = Maintenance; NS = Novel Stimulus; NT = Novel Tutor.

setting. In addition to replicating the naturally occurring evocative situations and demonstrating control over PB, the differentiated IISCAs identified motivating contexts for skills teaching and provided adequate baseline data against which to evaluate treatment. Teaching functional communication and tolerance skills was effective in reducing PB for two participants and all participants acquired the target skills. Treatment effects were extended across time and people and the procedures were found to be acceptable and implemented with fidelity. The significance of these findings in light of the research questions and previous research merits further exploration.
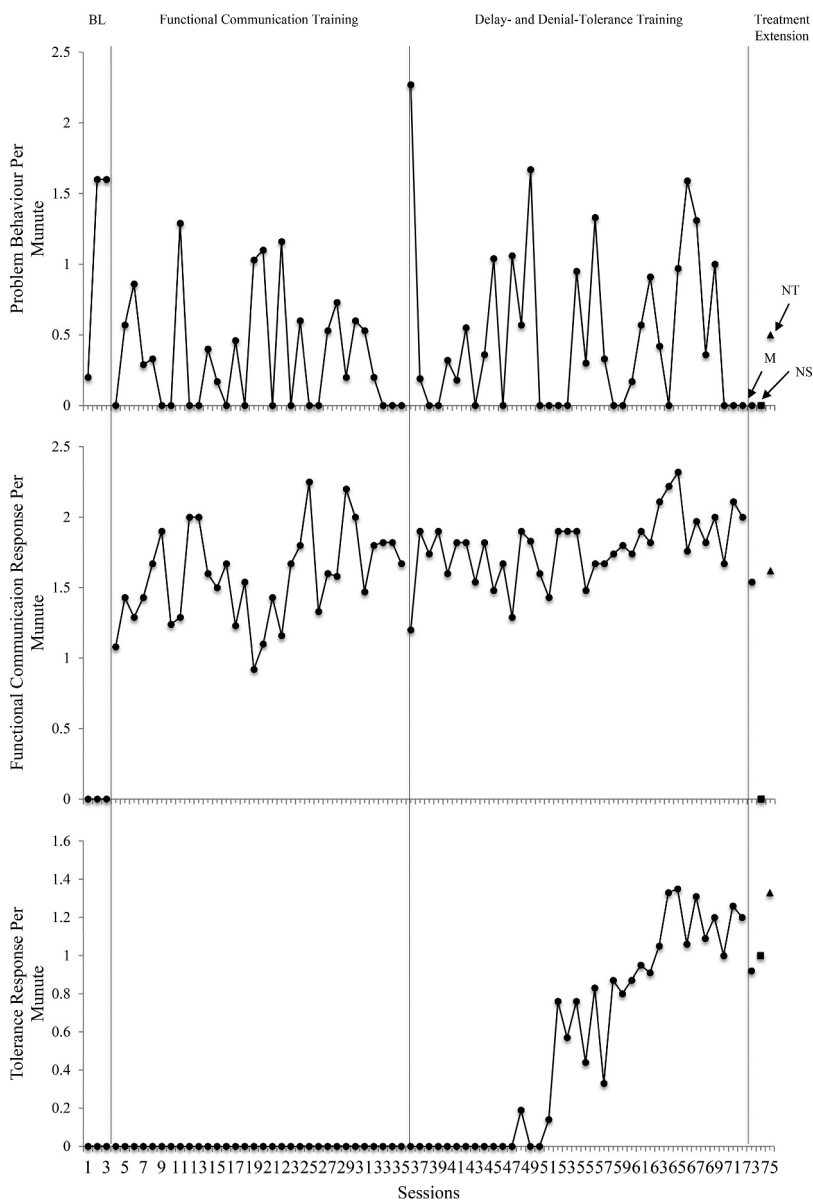
Figure 4. Results of the treatment evaluation for Reese. BL = Baseline; M = Maintenance; NS = Novel Stimulus; NT = Novel Tutor.

