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SI: TRAUMA-INFORMED PRACTICE IN BEHAVIOR ANALYSIS

A Two Step Validation of the Performance-Based IISCA: A Trauma-Informed Functional Analysis Model

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Abstract
Functional analyses often involve extended exposure to evocative events and problem behavior, which potentially places the client at risk of retraumatization. The performance-based, interview-informed synthesized contingency analysis (IISCA) is a brief analysis that is conducted in a single session and applies a trauma-assumed framework in the development of the assessment procedures (e.g., measures of calm, reinforcing precursors to avoid escalation and physical management). We conducted 12 applications of the performance-based IISCA in the United States and Brazil and (1) compared the results to a subset of 7 applications who also experienced the original IISCA and (2) incorporated a function-based treatment informed by the performance-based IISCA in a further subset of 5 of those 12 applications. The results support the use of the performance-based IISCA in that this variation of the IISCA corresponded with the original IISCA and informed effective treatment of problem behavior.

Keywords Functional analysis · Problem behavior · Synthesized contingencies · Trauma · Treatment validation

Functional analysis refers to the empirical process of identifying environmental contributors to problem behavior (Hanley, 2012). The environmental variables of interest often involve antecedents that evoke problem behavior and consequent events that reinforce problem behavior, the combination of which represents a hypothesized operant contingency. How this contingency is arranged depends on the specific functional analysis procedures employed. For example, the evocative events could be repeatedly presented during a functional analysis while reinforcers are removed on a time-based schedule, irrespective of any occurrence of problem behavior (Iwata et al., 1982/1994). In addition, the evocative events could be reserved for occasions as they naturally occur in the individual's environment (Sigafoos & Saggers, 1995). Although a multitude of different functional analysis formats currently exist, they all share some inherent risk of retraumatizing individuals with the presentation of evocative events and removal of reinforcers. It is in our best interest as clinicians to choose functional analysis procedures that reduce the likelihood of retraumatizing individuals who may have a history of adverse experiences.

Trauma has been defined as, "exposure to an event or series of events that adversely affects functioning and well-being" (Rajaraman et al., 2022, p. 40), and it is safe to assume that many individuals diagnosed with intellectual and developmental disabilities who exhibit problem behavior have been exposed to some adverse experiences that may contribute to trauma (Darnell et al., 2019; Kerns et al., 2015). Applying a trauma-informed framework to behavior analytic practice is a relatively new topic and entails adherence to four core commitments Rajaraman et al. (2022). First, practitioners must acknowledge trauma and the potential influence previous experiences with adverse events can have on an individual. That is, similar events can affect each individual differently based on their history, which would not only influence the efficacy of

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certain treatment procedures but may also be indicative for avoiding intrusive procedures that have the potential to retraumatize the individual. Second, a trauma-informed framework ensures that the individual maintains a feeling of safety and trust within the context in which they are provided services. Risks should be minimized and the individual should feel comfortable independently approaching and communicating with others. Third, practitioners are committed to promoting choice and shared governance as emblematic of the services they provide. A healthy therapeutic relationship is not one in which the practitioner designs a treatment without any input from the individual who will be the one experiencing those procedures. This commitment ensures multiple opportunities for the individual to have a say in their own care. The fourth commitment is for practitioners to emphasize skill-building when developing treatments as a means to empower the individual. Individual growth and learning is likely to support a successful road to recovering from trauma.

Although a trauma-informed approach to functional analysis has never been expressly considered in the past, some modifications that have been developed are likely to align with these aforementioned commitments. For example, some functional analysis formats change the measures of problem behavior from rate (requiring extended amounts of time to calculate) to latency (Thomason-Sassi et al., 2011) or percentage of trials (Sigafoos & Saggers, 1995), both of which only require a single instance of problem behavior during each observation period. This could help reduce exposure to potentially traumatizing events. In addition, other researchers suggested improving efficiency of the assessment process by reducing the number of sessions conducted (Northup et al., 1991) or reducing the session duration (Wallace & Iwata, 1999). Reducing time spent in the functional analysis would allow practitioners to focus more on skill-building during subsequent treatment.

Hanley et al. (2014) designed a novel functional analysis format that combined multiple procedural modifications including a single test condition representing an individualized contingency informed by the qualitative information obtained from a previously conducted open-ended interview and observation. This specific functional analysis format was conducted for the problem behavior of three children diagnosed with developmental disabilities and supported the identification of socially mediated functions in only two clinical visits on average. The researchers used the differentiated results of the functional analyses to design a function-based treatment that taught communication, tolerance, and cooperation skills while eventually eliminating problem behavior. This specific functional analysis format was later termed the interview-informed, synthesized contingency analysis (IISCA; Jessel et al., 2016) and although it is often recommended as a practical alternative to other potential formats, many of the procedures align with the core commitments of trauma-informed care.

Metras and Jessel (2021) recently introduced an IISCA format that specifically acknowledges, measures, and attempts to reduce the likelihood of trauma from the client's perspective. This format, the performance-based IISCA, is defined by particular elements influenced by the commitments to trauma-informed care. During the performance-based IISCA, the presentation and removal of reinforcement is dependent on participant performance. That is, the suspected reinforcers are presented following problem behavior and only removed following 30 s of no problem behavior. This is to reduce the potential for escalation due to repeated exposure to establishing operations (i.e., adverse events). In addition, establishing operations are only introduced when the client appears calm or is showing positive affect. A measurement of calmness or positive affect should minimize the likelihood that the implementation of the establishing operations leads to escalated rates of severe problem behavior, which may lead to the use of physical management techniques that could worsen or retraumatize the client. Another element of the performance-based IISCA is that the measurement of problem behavior is simplified to a count rather than a calculation of rate. Functional control is demonstrated after a number of instances of problem behavior are observed during the reinforcer absent intervals (RAIs) in comparison to the reinforcer present intervals (RPIs). Depending on the criterion, the performance-based IISCA could be completed within as little as three to five instances of problem behavior.

Iovino et al. (2022) conducted the performance-based IISCA with five autistic individuals who exhibited dangerous topographies of problem behavior such as SIB and aggression. However, the authors did not compare the performance-based IISCA to previously supported ways of conducting the analysis and, therefore, it has yet to be validated as an effective functional analysis that can inform function-based treatment procedures that reduce problem behavior. The purpose of this study was to provide an empirical evaluation of the performance-based IISCA with participants in the United States and Brazil. In addition, we evaluated the utility of the performance-based IISCA in two ways. A subset of participants experienced the original IISCA (Hanley et al., 2014) following the performance-based IISCA and the results of both were compared. This was conducted to determine the likelihood of the outcomes of the performance-based IISCA corresponding to that of the original IISCA. A secondary subset of participants then experienced a treatment informed by the results of the performance-based IISCA. The inclusion of a function-based treatment was used as a form of treatment validation (Hayes et al., 1987) indicating that the performance-based IISCA has utility for informing effective intervention and reducing problem behavior.

