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On the Occurrence of Dangerous Problem Behavior during Functional Analysis: An Evaluation of 30 Applications

Joshua Jessel[1], Debra Rosenthal[1], Gregory P. Hanley[2], Lauren Rymill[3], Megan B. Boucher[4], Monica Howard[5], Jesse Perrin[6], and Felipe M. Lemos[7]

Abstract

Functional analyses are often conducted by behavior analysts to understand the environmental variables contributing to an individual's problem behavior to better inform treatment implementation. While functional analyses are integral for designing function-based interventions, they often arrange contingencies to evoke and reinforce dangerous problem behavior. In Study 1 we reviewed 22 functional analyses with open-contingency classes including non-dangerous topographies of problem behavior and we found that participants were more likely to exhibit the non-dangerous behavior

[1]Queens College of the City University of New York, NY, USA
[2]Western New England University, Springfield, MA, USA
[3]TACT Clinic, Acton, MA, USA
[4]The Ivymount School, Rockville, MD, USA
[5]The ELIJA School, Levittown, NY, USA
[6]Pathways Strategic Teaching Center, Warwick, RI, USA
[7]Federal University of São Carlos (UFSCar), Sao Carlos, Brazil

Corresponding Author:
Joshua Jessel, Department of Psychology, Queens College, 65-30 Kissena Boulevard, Queens, NY 11367, USA.
Email: Joshua.Jessel@qc.cuny.edu

in 82% of the applications. We then conducted a single-subject comparison of closed and open-contingency classes with four additional participants in Study 2. Our results suggest that the functional analyses with the open-contingency class reduced the likelihood of observing dangerous problem behavior.

Keywords

functional analysis, open-contingency class, problem behavior, safety

Problem behavior is a highly debilitative repertoire that can interfere with the educational experiences of a child or the independent lifestyles of adults. Without proper behavioral intervention, problem behavior could worsen to the point of requiring intrusive management techniques such as pharmacological restraint, mechanical or physical restraint, or seclusion (Matson & Boisjoli, 2009). In fact, the severity of problem behavior among those diagnosed with autism spectrum disorder (ASD) has increased the prevalence of reliance on psychotropic medication, even among those younger than 5 years old (Mandell et al., 2008; Witwer & Lecavalier, 2005). The topography of problem behavior could vary between severe or dangerous (e.g., self-injury, aggression, or property destruction) and more mild or manageable forms (e.g., screaming, crying, or whining). Regardless of the topography of problem behavior, behavioral interventions involve discontinuing contingencies that contribute to target problem behavior and rearranging the reinforcers to support some form of alternative appropriate behavior (Hagopian et al., 2013; Newcomb & Hagopian, 2018). However, an empirical understanding of the active contingencies is often needed to develop an effective treatment (Campbell, 2003; Heyvaert et al., 2014). This empirical understanding conducted during a behavioral assessment has been termed the functional analysis.

Hanley et al. (2003) described a functional analysis as a general process for systematically identifying variables that influence problem behavior and inform subsequent treatment. In their review, Hanley et al. reported on 277 studies published since 1961 that included a functional analysis to establish a resource of contemporary methodology and inform strategies for implementation in practice. The authors' clinical recommendations included elements of experimental control, analytic efficiency, and safety. For example, Hanley et al. suggested relying on establishing operations and discriminative stimuli to improve differentiation between test and control conditions, which would enhance interpretations of experimental control. In terms of efficiency, clinicians are recommended to use brief session durations and brief functional analysis formats when necessary. Finally, the authors provided the clinical recommendation to close the contingency class during a functional analysis by providing the putative reinforcers contingent on only the targeted dangerous behavior. The authors suggested that reinforcing multiple topographies during a functional analysis (i.e., open-contingency class) could obscure the understanding of the relevant variables if the varying topographies have varying functions.

For example, Derby et al. (1994) conducted functional analyses for the problem behavior of four individuals diagnosed with intellectual disabilities. The functional analyses were conducted using an open-contingency class while the individual topographies were displayed separately and as an aggregate for comparison. The authors found that the aggregate display masked possible functions and that the different topographies of problem behavior tended to be sensitive to different reinforcers. Of course, the functional analyses for all of the participants included a topography of problem behavior maintained by automatic reinforcement, which may have influenced the outcomes. In addition, three of the participants exhibited stereotypy, a topography of problem behavior that could be more easily identifiable as being maintained by automatic reinforcement (Beavers et al., 2013). Therefore, functional analyses conducted with open-contingency classes including only socially mediated topographies reported by caregivers to be maintained by the same consequences may not be as susceptible to the limitation of obscured multiple functions.

Warner et al. (2020) conducted functional analyses in a consecutive case series with 10 participants who exhibited problem behavior. The specific functional analysis format included individualized contingencies evaluated in a single test condition for each participant informed by reports obtained from caregivers during an open-ended interview. The authors began the condition with the open-contingency class and systematically introduced extinction in a staggered format to determine if each topography was functionally similar. Warner et al. found that all topographies from the interview-informed, open-contingency class were functionally related in 90% (9 of 10) of the participants. Furthermore, the open-contingency class not only included the targeted dangerous problem behavior (e.g., aggression, self-injury) but far more benign topographies (e.g., whining, covering face) that could create a safer analysis. The results suggested that functional classes of different topographies of problem behavior, varying from non-dangerous to dangerous, can be inferred from caregiver reports obtained during the open-ended interview.

In a recent review of the functional analysis literature, Jessel, Hanley, et al. (2020) found that while many functional analysis formats exist, only a select few components have become standardized (i.e., multiple test conditions, uniform test conditions, play control condition, isolated contingencies). Interestingly, the original recommendation to limit the functional analysis to a closed-contingency class (Hanley et al., 2003) has been steadily declining with applied researchers preferring to include non-dangerous topographies in 57% of the studies reviewed since 1994. It is difficult to determine why that component was not as readily adopted; however, it may be that including non-dangerous behavior improves the safety of the functional analysis and acceptance among clinicians and caregivers. Especially considering that the previous recommendation for identifying if all topographies of problem behavior are functionally related required multiple contingency changes that resulted in the progressive worsening in the child's environment. In other words, the process required extended exposure to extinction that evoked increasingly dangerous behavior.

The purpose of the current two-part study was to validate the use of open-contingency classes during functional analysis. In Study 1 we analyzed the rates of dangerous and non-dangerous behavior during 22 functional analyses using open-contingency classes that reinforced any topographies reported by caregivers to be functionally similar. Two separate functional analyses (closed and open-contingency class) for four participants were conducted in Study 2 to determine if opening the contingency class resulted in a decrease in dangerous problem behavior.