The results of this study are consistent with previous findings supporting the IISCA as an efficient and effective model for determining the function of PB among children with ASD (Beaulieu et al., 2018; Boyle et al., 2020, 2019; Ferguson et al., 2020; Ghaemmaghami et al., 2016; Hanley et al., 2014; Herman et al., 2018; Jessel et al., 2016, 2019; Jessel, Ingvarsson, Metras, Kirk et al., 2018; Jessel, Ingvarsson, Metras, Whipple et al., 2018; Rose & Beaulieu, 2019; Santiago et al., 2016; Slaton et al., 2017, 2017; Taylor et al., 2018). Furthermore, this study added to the extant literature by examining the utility of the

IISCA for non-vocal children with ASD and intellectual disability. The assessment process was completed in less than an hour for each participant and IISCAs yielded differentiated outcomes immediately for James and Reese and following a secondary analysis for Alex. The fact that Alex's IISCA required redesign to more closely emulate natural contingencies illustrated that conclusions regarding behavioral function could not have been reached based on interview and observation alone. Analysis and, in Alex's case, reanalysis were necessary to demonstrate the relevance of the putative reinforcers that had been discovered through the interviews and observations. The speed with which the IISCA identified the functional reinforcers for each participant's PB supports the conclusion that the IISCA may be considered a safe and efficient approach to FA that yields clinically useful information regarding behavioral function. The present study adds to the current literature by extending these conclusions to non-vocal participants with ASD and intellectual disabilities.

The present findings also support the effectiveness of the function-based treatment process described by Hanley et al. (2014) for a representative sample of non-vocal children with ASD and intellectual disabilities. In line with previous research (Jessel et al., 2019; Jessel, Ingvarsson, Metras, Kirk et al., 2018; Jessel, Ingvarsson, Metras, Whipple et al., 2018; Santiago et al., 2016), FCT followed by delay-and denial-tolerance training successfully reduced PB for Alex and James and strengthened communication and tolerance skills for all participants. This demonstrates that these socially important skills can be taught using synthesized contingencies of reinforcement identified through interview, observation, and analysis. Furthermore, this study supports Santiago and colleagues' conclusion that these outcomes can be obtained when the intervention is implemented in school settings despite potential confounds such as noise levels in the classroom. In fact, it may be the case that implementation of the treatment procedures by the participants' tutors in their classroom enhanced ecological validity and thereby promoted generalization (i.e., training in natural environment). All participants demonstrated the target skills during sessions that were conducted after a four-week break and by a novel tutor. Presenting multiple exemplars of denial cues (e.g., "it's finished", "it's my turn", "not right now", "you'll have to wait") and an array of participant-specific academic demands throughout the treatment process may also have promoted generalization. It could be concluded that the treatment process described by Hanley and colleagues can produce positive effects that extend across time and people when implemented in school settings.

The insensitivity of Reese's PB to the treatment procedures must be discussed in terms of underlying causes and broader implications. Reductions in PB of at least 90% were reported following all applications of the IISCA that were reviewed by Coffey et al. (2020), suggesting that this is an issue without precedent in the literature. Affirming the consequent has been conceptualized as a method of determining the validity of the IISCA through evaluation of its ability to inform effective treatment (Coffey et al.; Sidman, 1960). From this perspective, the positive treatment results that were observed for Alex and James support the validity of their assessment results. Conversely, the fact that Reese's IISCA-informed intervention had no effect on his PB could be interpreted as suggesting that his IISCA failed to identify the true function of his PB despite yielding differentiated results. However, affirming the consequent is widely recognized as a logical fallacy (see Bowles, 1996) and the validity of the participants' assessment results cannot

simply be inferred from the results of their treatment evaluations. It is more likely that procedural differences during Reese's treatment yielded unfavorable results in comparison to Alex and James. The latter two participants were initially taught simple, picture-based FCRs that required very little effort. The simplicity and efficiency of these FCRs could have been critical to the reductions in Alex's and James' PB. It may be the case that locating and pressing the "my way" icon on the home page of the Proloquo2Go app was too difficult for Reese during the initial treatment phase and that simple FCRs similar to those taught to the other participants should have preceded this. Alternatively, Metras and Jessel (2021) described an emerging "performance-based" IISCA format in which reinforcement interval length is variable and determined by individualised indices of happiness, relaxation, and engagement. It is possible that these adaptations could have resulted in more positive treatment results for Reese.