Table 1 Participant demographics

Participant	Age	Sex	Citizenship	Race/Ethnicity	Diagnosis	Language Ability[a]	Problem Behavior
Alan	9	M	Brazil	Black	ASD, OCD	3	Agg, dis
Rich	9	M	USA	White Non-Hispanic	ASD, ADHD, LSD, LD	2	Agg, dis, SIB, physical intim
Lola	7	F	USA	White Hispanic	ASD, LSD, LD	3	Agg, dis, in. voc, dropping
Tobi	13	M	USA	White Non-Hispanic	ASD	2	Agg, dis, in. voc
Gabi	13	F	USA	White Hispanic	ASD, DS	3	Agg, dis, dropping, pushing
Osman	8	M	USA	South Asian	ASD, ADHD	4	Agg, dis, in. voc
Patrick	9	M	Brazil	White Hispanic	ASD	4	Agg, dis, in voc
Timmy	2	M	Brazil	White Hispanic	ASD	3	Dis, in. voc
Deniz	14	M	USA	South Asian	ASD	3	Agg, dis, SIB, in. voc
Mat	3	M	Brazil	White Hispanic	ASD	3	Dis, in voc
Yan	11	M	USA	South Asian	ASD	1	Dis, SIB, in. voc

Note. ASD refers to autism spectrum disorder. OCD refers to obsessive compulsive disorder. DS refers to Down's syndrome. ADHD refers to attention deficit/hyperactivity disorder, LSD refers to language and speech disorder. LD refers to learning disorder. Agg refers to aggression. Dis refers to disruptive behavior. SIB refers to self-injurious behavior. Physical intim refers to physical intimidation. In. voc refers to inappropriate vocalizations

[a]1 = nonvocal; 2 = 1-word utterances; 3 = short diffluent sentences; 4 = full fluency

Method

Participants

Eleven participants were included in this study. Seven were recruited in the United States and the remaining four were from Brazil. All participants in this study were referred for the assessment and treatment services of their problem behavior by health professionals (e.g., physicians, clinicians), teachers, or caregivers. The referring adults reported difficulty managing the problem behavior and that in many situations the problem behavior posed as a safety risk. For example, Yan bit his hands with such intensity and so frequently that he often created open wounds on a near daily basis and the tissue around his hands had permanent scarring. In addition, many of the participants were reported to require some level of restraint and were prescribed medication specifically to address their problem behavior. The caregivers of Lola reported severe bursts of tantrums where she would repeatedly drop on hard surfaces headfirst and the only way to protect her was for the father to hold her for around 30 min at a time until she calmed down. Restraint or seclusion was not used at any point during participation in this study; however, protective equipment such as soft mats were used. Participant demographic information is presented in Table 1.

Most of the participants were male (9 of 11) and the mean age was 8.9 years old (range: 2–14). Seven of the participants lived in the United States whereas the remaining four participants lived in Brazil. The race and ethnicities of the participants included white Hispanic (5 of 11), South Asian (3 of 11), white non-Hispanic (2 of 11), and Black or African American (1 of 11). All participants were diagnosed with ASD and five included comorbid diagnoses including obsessive compulsive disorder (OCD), Down's syndrome, attention deficit/hyperactivity disorder (ADHD), language and speech disorder, or a learning disorder. The majority of the participant could speak in short disfluent sentences (6 of 11). The remaining participants were fully fluent (2 of 11), could speak in one-word utterances (2 of 11), or were nonvocal (1 of 11). All participants exhibited a range of problem behavior ranging from dangerous (e.g., aggression, disruptive behavior, self-injurious behavior [SIB]) to non-dangerous (e.g., inappropriate vocalizations, physical intimidation).

Settings and Implementers

Sessions were conducted in the respective country where the participant lived with the implementers speaking in their native language (i.e., English in the United States; Portuguese in Brazil). The majority of the participants attended an outpatient clinic (8 of 11). The outpatient clinic typically had session rooms specifically designated for the assessment and treatment of problem behavior. The session rooms were approximately 3 m by 3 m and included a table with two chairs on one side and a soft or matted play area on the other. Doors in the session room were closed unless the caregivers reported that this would be a concern for their child or if the child made any verbal (e.g., "can I play with the door open?") or nonverbal (e.g., holding the door when attempting to close it) indications that they preferred the door being open.

The implementer conducted sessions for three participants in a specialized school. The large classrooms were separated into smaller sections for each student using transportable room dividers. Each section was approximately 3 m by 2 m and included the same materials as the outpatient clinic room. Finally, the implementer conducted sessions for one participant in their living room and dining room of their home. The living room included a television, couch, and coffee table. The dining room included in small table with two chairs. All implementers were trained by the first author and/or received seminar-based training in conducting the open-ended interview and IISCA procedures (cf., Whelan et al., 2021).

The age and experience of the implementers depended on the setting (i.e., outpatient clinic, specialized school, home) and country in which the procedures were implemented. The implementers of the outpatient clinic and home in the United States were students of a master's program in applied behavior analysis (ABA). The students were in their mid-20s and had a couple years of experience as registered behavior technicians (RBTs) in local clinics providing ABA services. The students were volunteers receiving supervision hours towards eventual certification as a board certified behavior analyst (BCBA) and licensed behavior analyst (LBA). The teachers at the specialized school in the United States had 1–5 years of experience in the field and were all RBTs. The teachers held bachelor's degrees, with some pursuing higher education of master's degrees in ABA, special education, and other related mental health specializations. All teachers underwent a highly structured and supervised 6-week training upon their initial hire and received ongoing treatment integrity checks. The implementers of the outpatient clinic in Brazil ranged from college level students majoring in psychology with at least 40 hr of basic training (content level equivalent to RBT) to psychologists with at least three years of clinical experience and advanced knowledge of ABA services.

Measurement

We measured problem behavior in two separate categories (dangerous and nondangerous). Dangerous problem behavior was considered any forms of aggression (e.g., hitting, scratching, biting others), SIB (e.g., hitting, scratching, biting self), or disruptive behavior (e.g., hitting, throwing, tearing objects). Nondangerous problem behavior was considered any topographies that could not result in physical harm to the participants or others (e.g., physical intimidation, inappropriate vocalizations). Physical intimidation referred to holding up one's fist as an indication that they were going to hit the implementer. All problem behavior were measured as a count and converted to a rate by dividing the count by the session duration. Each occurrence of problem behavior was represented in the performance-based IISCA whereas aggregate rates were represented in the original IISCA and treatment validation.