Study 1: Analysis of Problem Behavior using an Open-Contingency Class

Method

Participants and settings. Participants included 22 children between the ages of 2 and 14 years old ($m = 6$ years old) who exhibited multiple topographies of problem behavior that ranged from non-dangerous to dangerous. Participants were included if they were reported by caregivers, mental health professionals, or teachers to exhibit dangerous problem behavior that (a) interfered with daily life in the home or interrupted learning at school and (b) was in need of individualized behavioral assessment and treatment.

The majority of the participants (14 of 22) were diagnosed with ASD and were male (19 of 22). Six participants did not have a diagnosis, two participants had multiple diagnoses, and the remaining participant was diagnosed with Klienefelter's Syndrome. Participant language abilities were categorized as nonverbal, one-word utterances, short disfluent sentences, and fully fluent. Most participants were on each end of the continuum with eight categorized as being nonverbal and eight as fully fluent. The remaining six participants were split evenly between being able to use one-word utterances (3 of 22) and short disfluent sentences (3 of 22). Specific demographic information about each participant can be found in Table 1.

Sessions took place across multiple states in America and one participant living in Brazil. All functional analysis applications were collected from participants in multiple university-based clinics (11 of 22), specialized schools (6 of 22), and clinically oriented outpatient clinics (5 of 22). Sessions were conducted in a separate room often including a table to complete possible tasks and an area for play with preferred leisure items or snacks.

Response measurement and interobserver agreement. All participants exhibited multiple topographies of problem behavior. The topographies of problem behavior were separated into two possible categories as defined by Jessel, Hanley, et al. (2020). The category of dangerous problem behavior included any topographies that could cause harm to others, themselves, or objects (e.g., aggression, self-injury, property destruction). For example, Participant 4 was the height of her teachers and her dangerous problem behavior included choking others or biting her own hand to the point of leaving scarred tissue damage. Participant 7 exhibited self-injury in the form of head banging that caregivers reported to have left holes in their walls at home. All other problem behavior that did not involve risk of harm was included in the category of non-dangerous problem behavior (e.g., loud vocalizations, whining, swearing). Two separate rates were calculated for dangerous and non-dangerous behaviors. Rate of problem behavior was calculated by dividing the total instances in a session by the session duration. Percentages of problem behavior were also calculated by dividing the dangerous behavior by the sum of the dangerous and non-dangerous behavior.

A secondary observer independently scored a mean of 79% (range, 33%–100%) of the functional analysis sessions. Interobserver agreement (IOA) was calculated as a mean count per interval by splitting sessions into 10-seconds intervals (Cooper et al., 2007). The smaller number of recorded instances of problem behavior was divided by the larger number in each interval. The quotients of each interval were then summed and divided by the total number of intervals to get a mean. The mean IOA for dangerous and non-dangerous problem behavior was 99% (range, 96%–100%) and 98% (range, 91%–100%), respectively.

Procedures. The functional assessment procedures were similar to that of Hanley et al. (2014) and included a three-step process: interview, observation, and functional analysis. The interview was conducted by the researcher

Table 1. Participant Demographics.

					Problem behavior	
Application	Age	Sex	Diagnosis	Language ability	Non-dangerous	Dangerous
1	3	M	ASD	4	Loud voc, whining	Agg, des, dropping, elope
2	14	M	ASD	1	Loud voc	Agg
3	4	M	No diagnosis	4	Loud voc, whining, swearing, tongue wagging	Agg, des, SIB
4	14	F	ASD	4	Loud voc, complaining	Agg, des, SIB, elope
5	11	M	Klienefelter's Syndrome	4	Loud voc, swearing, growling, threats	Agg, des
6	5	M	ASD	4	Loud voc, whining	Agg, des, SIB
7	8	M	ASD, ADHD	2	Loud voc	Agg, des, SIB
8	3	F	ASD	2	Loud voc, whining	Des
9	2	M	ASD	2	Loud voc, body turn	Agg, des, elope
10	2	M	No diagnosis	1	Loud voc	Agg, des, tantrum
11	10	M	ASD	1	Loud voc	Agg, SIB
12	3	M	No diagnosis	3	Loud voc	Agg, des, tantrum
13	4	M	No diagnosis	3	Loud voc, growling	Des, SIB
14	3	M	No diagnosis	4	Loud voc, whining, protesting	Agg, des
15	9	M	ASD	4	Loud voc, threats	Agg, des, elope
16	4	M	No diagnosis	4	Loud voc, swearing	Agg, des, SIB
17	5	M	ASD	1	Face covering	Agg, des, SIB,flopping
18	6	M	ASD	1	Loud voc, garment mouthing	Agg, des, tantrum
19	3	M	ASD	1	Loud voc	Agg, SIB
20	6	M	ASD	1	Loud voc	Agg, des, SIB
21	8	M	ASD	1	Loud voc	Agg, SIB, flopping, tantrums
22	4	F	Hydrocephalus, CD, DBD	3	Loud voc, swearing	Agg, des

Note. ASD = autism spectrum disorder; CD = conduct disorder; DBD = destructive behavior disorder; Loud voc = loud vocalizations; Agg = aggression; Des = property destruction; SIB = self-injurious behavior.

and administered to the participants' caregivers prior to the observation and functional analysis. The interview included a number of open-ended questions (available in Hanley, 2012). The researcher asked descriptive questions regarding the problem behaviors, the antecedents and consequences, and the general context in which behavior occurred in order to help identify the ecologically relevant contingency to be evaluated in the functional analysis. Furthermore, multiple questions were directly related to identifying caregiver-reported non-dangerous behavior identical to the questions used in Warner et al. (2020). Caregivers were asked to describe (a) different ranges of intensities, (b) topographies that could precede more dangerous behaviors, and (c) if the different topographies occurred within the same context. The researcher was able to use this information to distinguish between different topographies of problem behavior that were likely to be functionally related and those that were functionally distinct. For example, a caregiver could have reported that their child will whine or cry when you first take away a toy but will begin to hit or kick as they continue to get upset if you do not return the toy. Because the problem behaviors occurred in progression related to the same establishing operations, they would have been included in the contingency class. On the other hand, the caregiver could have reported screaming and SIB to be problematic; however, further specifying that screaming occurred in the presence of homework whereas SIB occurred throughout the day regardless of external environmental influence. In that case, SIB would be considered functionally distinct and not included in the contingency class. Therefore, the only topographies of problem behavior (non-dangerous and dangerous) that were included in the contingency class were reported by caregivers to co-occur or be functionally related. The interview required 15 to 30 minutes to conduct.