The finding that none of the participants generalized the omnibus mand across stimuli also warrants further discussion. While Hanley et al. (2014) observed generalization of communication skills to novel evocative situations for all participants, Alex and James required prompting to emit the complex FCR when access to the school's gymnasium was terminated. Similarly, Reese emitted a specific mand for kinetic sand rather than the omnibus mand during the generalization probe. Failure of omnibus mands to generalize across stimuli has precedent in the literature (Berg et al., 2007; Tsami & Lerman, 2020) and is deeply problematic. If participants only learn to communicate in the presence of specific establishing operations, then this restricted stimulus control might impede appropriate responding in evocative contexts that are not identical to those during treatment.

A related phenomenon that has been theorized to affect generalization across stimuli among people with ASD is stimulus over-selectivity, which occurs when responding is controlled by only a subset of the relevant stimuli (e.g., Falcomata et al., 2007). Unlike Hanley et al. (2014) participants, the participants in the present study and those in studies conducted by Berg et al. (2007) and Tsami and Lerman (2020) were diagnosed with an intellectual disability co-occurring with ASD. This may have affected stimulus over-selectivity and generalization of the omnibus mand. For example, Reed et al. (2009) found that only children with ASD who had higher intellectual functioning began responding to initially under-selected cues when responding to initially over-selected cues had been extinguished. The authors suggested that two forms of stimulus over-selectivity may in fact exist, with higher intellectual functioning being associated with performance deficits that are attributable to an "over-sensitive" comparator mechanism (see Reed, 2011) and lower intellectual functioning being associated with attentional deficits in sampling all elements of a stimulus (see Dube et al., 1999). In line with this, Kelly et al. (2015) identified an inverse relationship between verbal intellectual functioning and stimulus over-selectivity among children with ASD. It may be the case that generalization of the omnibus mand across stimuli was not observed in the current study because of the presence of co-occurring intellectual disabilities, which may be associated with attentional deficits resulting in greater stimulus over-selectivity.

One potential solution to this issue would be to explicitly teach the omnibus mand in novel evocative situations. Alternatively, the procedures that have since been described by Ward et al. (2021) could be used to teach specifying mands immediately following acquisition of an omnibus mand. After establishing omnibus mands for all of the putative

reinforcers that comprised the participants' synthesised reinforcement contingencies, the researchers successfully taught specifying mands for each reinforcer sequentially. They suggested that omnibus mands are important for accelerating the elimination of PB that is maintained by multiple synthesised reinforcers and that, once PB is eliminated, teaching specifying mands can empower participants to request momentarily valuable reinforcers. This approach would obviate concerns relating to generalization of the omnibus mand to novel situations because specifying mands for the reinforcers that are of value in these situations could be taught using the procedures described by Ward and colleagues. It may be the case that Alex, James, and Reese would have benefitted from learning to specify the reinforcers that were valuable to them in a given moment as part of the FCT phase, rather than being expected to generalize an omnibus mand despite the potential presence of attentional deficits resulting in stimulus over-selectivity.

In relation to the final research question, the treatment procedures were found to be acceptable and implemented with fidelity. All tutors rated the intervention as highly acceptable and effective, and high treatment fidelity scores were achieved across all phases for all participants. Other investigations of IISCA-informed interventions have also yielded positive outcomes regarding treatment acceptability (Beaulieu et al., 2018; Hanley et al., 2014; Herman et al., 2018; Jessel et al., 2019; Jessel, Ingvarsson, Metras, Kirk et al., 2018; Jessel, Ingvarsson, Metras, Whipple et al., 2018; Rose & Beaulieu, 2019; Santiago et al., 2016; Slaton et al., 2017; Taylor et al., 2018) and fidelity (Beaulieu et al.; Rose & Beaulieu). Taken together, these findings contradict the argument that researchers have made regarding the cumbersome nature of IISCA-informed interventions (Fisher et al., 2016). If the synthesized contingencies had made the treatment process excessively difficult for the tutors to implement, they would have made frequent mistakes during treatment sessions and/or reported the intervention to be unacceptable. Given that applying synthesized contingencies of reinforcement to strengthen communication and tolerance skills appears to be an effective, acceptable, and practical intervention for PB, the intrinsic analytic imprecision of the IISCA would not seem to warrant much concern. As Slaton et al. (2017) concluded, the risk of including functionally irrelevant contingencies in treatment plans is likely to be outweighed by the benefits that are associated with precise replication of the challenging contexts that led to PB.