We also measured instances of appropriate behavior. This included interactive behavior defined as the participant positively engaging with the implementer through conversations or gestures (e.g., "look at this!," "I like playing with you"). We measured interactive behavior as an indication of the participant being happy, relaxed, and engaged during the reinforcement interval. In addition, interacting with others was indicative of the participant feeling safe and trusting of the implementer. Target forms of communication included a simple functional communication response (FCR) and a complex FCR. Both the simple and complex FCRs were omnibus mands and were selected based on the baseline language abilities of the participants. The topography of the simple FCR was at or below the participant's language abilities to reduce effort in engaging in the response. For three of the five participants (Osman, Lola, Tobi) the simple FCR was "My way" and the complex FCR was "My way please!" Rich's simple FCR was "My" and his complex FCR was "My way." Although Gaby could communicate using short disfluent sentences, she often exhibited selective mutism and rarely vocally communicated with anyone other than her mother. Therefore, we incorporated picture icons as Gaby's modality for communicating and her simple FCR involved handing the implementer a 4-in × 4-in picture icon and her complex FCR involved a smaller 2-in × 2-in icon. The smaller icon was considered more complex because she had difficulty with fine motor dexterity. Variations of "My way" were often selected as the FCR because it has been commonly used in the literature as an omnibus mand for synthesized reinforcement (e.g., Jessel et al., 2018) and the participants did not have any reported previous history with that response. Caregivers were often consulted when selecting the topography of the target communication responses and a different response would have been considered had they expressed concern. However, all caregivers who were consulted agreed with the use of suggested communication responses. Although participants were not consulted on the selection of their own communication response, different responses would have also been selected had the participants indicated any displeasure with the response (e.g., protesting its use).

Two other forms of appropriate behavior were measured as durations. Calmness was defined as the participant sitting with a positive (e.g., smiling, laughing) or neutral affect without exhibiting any erratic movements indicating distress (e.g., flailing arms, shaking legs, constantly looking around the room) or problem behavior. Engagement was defined as contact with preferred items indicative of play (e.g., staring at the tablet and clicking on videos, shoveling sand in sandbox). Reinforcement was another duration-based measure

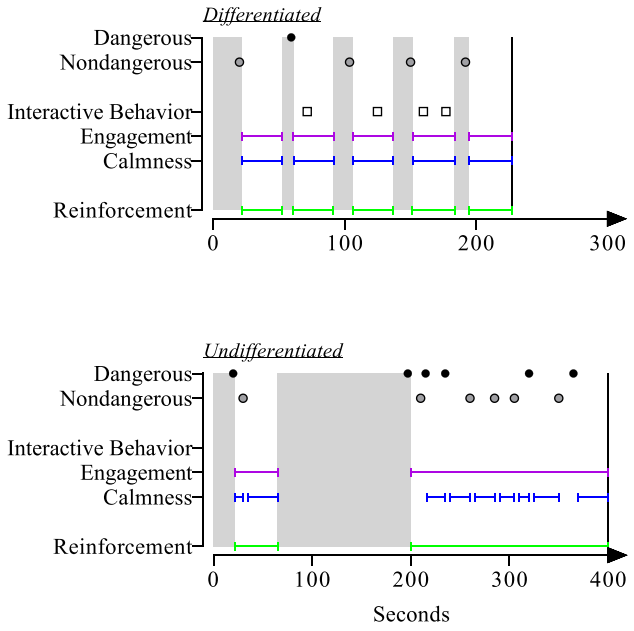

Fig. 1 Hypothetical data indicating differentiated and undifferentiated outcomes during the performance-based IISCA. *Note*. The vertical line indicates the termination of the analysis. Shaded area indicates intervals in which the evocative events are present. The top panel presents a differentiated outcome in which problem behavior is only observed when the evocative events are present and interactive behavior is only observed during reinforcement. This results in a reliable pattern of frequent interchanges between evocative events and reinforcement. The bottom panel presents an undifferentiated outcome where problem behavior is occurring during most events, with the majority observed during reinforcement. The participant is infrequently calm, resulting in longer periods of reinforcement without returning to the evocative events

that began with the discontinuing of evocative events and presentation of preferred events and was terminated with the reverse of the discontinuing of the preferred events and presentation of evocative events. These measures were calculated as a percentage during the original IISCA by dividing the duration by the total session and multiplying by 100.

Experimental Design

The frequency of problem behavior during the performance-based IISCA was visually analyzed and compared across periods when the reinforcers were absent and present. Functional control was demonstrated when consistent patterns were observed with instances of problem behavior occurring more often when the reinforcers were absent than during intervals in which the reinforcers were present. Figure 1 presents two examples of hypothetical data representing a differentiated and undifferentiated outcome. In the representation of a differentiated outcome (top panel), the problem behavior occurred periodically in a predictable fashion following the removal of the reinforcers. Interactive behavior tended to occur during reinforcement and the participant was calm and engaged during this time. The differentiated outcome resulted in five instances of problem behavior across five presentations of the reinforcer. In the representation of an undifferentiated outcome (bottom panel), the nondangerous and dangerous problem behavior occurred at unpredictable moments after extended exposure to when the reinforcer was absent and bursts when the reinforcer was present. The participant may have been engaged with the item but were not continuously calm when reinforcement was available. The results of the undifferentiated outcome presents an uneven ratio of problem behavior to presentations of reinforcement. The undifferentiated outcomes with continued occurrence of problem behavior during reinforcement could also be indicative of automatic reinforcement. That is because persistent problem behavior maintained by automatic reinforcement would continuously extend the reinforcement interval without abating. The design of the performance-based IISCA, therefore, allowed us to rule out the observable influence of automatic reinforcement.

The visual analysis of the frequency of problem behavior during the performance-based IISCA was also supplemented with a within-session analysis of the occurrence of problem behavior during the RAIs and RPIs (Jessel et al., 2016). The instances of problem behavior during the RAIs were summed and divided by the total instances of problem behavior to calculate a percentage. Functional control was supported by this within-session analysis when the majority of problem behavior (i.e., greater than 50%) occurred during the RAIs in comparison to the RPIs.

The original IISCA was conducted using a multielement design. The rapid alternation of the test and control sessions allowed functional control to be demonstrated when elevated rates of problem behavior were observed during the test sessions and no or little problem behavior observed during the control sessions.