Following the interview, a brief 10 to 30-minutes observation was conducted during which the researcher unsystematically arranged the problematic context including the antecedent and consequent variables described by the caregiver during the interview. The caregivers were present during this time and were consulted to ensure that the contingency identified represented that which they would like to be evaluated during the functional analysis and targeted for subsequent treatment. The observation was used to (a) calibrate the individualized contingency and (b) refine the definition of problem behavior based on any new topographies that were observed during that period. To calibrate the contingency, the researcher incorporated ecologically relevant variables that may have been overlooked during the interview based on participant performance during the observation and in-situ feedback from the caregivers. For example, if problem behavior was not readily occurring in the presence of the establishing operations informed by the interview, caregivers were available to suggest how the antecedents could be slightly modified to be more representative of what was likely to evoke problem behavior in their previous experiences. The researcher could also refine the definition of problem behavior in two possible ways. First, the researcher could have observed previously unreported non-dangerous problem behavior that preceded an escalation to dangerous problem behavior. Second, the researcher could have observed previously unreported dangerous problem behavior. In both cases, the caregiver would have been consulted to ensure the behaviors belong within the same functional class and then added to the definition. The observation ended when the researcher was able to construct the contingency to be evaluated in the test condition of the subsequent functional analysis.

The specific functional analysis format used has been termed the interview-informed, synthesized contingency analysis (IISCA; Jessel et al., 2016). The median session duration was 5 minutes (range, 3–5 minutes). Each IISCA included a single test condition compared to a matched control. Information obtained from the open-ended interview and observation were used to design the conditions. During the test condition, the evocative events were arranged that were likely to precede the targeted problem behavior. Preferred events that were reported to serve as reinforcers were then provided for 30 seconds following each instance of the problem behavior. On the occasion that the rates of problem behavior during the test and control conditions were undifferentiated, the researcher returned to the interview and observation to determine what may have led to the unsuccessful results. The researcher then developed a second IISCA based on the newly acquired information. A second iteration of the IISCA was required in 18% of the applications (4 of 22). The mean IISCA duration was 24 minutes (range, 15–40 minutes). Individualized information about the IISCA procedures can be found in Table 2.

Experimental design. A multi-element design was used to evaluate functional control over problem behavior during the IISCA (Johnston & Pennypacker, 2009). The design was often structured with a control condition and a test condition in an alternating sequence (either CTCTT or CTCTCT). The design was a rapid alternation of the two conditions in which the initial phase represented the control condition. Each control-test sequence was repeated at least two times and extended depending on the differentiation in the rate of problem behavior across the two conditions.

Results and Discussion

The results of the IISCAs for all 22 participants are summarized in Figure 1.[1] Higher rates of overall problem behavior (top panel) was observed in the test

Table 2. Interview-Informed, Synthesized Contingency Analysis (IISCA) Information.

					Individualized contingency	
Application	Location	Session (min)	Analysis duration	Iteration	Evocative event(s)	Preferred event(s)
1	Outpatient clinic	5	25	1	Transition to ADL tasks	Access to TV with mom
2	Specialized school	5	25	1	Blocked access to edibles	Free play with edibles
3	University-based clinic	5	25	1	Independent play and divided attention with dad	Child-directed play with dad
4	Specialized school	5	25	1	Difficult tasks with frequent correction and divided positive attention	Child-directed conversation
5	Specialized school	3	15	2	Difficult academic worksheets	Independent access to tablet and edibles with optional preferred worksheets
6	Specialized school	5	30	1	Transition to workstation	Child-directed play
7	University-based clinic	3	18	2	Adult instructions and transitions	Independent access to tablet
8	Outpatient clinic	5	25	1	Academic instructions	Child-directed play
9	Outpatient clinic	5	25	1	Transition to lunch table	Independent access to tablet
10	University-based clinic	5	30	1	Denied access to tablet	Independent access to tablet

(continued)

Table 2. (continued)

Application	Location	Session (min)	Analysis duration	Iteration	Individualized contingency	
					Evocative event(s)	Preferred event(s)
11	University-based clinic	5	40	1	Transition to ADL tasks	Child-directed play
12	Outpatient clinic	3	18	1	Blocked access and adult-directed play	Free play
13	Outpatient clinic	5	25	1	Academic work	Interactive play with plastic fruit
14	University-based clinic	5	25	1	Adult-directed play	Child-directed play
15	Specialized school	3	18	2	Transition to workstation	Free play with edibles
16	University-based clinic	5	30	2	Transition to cleaning	Child-directed play
17	University-based clinic	5	30	1	Academic instructions	Interactive play
18	University-based clinic	3	15	1	Mom instructed transitions	Interactive play
19	University-based clinic	3	15	1	Transitions	Independent access to tablet
20	University-based clinic	3	15	1	Academic instructions	Interactive play
21	Specialized School	5	30	1	Blocked access to rituals and items	Uninterrupted access to rituals and items
22	University-based clinic	5	25	1	Adult-directed play	Child-directed play

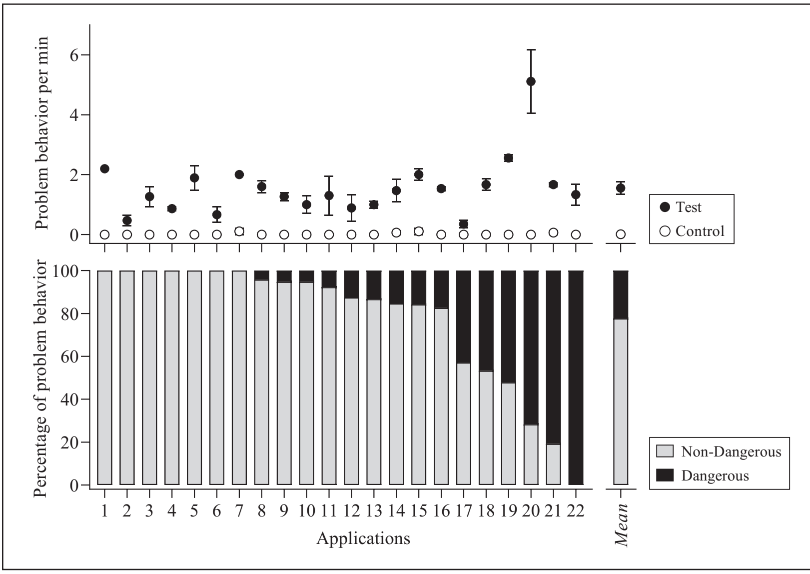

Figure 1. Summary of problem behavior during functional analyses with open-contingency classes.
Note. Each point represents the mean response rate across all test (closed circle) and control (open circle) sessions per application with standard error of the mean (SEM).