The present findings support the generality of the assessment and treatment processes described by Hanley et al. (2014). Although the original study and most subsequent investigations have been conducted in clinical settings, it appears that the procedures also yield positive outcomes when implemented in school settings. The present study also adds to the small body of evidence supporting the applicability of the IISCA to non-vocal individuals and those with intellectual disabilities as well as ASD. Another strength of this study was that it included treatment acceptability and fidelity evaluations. Only six studies have reported data on the acceptability of this treatment process (Ferguson et al., 2020; Hanley et al.; Jessel, Ingvarsson, Metras, Whipple et al., 2018; Jessel, Ingvarsson, Metras, Kirk et al., 2018; Jessel et al., 2019; Santiago et al., 2016) and no previous research has assessed the fidelity with which it was implemented. Assessing these critical treatment components is particularly important in light of Fisher et al. (2016) claim regarding the cumbersome nature of IISCA-informed interventions. Overall, this study supports the generality and practicality of the assessment and treatment processes described by Hanley and colleagues.

Despite these strengths, the present findings must be interpreted with caution in light of several important limitations. One concern related to functional control surrounds the use of picture exchange cards by for Alex and James. The larger card was only available during simple FCT, and participants only began to wear the wristbands with the smaller cards when complex FCT began. As such, the target response for each phase could not occur prior to the beginning of that phase. All participants did have their specific type of assistive technology available to them during the test sessions of the differentiated FA conditions (i.e., baseline measures) and although specific cards were developed for simple and complex FCT sessions that were not available during baseline, participants did not use their extant devices (PECS or Prologue) during the test session. This is important to note although we believe that it does not completely negate the functional control that was demonstrated during the treatment evaluations for these participants. The test sessions of the differentiated FAs may represent a true picture of the participants' performance in relation to functional communication abilities because they did not attempt to use specifying mands that were available to them through their respective assistive technologies. Other researchers have encountered this same issue when including nonvocal participants in studies. For example, Jessel et al. (2018) describe picture exchange for nonvocal children as a potential limitation to the demonstration of functional control because each response may only occur when the respective cards are available. Another limitation of this study is that there was no direct comparison between the IISCA and other forms of FA. Although the results suggest that the IISCA is an efficient and effective model for obtaining clinically useful information regarding behavioral function, it is unclear whether its utility exceeds that of other models. The conclusions from this study are further limited by the exclusion of measures of socially impactful outcomes such as global functioning and academic performance. Whether or not treatment effects extended across the day and over longer periods of time is unknown. Each of these limitations must be considered when interpreting the findings of the present study.

Although this study adds to the growing evidence base supporting the utility of the IISCA in informing the treatment of PB among children with ASD, there are some unanswered questions that could be addressed through future research. The generality of the IISCA and its associated function-based treatment should be further explored by applying the procedures in different settings across a wider range of participant characteristics. Future studies should also measure a broader range of outcomes (e.g., global functioning and academic performance) over longer periods of time. More comparative analyses such as those conducted by Slaton et al. (2017) are also necessary to establish whether, or under what circumstances, the utility of the IISCA exceeds that of other FA models. In particular, treatment acceptability and fidelity should be assessed in order to determine whether interventions that are informed by the results of one model are more practical than those informed by the results of another. Research aiming to clarify aspects of the treatment procedures described by Hanley et al. (2014) would also be helpful. In particular, the criteria for each phase of treatment should be examined given that Reese met the first two criteria despite the insensitivity of his PB to the procedures and the "performance-based" IISCA described by Metras and Jessel (2021) should be further explored. Continued research will help to establish the utility of the IISCA in informing the treatment of PB among children with ASD.

Results of the present study suggest that the IISCA is an efficient and effective model for determining the function of PB among children with ASD. This study provides evidence for the effectiveness, acceptability, and practicality of the function-based treatment process described by Hanley et al. (2014). This adds to a growing corpus of research supporting the incorporation of these assessment and treatment procedures into practice. Continued investigation of the utility of the IISCA will allow practitioners to make more informed decisions regarding the assessment and treatment of PB among children with ASD.

Compliance with ethical standards

All procedures performed in this study were in accordance with the ethical standards of the institutional research ethics committee and with the 1964 Helsinki declaration and its later amendments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Ethical statement

The authors of this manuscript confirm that the study conducted received approval from an ethics research board at the institution in which the first and corresponding authors are affiliated. This research was conducted in an ethical and responsible manner in accordance with ethical standards and guidelines followed.

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