A combination of design elements were used during the treatment validation. First, a brief reversal probe was introduced following the first phase of treatment teaching a simple FCR. Therefore, the design was an ABaB reversal whereby the uppercase letters refer to phases with repeated measures and the lowercase letter refers to the implementation of a single session. Functional control was demonstrated when problem behavior returned during the probe and was eliminated when the treatment phase was reintroduced. Second, elements of a multiple baseline design were used to teach two different communication responses in a staggered fashion. Functional control was demonstrated when the communication responses occurred at elevated rates only when the reinforcement contingency was arranged to support the target response.

Interobserver Agreement and Procedural Fidelity

A secondary observer collected data during 100% of the performance-based IISCAs for all participants and at least 33% of the original IISCAs and treatment validation phases. Each sessions was divided into 10-s intervals and the smaller value was divided by the larger value to calculate a partial agreement score. The average was then calculated across the session and multiplied by 100 to get a percentage. Mean interobserver agreement (IOA) for nondangerous problem behavior, dangerous problem behavior, interactive behavior, calmness, engagement, and reinforcement during the performance-based IISCA across participants was 96% (range: 91%–100%), 99% (range: 99%–100%), 93% (range: 70%–100%), 92% (range: 87%–96%), 93% (range: 86%–98%), and 93% (range: 88%–98%), respectively. Mean IOA during the original IISCA was 97% (range: 89%–100%), 99% (range: 98%–100%), 92% (range: 67%–100%), 92% (range: 88%–97%), 92% (range: 89%–97%), and 91% (range: 88%–98%) for nondangerous problem behavior, dangerous problem behavior, interactive behavior, calmness, engagement, and reinforcement, respectively. Mean IOA for the participants who experienced the treatment validation was 100%, 100%, 93% (range: 84%–97%), 92% (range: 84%–97%), 93% (range: 89%–97%), 98% (range: 91%–100%), and 93% (88%–97%) for nondangerous problem behavior, dangerous problem behavior, interactive behavior, calmness, engagement, communication, and reinforcement, respectively.

An observer also collected data on the correct implementation of the procedures during 100% of the performance-based IISCA and at least 33% of the original IISCA and treatment validation. A list of tasks were presented on a sheet and the observed scored if the implementer executed each task correctly. For example, this included presenting synthesized reinforcers following problem behavior during the performance-based and original IISCAs or presenting those same reinforcers contingent on target communication during the treatment evaluation (full task lists available upon request). The correct number of tasks was then divided by the total number of tasks and multiplied by 100 to get a percentage accuracy of implementation. The mean procedural integrity during the performance-based IISCA, original IISCA, and treatment validation was 96% (range: 67%–100%), 95% (range: 67%–100%), and 100%, respectively.[1]

A secondary observed independently collected their own data on procedural fidelity using the same list of tasks. At least 33% of sessions in which treatment integrity was collected were randomly selected to calculate IOA. An agreement was scored when both observers identified the task as being implemented correctly or incorrectly. A disagreement was scored when one observer identified the task as being implemented correctly whereas the other observer identified the task as being implemented incorrectly. IOA was 100% across the performance-based IISCA, original IISCA, and treatment validation. Individual IOA, procedural integrity, and IOA of procedural integrity can be found in the Supplemental Material.

Procedures

Phase 1: Performance-Based IISCA

All participants experienced Phase 1, which consisted of the performance-based IISCA. In addition, one participant (Yan) experienced the performance-based IISCA twice because there were reports from therapists who provided his clinical support that his problem behavior occurred in two different contexts. Thus, the implementers conducted 12 applications of the performance-based IISCA across 11 participants. The procedures of the performance-based IISCA and how they relate to the core commitments of trauma-informed care are summarized in Table 2.

The evocative events and preferred events included in the performance-based IISCA were informed by an open-ended interview (see Hanley, 2012, appendix). The interviewer used the open-ended interview to ask caregivers (parents, teachers, or clinicians) questions regarding any (1) antecedents that have and are likely to evoke problem behavior; (2) the topographies of dangerous problem behavior that are of concern and non-dangerous problem behavior that precede escalation; and (3) preferred events that have and are likely to serve as reinforcers for the problem behavior.

Implementers engaged with the participants while the caregivers were being interviewed to help build rapport before any functional analyses were conducted. Some of the implementers may have known or worked with the participant prior to beginning the study; however, this was not always the case and for some this was participants' first interaction with the implementer. Therefore, it was required that all participants first experience a period of unstructured play with implementers. This is aligned with the trauma-informed care commitment to establishing a context in which the individual can trust those around them and feels emotionally and physically safe. The participants were provided with noncontingent access to preferred items while the implementers followed their lead during play, allowing the participant to guide play without presenting any potential evocative events. This unstructured play period continued until the implementers believed the participants were comfortable and felt safe in their current surroundings (e.g., exploring without

[1] The low value of the range was from a single implementer in Brazil who had no prior experience with conducting functional analyses.

Table 2 How the performance-based IISCA aligns with the core commitments of trauma-informed care

Core Commitments to Trauma-Informed Care	Performance-Based IISCA Procedures
Acknowledging Trauma and its Potential Impact	1. Conducting an open-ended interview to understand an individual's experience with adverse events. 2. Reducing exposure to a maximum of five presentations of the evocative events. 3. Avoiding physical management strategies.
Ensure Safety and Trust	1. Building rapport during unstructured play before conducting analysis. 2. Allowing assent to be withdrawn at any time. 3. Reinforcing precursors to dangerous problem behavior. 4. Extending access to preferred events until individual is calm.
Promote Choice and Shared Governance	1. Delivering preferred events prior to escalation in emotional outburst. 2. Programming evocative and preferred events to be under complete control of the individual's behavior. 3. Honoring requests during access to reinforcement.
Emphasize Skill Building	1. Using the results of the performance-based IISCA to inform skill-based treatment teaching communication, toleration, and cooperation.

Table 3 IISCA characteristics

Participant	Implementer	Location	Evocative Events	Preferred Events
Alan	Trained clinician	Outpatient clinic	Adult-directed play	Independent play
Rich	Behavior therapist	Outpatient clinic	Interruption of play with phone and tablet	Free play with phone and tablet
Lola	Behavior therapist	Outpatient clinic	Transition to workstation with DTI	Independent access to tablet
Tobi	Behavior therapist	Home	Transition to workstation with emphasized error correction	Independent play with tablet
Gabi	Teacher	Specialized school	Adult-directed play	Independent play with honored bids for attention
Osman	Behavior therapist	Outpatient clinic	Transition to workstation with reading material	Child-directed play
Patrick	Trained clinician	Outpatient clinic	Transition to workstation	Interactive play
Timmy	Trained clinician	Outpatient clinic	Transition to table-top tasks	Interactive play
Deniz	Behavior therapist	Outpatient clinic	Transition to workstation with math work	Free access to self-stimulatory toys
Mat	Behavior therapist	Outpatient clinic	Interrupted play with mom	Free play with mom
Yan (1)	Teacher	Specialized school	DTI	Independent play with self-stimulatory toys and tablet
Yan (2)	Teacher	Specialized school	Removed access to self-restraint and protective equipment	Returned access to self-restraint and protective equipment

hesitation, interacting with the implementer, no sudden movements, not repeatedly searching for safety signals from caregiver). This typically lasted the period of the interview. All participants were eventually deemed to feel comfortable with the implementer and the performance-based IISCA was introduced thereafter.