condition (*M* = 1.71 responses per min [RPM]; *SD* = 1.17) in comparison to the control condition (*M* = 0.02 RPM; *SD* = 0.04). In fact, 77% (17 of 22) participants did not exhibit any problem behavior during the control condition. This suggests that a socially mediated function was identified for all 22 participants. When problem behavior was evaluated as the two disaggregated categories (bottom panel), 82% (18 of 22) of the participants exhibited more non-dangerous problem behavior in comparison to dangerous problem behavior. In addition, 32% (7 of 22) of the participants did not engage in any dangerous problem behavior throughout the entire IISCA.

The percentages of dangerous and non-dangerous problem during the first and final test sessions of the IISCAs are presented in Figure 2. During the first test session, the percentage of non-dangerous behavior (*M* = 63%; *SD* = 43.09) was higher than the dangerous behavior (*M* = 28%; *SD* = 39.09).[2] By the final test session, the percentage of non-dangerous behavior increased further (*M* = 86%; *SD* = 30.68) in comparison to the dangerous problem behavior (*M* = 14%; *SD* = 30.68). This suggests that as sessions are conducted in the IISCA, participants may begin to allocate problem behavior to more non-dangerous topographies.

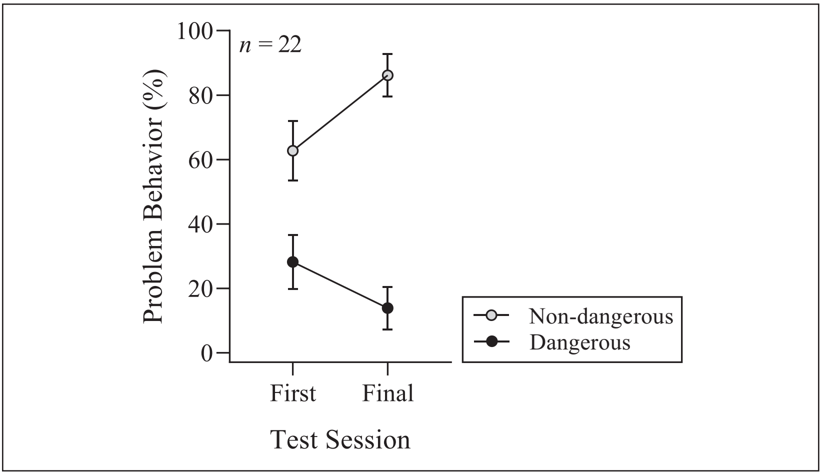

Figure 2. Problem behavior during the first and final test sessions of the functional analysis.
Note. Bars represent standard error measurement.

We found that functional analyses using open-contingency classes produced differentiated outcomes that implicated a socially mediated function of a class of problem behavior. In addition, most participants were likely to exhibit the non-dangerous topographies of problem behavior during the functional analysis and this percentage of non-dangerous behavior increased as test sessions were repeated. Thus, the open-contingency class seems to have created an overall safer environment for the individual and therapist and extended exposure to the contingency only reduced the danger further.

Due to the informal categorization of language abilities, we are limited in evaluating correspondence between verbal aptitude and the occurrence of dangerous problem behavior. There is evidence to suggest that problem behavior is more likely to be associated with individuals diagnosed with ASD and greater language impairments because those individuals may (a) lack more advanced verbal coping mechanisms and (b) the consistent ability to independently mand when placed in a particularly motivating environment (Sigafoos, 2000; Williams et al., 2018). This is especially considering that many of the non-dangerous behaviors identified in the current study included verbal responses such as complaining, whining, swearing, or threatening. Without the ability to engage in these non-dangerous verbal responses, the individual may more readily transition to dangerous topographies. Applied researchers and clinicians may want to attempt to identify other more motor related or emotive topographies of non-dangerous problem behavior (e.g., covering ears, closing eyes, flapping arms) for those with severe language impairments during functional analyses and use more formal assessments of language abilities (e.g., Vineland Adaptive Behavior Scales; Sparrow et al., 2005) to allow for Supplemental Material analysis.

The generality of these findings are somewhat limited by the fact that the majority of the functional analyses were conducted in a university-based outpatient clinic when similar mental-health services are typically provided in community-based settings (Brookman-Frazee et al., 2010). It is important to point out that using university-based facilities for applied research is common practice and the procedures of the current study are indicative of a far larger reliance on experimentally clean settings (Kasari & Smith, 2013). That is, there may be an imbalance in applied research favoring studies evaluating attributes of efficacy (i.e., demonstration of causal relations in highly controlled settings) over those of effectiveness (i.e., demonstration of clinical utility in environment of interest). Although we should continue to be mindful of the importance of first establishing a specific behavioral technology as efficacious, researchers should continue along the continuum of research toward concerns of practical interest such as feasibility, generality, and cost-effectiveness (Ghaemmaghami et al., 2021).

With less exposure to the dangerous topographies of problem behavior, it seems clear that opening the contingency class is likely to create a safer experience during the functional analysis. However, it is somewhat difficult to unequivocally support the assumption that the non-dangerous and dangerous behavior existed within the same functional class. That is because the participants only experienced a functional analysis with the open-contingency class. Therefore, it is unknown if the more dangerous topographies would have occurred if the contingency was closed to only reinforcing those dangerous behaviors. Furthermore, the participants' problem behavior met the operational definition to be designated as dangerous topographies but children as young as two years old were included and the level of severity, when considering aggression or property destruction, was unlikely to be equivalent to older individuals with more chronic patterns of debilitative repertoires.

Study 2: Comparison of Closed and Open-Contingency Classes

The non-dangerous behavior is only targeted in the open-contingency class if caregivers report their co-occurrence with the dangerous problem behavior during the open-ended interview. Furthermore, the non-dangerous problem behavior is often reported to occur before the dangerous problem behavior, ensuring that the non-dangerous topographies are more likely to be reinforced and observed within a session. In order to evaluate the functional relevance of the different problem behavior, researchers have shifted contingencies between the varying topographies from the putative functional class (Borrero & Borrero, 2008; Smith & Churchill, 2002). For example, Smith and Churchill (2002) conducted two functional analyses for each of the four adults diagnosed with intellectual disabilities. During the first functional analysis, the reinforcers were presented contingent on the dangerous behavior (i.e., self-injury, aggression). In the second functional analysis the contingency was shifted to the purported non-dangerous precursors (e.g., negative vocalizations). The contingency class remained closed but varied on what topographies were reinforced. Smith and Churchill found that reinforcing precursors resulted in a decrease in dangerous behavior with near or complete elimination for almost all participants during the functional analysis period.

In Study 2, we used a similar method of shifting the contingency class to non-dangerous behavior; however, the class was opened to include all target problem behavior instead of isolating only the non-dangerous topographies in a closed contingency. All participants were older than five years old and were reported to exhibit chronic problem behavior that had caused significant harm to others or themselves in the past.

Methods

Participants and settings. Four participants were included in this study, all diagnosed with ASD. Individuals were selected to participate because the caregivers reported prolonged difficulty managing their child's dangerous problem behavior and that problem behavior had resulted in serious injury to the participant or others on multiple occasions. The first participant, Sally, was a 9-year-old female. Sally was nonverbal but was able to communicate using a speech generated device. Sally attended a district school and was in a special education class. Sally's sessions were conducted during her at-home ABA sessions, which she received 5 days a week for 2 hours each day. She was referred by her caregivers for inclusion in this study because she exhibited aggressive problem behavior. Sally's biting and scratching was so severe that it often caused bleeding and tissue damage to the point that caregivers and therapists reported the necessity of wearing long sleeved shirts when around her or maintaining a set of protective gear around at all times. In addition, Sally's therapist reported requiring medical attention after receiving a particularly dangerous bite to her arm. Sally's sessions took place at her house in the backyard on her trampoline. The trampoline was a 3-m circle with netting surrounding it to ensure that the participant and therapist could not fall out. Other items in the area included a 1 m by 1 m table and a garage. The backyard was surrounded by a white picket fence on all sides.

Michelle was a 20-year-old female. Michelle communicated using short disfluent sentences. Michelle attended a special education school and sessions were conducted at a university-based clinic. Caregivers reported difficulty managing Michelle's problem behavior at home such as aggression and property destruction. In fact, the caregivers reported often having to leave the room in fear for their safety when Michelle became destructive throwing large objects (e.g., chairs, hair dryers) reaching the height of their heads. Michelle's mother personally reported wearing a hat in the house to avoid having her hair pulled out or Michelle grabbing her hair and pulling her to the ground during aggressive bursts. The researcher conducted sessions in a 2.5 m by 2.5 m room with a table and two chairs.

Steve was a 7-year-old male and used short disfluent sentences to communicate. His native language was Ukrainian but he was learning English at the time of his participation in the study. Due to Steve's problem behavior, he did not attend school and instead he was provided with 5 hours of ABA services per day in his home. Steve's sessions were conducted while receiving the ABA services in his home. Steve was referred by one of his paraprofessionals because he exhibited aggressive behavior and property destruction. His head butting reportedly gave a staff member a concussion and his hitting caused bruising on multiple occasions. Steve's sessions took place in his apartment in the family room. The family room was a 3.5 m by 2 m room with a couch, a mini trampoline, a table, and four chairs. Other items included two smart phones and picture cards for tacting.

Iser was a 14-year-old, nonverbal male who used a speech-generated device to communicate. Iser attended a special-education day-program for individuals with developmental disabilities. Iser's sessions were conducted at his special-education day-program. His teachers reported difficulty managing Iser's aggression. A large table had to be placed in between Iser during lessons at the request of the teachers who were afraid for their safety when sitting next to him. The distance between the large table provided enough space to evade his scratching and hitting that often caused bleeding or bruising. Iser's sessions took place in his typical classroom setting. His classroom was 12.8 m by 6.5 m with his desk and two accompanying chairs. Other items included his iPad for communication, chips, and candy-canes.

Response measurement. During the initial IISCA, the researcher only measured dangerous problem behavior because the non-dangerous behavior had not yet been identified. In other words, the initial functional analysis was conducted as if only dangerous problem behavior was targeted and identified. For Sally, dangerous problem behavior was defined as various forms of aggression including biting, hitting, and grabbing others. Michelle's dangerous problem behavior included aggression (biting, hair pulling, grabbing others) and property destruction (throwing objects). Steve's dangerous problem behavior also included a combination of aggression and property destruction in the form of hitting others and throwing or flipping large objects. Iser exhibited aggression in the form of biting, hitting, scratching, and pinching others.

The final IISCA included both dangerous and non-dangerous behavior. The definition of non-dangerous problem behavior for Sally, Michelle, and Steve all included loud vocalizations (e.g., screaming, yelling, crying). Two motor related topographies were specifically included for the nonverbal participants. The non-dangerous behavior for Sally and Iser included light arm tapping and arm pulling for Sally and Iser, respectively. Caregivers reported that these behaviors were far more acceptable forms of "begging" or "nonverbal whining" that often preceded the more dangerous behavior.

Inter-observer agreement and procedural fidelity. We calculated inter-observer agreement (IOA) using mean count per interval. A secondary observer independently scored sessions live and simultaneously with the primary observer. Sessions were separated into 10-seconds intervals and the larger number during each interval was divided by the smaller number to calculate a percentage agreement. The mean was then calculated for each session. A secondary observer scored 64% and 50% of the functional analysis with the closed-contingency class and functional analysis with the open-contingency class, respectively. The mean IOA of dangerous problem behavior during the functional analysis with the closed-contingency class was 100% across participants. The mean IOA of dangerous and non-dangerous behavior during the functional analysis with the open-contingency class were both 95% (range, 92%–100%).

Procedural fidelity was collected to ensure a high degree of correct implementation of procedures during the functional analyses (Ledford & Gast, 2018). The researcher broke down the control and test condition into a task analysis. A "+" was indicated when the step was implemented correctly and a "−" was indicated when the step was implemented incorrectly or neglected. Treatment integrity was collected for at least 40% of sessions and was 100% for all participants.