Following the interview with each caregiver, the implementer used the information to identify caregiver-informed precursors in the same response class as the dangerous problem behavior (Warner et al., 2020) and design a unique and ecologically relevant contingency to be evaluated during the performance-based and original IISCA. Questions regarding the range of intensities and hierarchy of different topographies of problem behavior as they occurred in time were used to identify the precursors. The specific evocative and preferred events for each participant are presented in Table 3. The performance-based IISCA was preceded by a 3-min period of access to the participants' individualized preferred events. The performance-based IISCA began once the preferred events were removed and the evocative events were presented. Any problem behavior during this time resulted in the returned access to the preferred events for at least 30 s. If problem behavior occurred when the participant had access to the preferred events or if they were not calm, the 30-s timer was reset. Therefore, the preferred events were not removed and the evocative events were not presented until the participant exhibited at least 30 s with calm behavior and the absence of problem behavior. If problem behavior continued to occur and the participant did not return to a calm state (i.e., resetting the

30-s timer five times consecutively during one reinforcement interval), the implementer would have discontinued the performance-based IISCA and returned to open-ended questioning with the caregivers to redesign the contingency being assessed. The implementer repeated the process of removing reinforcers and presenting evocative events five times, for most participants, before the performance-based IISCA was discontinued. The evocative events were only presented three times after this was deemed sufficient when consulting the caregivers and clinicians working with one participant (Alan).

Any communication or requests to continue engaging with the preferred events were acknowledged and denied (i.e., "Sorry buddy, we are working on this right now") during the performance-based IISCA. If the participant exhibited interactive behavior during the presentation of the evocative events they were redirected to the evocative event. However, interactive behavior that occurred during the presentation of the preferred events was briefly acknowledged (e.g., "That is a train!") or honored if it was a reasonable request. For example, Osman reportedly preferred to direct play and would often tell the implementer how they could help him build sandcastles. During the 30-s access to the preferred events the implementer played with the items according to the Osman's verbal specifications.

During the performance-based IISCA the participant could leave the session at any time. If the participant provided any indication that they would like to leave the room, the implementer would first attempt to ask the participant about particular preferences available in the room (e.g., "You sure you don't want to play with the magnet toys?"). However, the implementer did not physically block the participant from leaving if they continued and the implementer acknowledged their feelings (e.g., "I understand buddy, let's go see what's going on out there"). Once outside of the session room, the implementer asked the caregiver about other preferred items that the participant may be looking for and periodically asked the participant if they would like to enter again, now with any other items they may have selected. This occurred infrequently and the participant

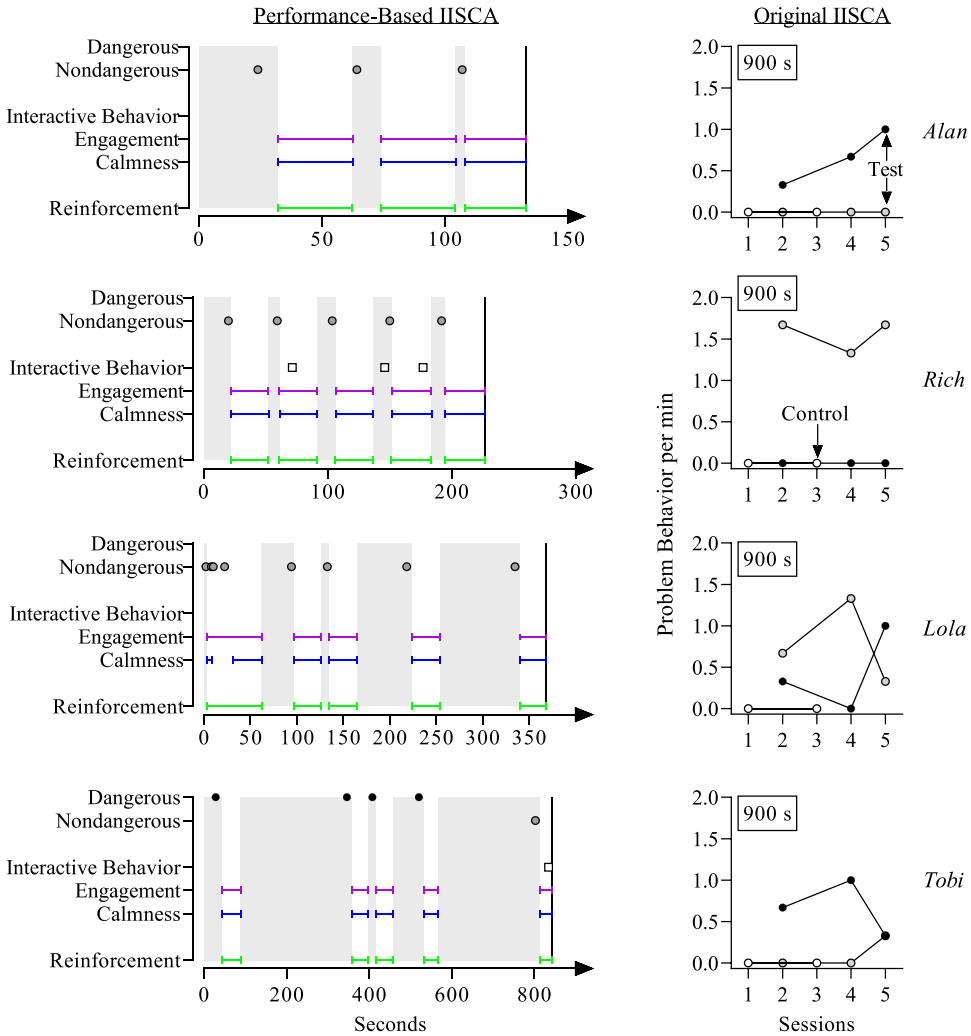

Fig. 2 Results of the performance-based IISCAs and original IISCAs for four of seven participants who experienced both. Note. The vertical line indicates the termination of the analysis. Shaded area indicates intervals in which the evocative events are present. Black circles represent dangerous problem behavior. Grey circles represent nondangerous problem behavior. Values in the box indicate the total duration of the original IISCA

always independently elected to reenter the room. Had the participant continued to indicate that they did not want to be there, the sessions would have been discontinued and their participation would have been reevaluated. However, this did not occur. In addition, many of the other qualities of the performance-based IISCA were aligned with this assent-based approach (Breaux & Smith, 2023) in that we included behavioral indicators of assent (e.g., calm, interacting with and sitting next to implementers) and the occurrence of any problem behavior, precursors or dangerous topographies, resulted in the brief discontinuation of evocative events and shorter sessions (i.e., the analysis duration was dependent on performance and not on time).