General procedures and design. The procedures were identical to Study 1 (i.e., open-ended interview, observation, and IISCA) with the exception that two applications of the IISCAs were conducted with each participant creating a total of eight IISCA applications. In addition, the IISCA used the same multielement design. The interview and observation were once again vital for the selection and targeting of the multiple topographies of problem behavior. The non-dangerous and dangerous problem behavior were selected based on caregiver report and direct observation suggesting that the behaviors all existed within the same functional class (e.g., co-occurring, non-dangerous behavior temporally preceding dangerous behavior).

Study 2 included the additional step of using the initial functional analysis to validate the non-dangerous behaviors reported by caregivers during the interview to be include in the subsequent functional analysis. Any non-dangerous topographies that reliably occurred prior to the dangerous problem behavior and happened infrequently when the participant had access to the reinforcers were identified. Caregivers were present throughout the entire process and observed their child as they experienced both functional analyses. In addition, caregivers were consulted and asked questions such as, “Does [possible non-dangerous behavior] indicate that she is getting angry and is likely to [dangerous problem behavior]?” If the caregiver affirmatively answered the question, the contingency class was then expanded to include both dangerous topographies and caregiver-reported non-dangerous topographies in the final functional analysis (i.e., open-contingency class). Had the caregiver reported different non-dangerous problem behavior they noticed during the initial functional analysis in comparison to what they had originally indicated during the interview, the final functional analysis with the open-contingency class would have included all topographies. However, that which the caregivers reported during the interview always corresponded with their reports during the initial functional analysis.

The initial IISCA only included the dangerous problem behavior in the contingency class (i.e., closed-contingency class). The final IISCA included both dangerous and non-dangerous problem behavior in the contingency class (i.e., open-contingency class). Caregivers were present throughout the entire process and observed their child as they experienced both IISCAs. The duration of the IISCA sessions were 3 to 5 minutes. The mean duration of the initial IISCA was 24.5 minutes (range, 15 to 40 minutes) while the mean duration of the final IISCA was 17.5 minutes (range, 15 to 25 minutes).

Individualized procedures. During the test condition of Sally’s IISCA, the researcher and caretaker would divide their attention and talk to each other instead of providing Sally with complete attention while on the trampoline. The researcher would not jump, and no task demands were provided. Contingent on the problem behavior, the researcher would stop talking to the caretaker and play together with Sally on the trampoline for 30 seconds. During the control condition the researcher would continuously jump and interact with Sally regardless of if problem behavior occurred. For Michelle, the researcher would interrupt her song she was listening to by taking her phone and clicking on links to different music videos during the test condition of the IISCA. The only demand required was for Michelle to give up her phone. Contingent on the problem behavior, the researcher would give Michelle her phone back and return to the music video that was interrupted for 30 seconds. During the control condition, Michelle was given independent and uninterrupted access to her phone. In the test condition of the IISCA conducted with Steve the researcher would have the mother leave the room with two phones (Steve played games on his phone and watched videos on his mother's phone) and have Steve walk to the table to complete discrete-trial instructions. Contingent on problem behavior, the instructions were removed and the mother returned with the two phones for 30 seconds. When the control condition was initiated, Steve would have noncontingent access to the two phones and his mother would comply with any mands. For Iser, the researchers would begin the test session providing praise and access to a snack basket full of chips and candy canes. The basket and social interaction were then removed and contingent on problem behavior, the researcher would provide Iser with 30-seconds access to the basket of preferred edibles along with praise and compliments. During the control condition, Iser was provided with noncontingent access to the basket and was complemented by the therapist approximately every 5 seconds.

Results and Discussion

The results of the IISCAs for all participants are presented in Figure 3. During the IISCAs with closed-contingency classes (left panels), elevated rates of dangerous problem behavior were observed ($M = 0.78$ responses per min [RPM]; $SD = 0.37$) in the test condition and dangerous problem behavior was not observed in the control condition. The results of the IISCAs with the closed-contingency class suggested that the dangerous problem behavior of all participants was sensitive to the caregiver-informed contingencies. The final IISCA was then conducted with an open-contingency class (right panels). Elevated rates of problem behavior were again observed during the test condition; however, all participants exhibited higher rates of non-dangerous problem behavior ($M = 2.5$ RPM; $SD = 1.6$) in comparison to the dangerous problem behavior ($M = 0.19$ RPM; $SD = 0.17$).

The results of the eight functional analyses conducted with the four participants indicated that all targeted problem behavior existed within the same functional class and that non-dangerous problem behavior was likely to be exhibited when the contingency class was opened. In addition, the researchers were able to successfully identify motor related topographies of non-dangerous behavior based on caregiver reports from the interview. While there was

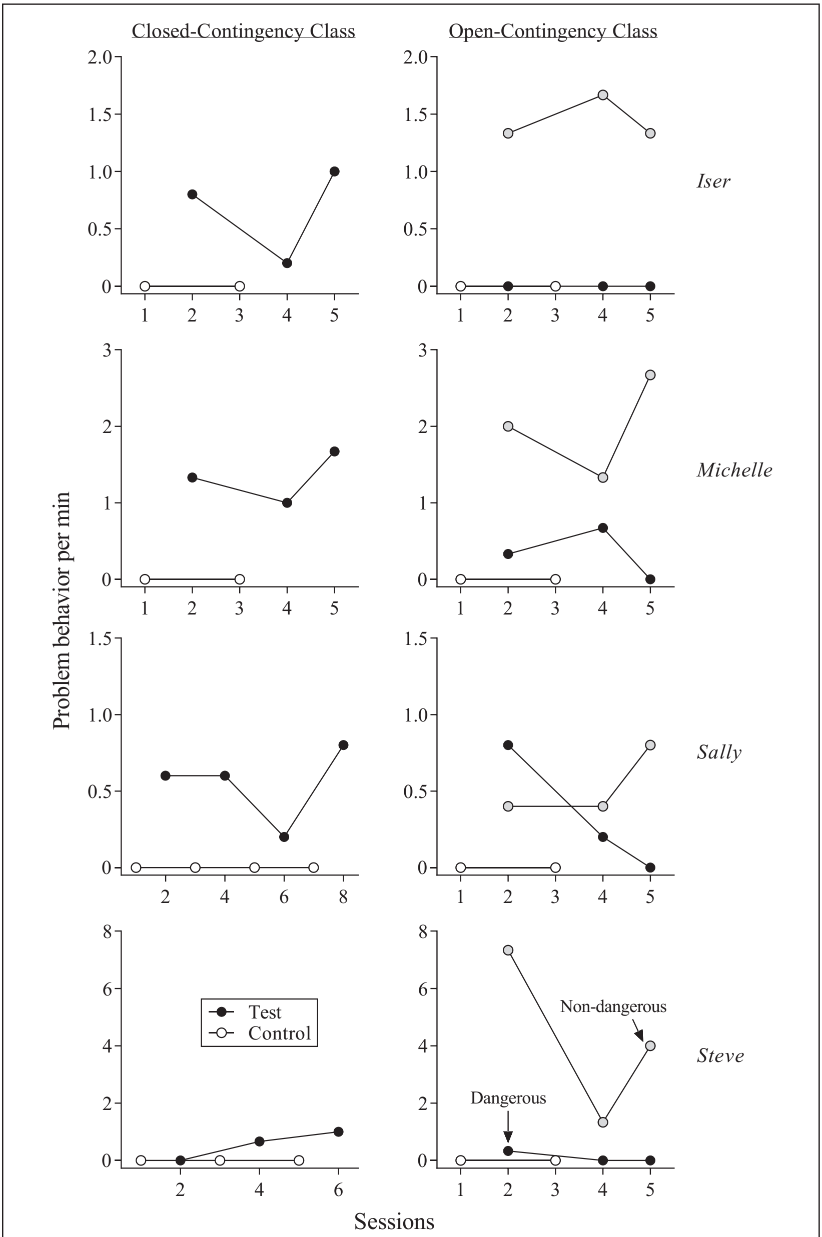

Figure 3. Comparison of four functional analyses with closed and open-contingency classes.

some carryover of the dangerous problem behavior in the functional analysis with the open-contingency class for some of the participants, by the final session, there were no dangerous problem behaviors emitted. From the first analysis using a closed-contingency class to the second analysis using an open-contingency class there was a 75% decrease in dangerous behavior. Of course, considering the potential of an order effect, dangerous problem behavior could have also decreased with the repeated sessions when extended to the functional analysis with the open-contingency class, which always followed the functional analysis with the closed-contingency class. In other words, dangerous problem behavior for all participants could have decreased over time. However, this is highly unlikely to be the case considering that these participants were specifically selected because they exhibited chronic and severe topographies of problem behavior. For example, the caregiver of the 20-year-old participant reported dangerous problem behavior to be a lifelong disorder. To assume that dangerous problem behavior for all four participants simply eliminated after a 25-minutes analysis seems to be a large interpretative leap.

It is interesting to note that all four of the participants shifted responding from dangerous to non-dangerous behavior when the contingency class was opened. These findings are somewhat at odds with Slaton et al. (2017) who conducted functional analyses with open-contingency classes including caregiver-reported precursors with children diagnosed with ASD. Five of the nine participants exhibited higher levels of the dangerous problem behavior even though non-dangerous topographies were included in the contingency class. It is possible that some individuals may have a specific history of reinforcement for the dangerous problem behavior, making the dangerous behavior far more likely to contact reinforcement immediately during the functional analysis. Future research could attempt to create assessments for identifying these participants who are predicted to exhibit dangerous problem behavior during the functional analysis. This could help improve therapist and child safety by using specific preparations for the dangerous behavior, such as modifying functional analysis formats that (a) don't require repeated instances of problem behavior during a session (Jessel et al., 2018b) or (b) don't require repeated sessions (Jessel, Metras, et al., 2020). Nevertheless, clinicians should include non-dangerous problem behavior during the functional analysis because in many cases it can reduce instances of dangerous problem behavior.

General Discussion

The outcomes of this two-part study support the use of open-contingency classes during functional analysis of problem behavior when multiple topographies, dangerous and non-dangerous, reportedly occur and exist within the same functional class. We found that parent-informed topographies from the open-ended interview were accurate representations of the functional class of the more severe, dangerous problem behavior, replicating previous research with similar findings (Warner et al., 2020). This is especially important to note for clinicians who are in need of practical and safe assessment methods for developing effective interventions.

Fritz et al. (2013) developed an experimental analysis for identifying non-dangerous problem behavior that occur prior to the more dangerous topographies (i.e., precursors). The precursor analysis involved presenting evocative events in trials and terminating the trial once the dangerous problem behavior was exhibited. The precursor analysis was conducted in a minimum of 10 trials across two or three different evocative events after which the functional similarity between the non-dangerous and dangerous behavior was evaluated in the calculation of several conditional probability analyses. Using this collection of methods, the authors were able to identify multiple non-dangerous precursors to the dangerous problem behavior for most of the 16 participants. Therefore, advanced technologies exist for identifying non-dangerous behavior; however, they often require specialized training in quantitative models (e.g., conditional probability analyses) that many practitioners do not have. Furthermore, the purpose of identifying non-dangerous problem behavior to improve safety is somewhat obscured by the fact that the precursor analysis requires the dangerous problem behavior to occur and be reinforced. It seems as though extended and complex analyses may continue to be useful for certain experimental questions among researchers but our results suggests that caregiver-informed topographies from an open-ended interview are sufficient in a clinical setting. Considering that many clinicians currently find the functional analysis alone to be time-consuming and a barrier to its use (Hanley, 2012; Oliver et al., 2015), it is important to improve the efficiency of an assessment period and reduce any superfluous procedures.

Opening the contingency class may improve the efficiency of the functional analysis for multiple reasons. First, participants may require extended exposure to the contingencies in order for the other less dangerous behavior in the hierarchical class to first contact extinction before the dangerous topographies are emitted. Magee and Ellis (2000) conducted functional analyses with open-contingency classes for the problem behavior of two participants diagnosed with intellectual and developmental disabilities. Initially, elevated rates of nondangerous problem behavior occurred (i.e., out-of-seat, mouthing) and the dangerous topographies of problem behavior (i.e., destruction, aggression) did not emerge until the sequential introduction of extinction for each topography. In other words, individuals who exhibit problem behavior may be more likely to emit the dangerous topographies only after some period of time in which the less dangerous precursors no longer produce the reinforcers.

Second, dangerous problem behavior may require extended experience with establishing operations to be evoked, whereas less dangerous behavior may occur more readily. Smith and Churchill (2002) found that for three of the four participants, higher rates of the precursors were observed in comparison to the dangerous topographies of problem behavior when respective reinforcement contingencies were arranged. We obtained similar results with all participants in Study 2 exhibiting fewer instances of dangerous problem behavior in the functional analysis with the closed-contingency class in comparison to the precursors in the functional analysis with the open-contingency class. Thus, opening the contingency class to include less dangerous precursors may improve the efficiency of the functional analysis by reducing the need for extended time exposed to an establishing operation in order for the dangerous problem behavior to occur.