Once a differentiated outcome supporting the identification of a socially mediated function for problem behavior was observed (i.e., problem behavior consistently occurring during the evocative events), the implementer conducted the original IISCA. The original IISCA was always conducted after the performance-based IISCA because prior exposure could increase the likelihood of differentiated outcomes, which we controlled for by conducting the performance-based IISCA first (cf., Thomason-Sassi et al., 2011). That is, the performance-based IISCA is intended to be an efficient alternative to the original IISCA and any prior experience to the contingencies could act as a confound improving differentiation. If differentiated outcomes were not obtained, the implementers would have returned to the open-ended questioning to reconfigure the individualized contingency. However this did not occur.

Phase 2: Original IISCA

A subset of seven participants experienced the original IISCA. The implementer selected these participants based on convenience and participant availability. Many of the participants required the assessment and treatment process as a form of clinical services. Some clinicians continued to receive consultative support but opted to continue providing services in an unsystematic fashion and not represented in an experimental design.

The same contingency from the performance-based IISCA was evaluated during the original IISCA (i.e., a second interview was not conducted). The original IISCA consisted of a single test condition compared to a matched control condition. Sessions were 3 min for all participants except Patrick, who had 5-min sessions (decided by the clinician working with Patrick). During the control condition, the implementer did not present the evocative events and the participant had noncontingent continuous access to the preferred events. If problem behavior occurred at any point during the control, it would have been ignored. All interactive behavior during the control condition were briefly acknowledged or honored. The test condition began with the presentation of the evocative events. If problem behavior occurred, the evocative events were removed and the preferred events presented for 30 s. Any problem behavior that occurred during access to the preferred event did not result in extended access and the implementer re-presented

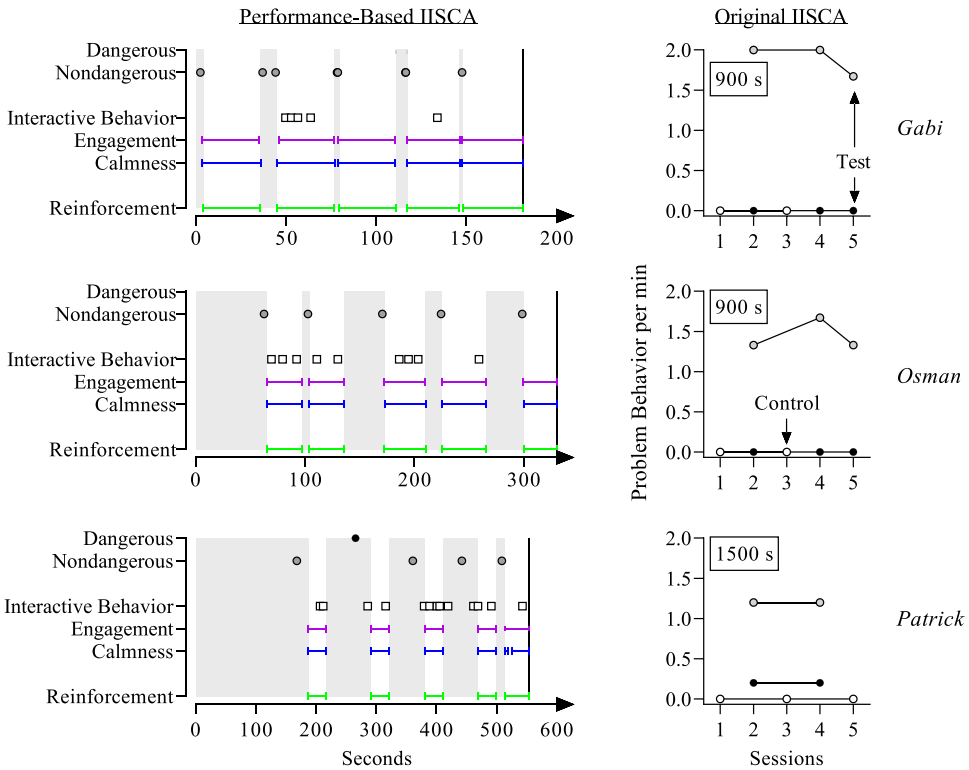

Fig. 3 Results of the performance-based IISCAs and original IISCAs for three of seven participants who experienced both. Note. The vertical line indicates the termination of the analysis. Shaded area indicates intervals in which the evocative events are present. Black circles represent dangerous problem behavior. Grey circles represent nondangerous problem behavior. Values in the box indicate the total duration of the original IISCA

the evocative events once the 30-s period had elapsed irrespective of behavior. The implementer acknowledged and denied any communication throughout the test sessions and interactive behavior was briefly acknowledged or honored during the 30-s access to the preferred events.

The treatment validation would have been conducted regardless of if the original IISCA resulted in a differentiated outcome. The results of the performance-based and original IISCAs identified a context in need of treatment and provided empirical evidence that the parent-informed preferred events served as reinforcers for problem behavior. Therefore, the preferred events are recognized as reinforcers during the treatment validation.

Phase 3: Treatment Validation

Similar to Phase 2, a subset of five participants continued to experience the entirety of the assessment and treatment procedures. The treatment procedures for all participants was a variation of functional communication training (FCT) teaching multiple communication responses of increasing complexity (Ghaemmaghami et al., 2018).

The test sessions from the original IISCA served as the initial baseline for all participants. In addition, the same procedures were used during the return to baseline probe. The simple FCR no longer resulted in access to reinforcement and the implementer presented a denial (e.g., "not right now") before continuing to present the evocative events. Any problem behavior resulted in the presentation of the reinforcers for 30 s. In addition, the reinforcement duration was not extended if the participant exhibited problem behavior during access to the preferred events.