Opening the contingency class and including non-dangerous topographies also increased the safety of the assessment context. Dangerous problem behavior was less likely to be observed when the contingency class was opened. Figure 4 provides an overview of the occurrences of dangerous problem behavior during Study 1 and Study 2. Although reducing the rate of dangerous problem behavior is likely to improve safety, future researchers should also incorporate direct measures of injury when possible (Kahng et al., 2015). Safety was also increased as reported by the caregivers. Two of the caregivers even commented that they prefer the functional analysis with the open-contingency class because they have difficulty "turning off" the dangerous problem behavior once it is started. Therefore, the dangerous problem behavior for some individuals may occur in emotional bursts and continue long after the functional reinforcers have been presented.

Tarbox et al. (2004) found similar outcomes during the functional analysis of low-rate dangerous behavior emitted by three adults diagnosed with developmental disabilities. Initial functional analyses provided inconclusive results without any dangerous problem behavior observed. Sessions were then only initiated once problem behavior occurred and the participants began to emit high levels of dangerous problem behavior during the test conditions. This suggests that including non-dangerous topographies may improve the safety of the analysis by reducing the probability of bursts of dangerous topographies; however, future researchers should continue to evaluate this claim. For example, it is possible to measure latency to the offset of problem behavior following the delivery of the reinforcers and compare the time to offset between non-dangerous and dangerous topographies.

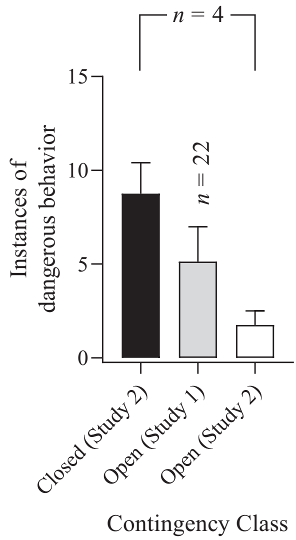

Figure 4. Summary of dangerous problem behavior during study 1 and 2.
Note. Bars represent standard error measurement.

A limitation of this study was that there were no systematic treatment evaluations. Therefore it is difficult to determine if treatments informed by functional analyses including an open-contingency class would be as effective as functional analyses directly evaluating the dangerous behavior. Although from a clinical perspective, many of these participants went on to receive function-based interventions that reportedly reduced their problem behavior. Furthermore, positive treatment outcomes have been achieved in the published literature using similar procedures (e.g., Beaulieu et al., 2018; Ghaemmaghami et al., 2016; Hanley et al., 2014; Jessel et al., 2018a; Ferguson et al., 2020, Rose & Beaulieu, 2019; Santiago et al., 2016; Slaton et al., 2017). That being said, additional participants should continue to be evaluated using this preparation to ensure that an assessment identifying the functions of non-dangerous behavior will still inform effective function-based treatment of dangerous problem behavior.

Overall, our results provide empirical support for the widely accepted practice among applied researchers of targeting non-dangerous problem behavior during a functional analysis (Jessel, Hanley, et al., 2020). Furthermore, we are recommending that clinicians use an open contingency class as a tool to reduce risk and potential danger (Wiskirchen et al., 2017) because doing so does not seem to negatively impact the ability of the functional analysis to identify socially mediated functions.

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Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Joshua Jessel declares a part-time consultant position with FTF Behavioral Consulting. Debra Rosenthal declares that she has no conflict of interest. Gregory P. Hanley declares that he is the owner/founder of FTF Behavioral Consulting. Lauren Gary declares that she has no conflict of interest. Megan B. Boucher declares that she has no conflict of interest. Monica Howard declares that she has no conflict of interest. Jesse Perrin declares that he has no conflict of interest. Felipe M. Lemos declares that he has no conflict of interest.

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Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

ORCID iDs

Joshua Jessel https://orcid.org/0000-0002-1649-2834

Felipe M. Lemos https://orcid.org/0000-0001-5511-7423

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supplemental Material

Supplemental material for this article is available online.

Notes

1. Individual data sets available as Supplemental Material.
2. Sum of the percentage of non-dangerous and dangerous does not equal 100% because no problem behavior (dangerous or non-dangerous) was observed during the remaining 9% of applications.

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Author Biographies

Joshua Jessel, PhD, BCBA-D, LBA, is an assistant professor teaching graduate level courses in the Applied Behavior Analysis master's program at Queens College. His primary research interests include developing safe and efficient methods for assessing problem behavior of those diagnosed with autism and other related developmental disorders.

Debra Rosenthal, MA, BCBA, LBA, was a student in the Applied Behavior Analysis master's program at Queens College completing a thesis under the mentorship of Dr. Joshua Jessel. She is currently a service provider for children diagnosed with autism.

Gregory P. Hanley, PhD, BCBA-D, LBA, is a research professor at Western new England University and founder of FTF Behavioral Consulting, an international training and consulting group based in Worcester, Massachusetts. His primary research focuses on the assessment, treatment, and prevention of problem behavior and sleep problems, and on empirically-derived values for practitioners.

Lauren Rymill, MS, BCBA, LABA is a practicing behavior analyst who specializes in the education of children with autism. Lauren has spent most of her professional career dedicated to working with children with moderate to severe challenging behaviors and high rates of automatically maintained behaviors.

Megan B. Boucher, MA, BCBA, is currently a clinical director and certified special education/elementary education teacher at Peachtree Autism Services. Her primary interests include prevention of the development of problem behavior, evidence-based instructional practices for students with learning needs, and teacher/caregiver training.

Monica Howard, PhD, BCBA-D, LBA, is the executive director of The ELIJA School, an ABA school for children with autism in Levittown, NY. Her primary focus

is on clinical application of effective interventions to reduce challenging behavior with individuals diagnosed with severe autism.

Jesse Perrin, MA, BCBA, is a BCBA and research coordinator for Pathways Strategic Teaching Center and adjunct faculty member for Salve Regina University. His research focuses on the assessment and treatment of severe problem behavior.

Felipe M. Lemos, MSc, is a graduate level faculty member in the Applied Behavior Analysis certification program at Censupeg and Neurokind Courses and Specializations in Sao Carlos, Brazil. In addition, he provides services as a consultant in functional analysis to Luna ABA. His primary research interests include functional behavior assessment and prevention of problem behaviors.