Following baseline, the implementers conducted training trials to teach the participants to emit the target communication response. The implementer conducted behavioral skills training (BST) for those of whom were fluent. That is, the implementer first explained the importance of communication before modeling how to use the target FCR appropriately. The implementer and the participant then practiced using the FCR when the evocative events were presented while providing in-situ prompting and feedback when necessary. The treatment validation sessions began once the participant was able to emit the communication response independently twice in a row. For those of whom were not fully fluent, the implementer taught the target communication response using a most-to-least prompt fading strategy. Following the introduction of the evocative event, the implementer immediately modelled the vocal response or physically prompted the child to hand over the picture icon, which resulted in 30-s access to the reinforcers. The prompt was then progressively faded and systematically delayed as the participant displayed independent communication. The treatment validation sessions began following two sessions of five trials with all independent communication. No data were retained following the training sessions.

During the treatment validation of FCT, all prompts were discontinued. The implementer arranged the evocative event and only re-presented the reinforcers for 30 s following the independent use of the target communication response. All problem behavior was ignored during this time and the 30-s access to reinforcement did not extend to be comparable to the baseline condition. For example, the implementer began session for Osman telling him that "play was all finished" and that it was time to "read books" at the workstation. If at any point Osman said, "My way," the instruction to transition to the workstation was

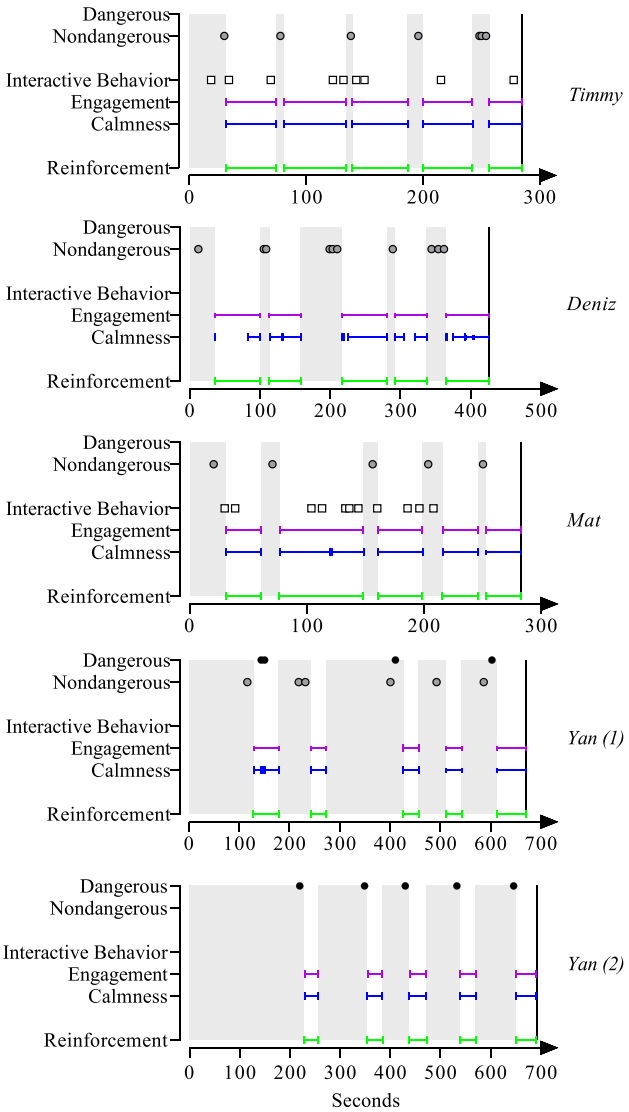

Fig. 4 Results for the participants who only experienced the performance-based IISCA. *Note*. The vertical line indicates the termination of the analysis. Shaded area indicates intervals in which the evocative events are present. Black circles represent dangerous problem behavior. Grey circles represent nondangerous problem behavior

discontinued and he was provided with returned access to the play area where the implementer honored any specific requests related to play. If problem behavior occurred, the implementer would have continued to guide Osman to the workstation and present the reading material. Any interactive behavior was only briefly acknowledged or honored during the 30-s access to the reinforcers.

This process was repeated for all but one participant (Gabi) in order to teach the participants increasingly complex communication skills. Therefore, the first communication response taught was a simple FCR. Once the participant successfully acquired the simple FCR, the implementer taught a second more complex FCR that built off of the sentence structure of the initial simple response. The treatment procedures for teaching the simple and complex FCRs were identical.

Results

The results of the performance-based IISCA for the 12 applications across 11 participants are presented in Figs. 2, 3 and 4 (left panels). Problem behavior tended to occur when the evocative events were presented and preferred events removed for all participants. That, is all participants exhibited greater than 50% of problem behavior during the RAIs and 83% (10 of 12) of the applications did not exhibit any problem behavior during the RPIs (see Fig. 5). In addition, 67% of the applications (8 of 12) exhibited only nondangerous problem behavior during the entire performance-based IISCA. Access to the preferred events was extended due to some problem behavior or lack of calm behavior with 42% of the applications (5 of 12); however, for most participants who required extended access to the preferred events, this only occurred on occasion and they returned to calm behavior shortly after. Seven of the 12 applications (54%) exhibited some interactive behavior during access to the preferred event. Overall, the results of the performance-based IISCA were differentiated for all applications.

The results of the original IISCA for seven applications are presented in Figs. 2 and 3 (right panels). No problem behavior (dangerous or nondangerous) was observed during the control condition and elevated rates of problem behavior was observed during the test condition for all participants. In

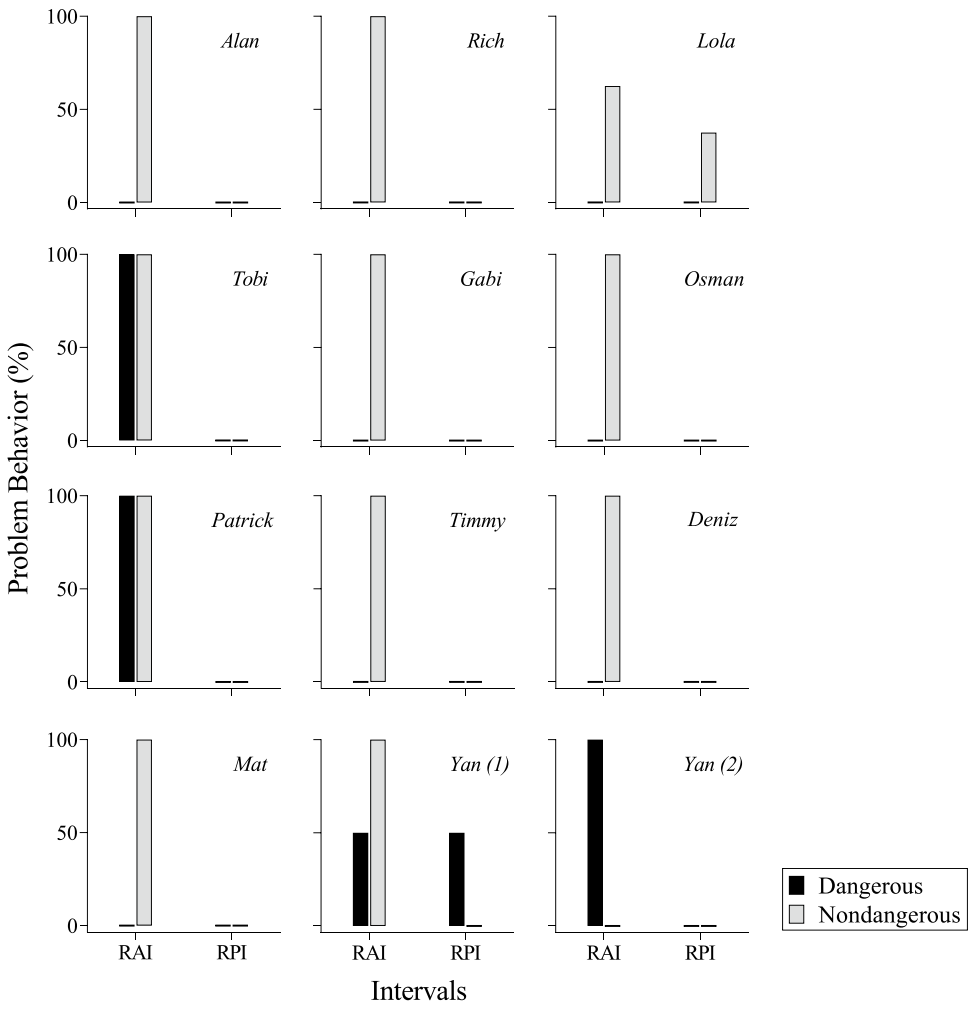

Fig. 5 Percentage of problem behavior when the reinforcers were present and absent during the performance-Based IISCA. *Note*. RAI refers to reinforcer absent interval. RPI refers to reinforcer present interval

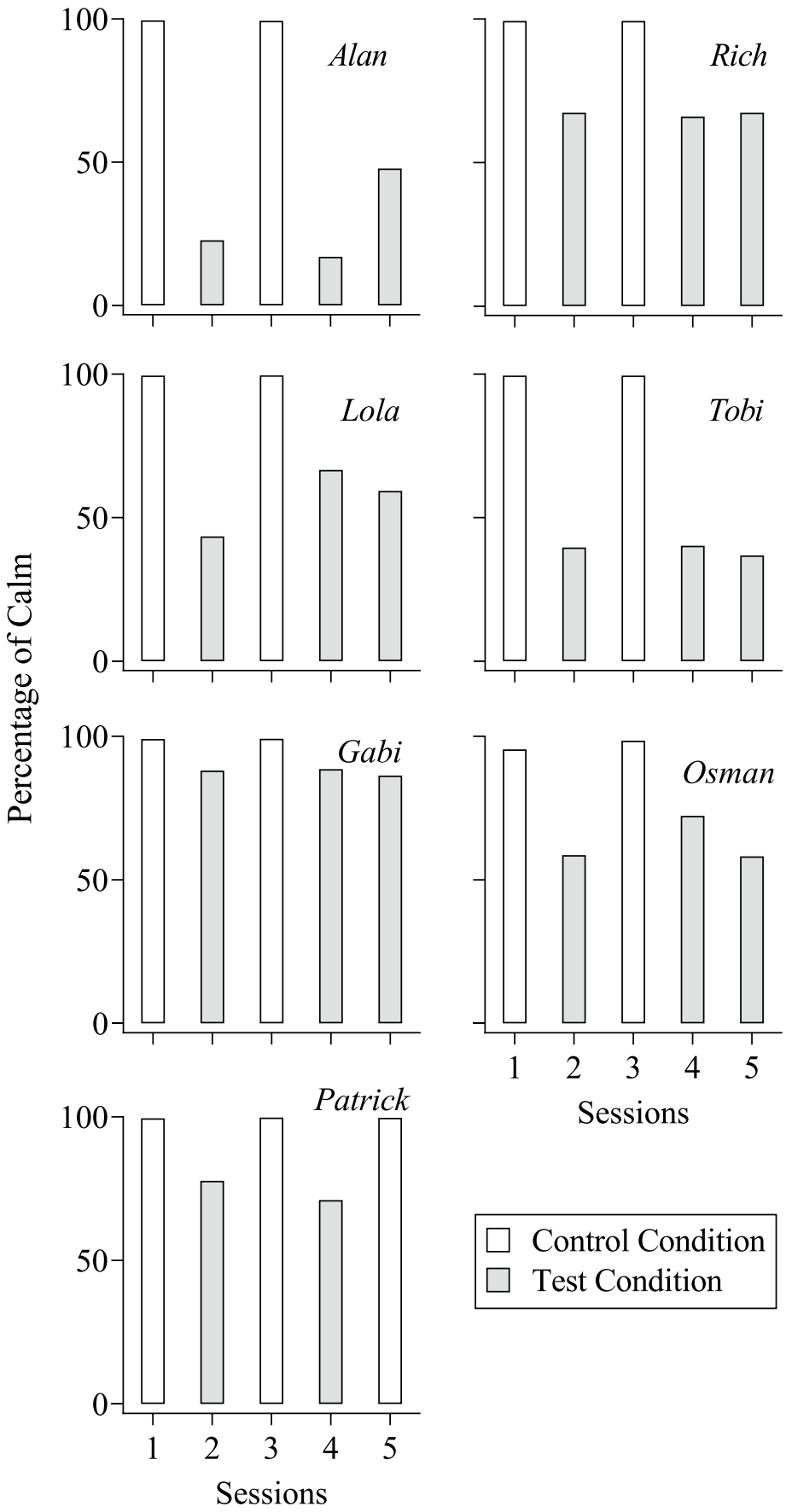

Fig. 6 Percentage of calm during the original IISCA

particular, 43% (3 of 7) exhibited only nondangerous behavior during the entire original IISCA. The remaining 43% (3 of 7) and 14% (1 of 7) exhibited a mix of problem behavior and only dangerous problem behavior, respectively. In addition, more calm behavior was consistently observed during the control condition ($M = 99\%$; $SD = 1$) in comparison to the test condition ($M = 60\%$; $SD = 20$) for all participants (see Fig. 6). The results of the original IISCA corresponded to the results of the performance-based IISCA for all participants who experienced both.

The results of the comparison between the performance-based and original IISCA are summarized in Fig. 7 and Table 4. The performance-based IISCA required a mean of 431 s (7 min) to conduct, whereas the original IISCA required 986 s (16 min). This suggests a 56% improvement in analytic efficiency (i.e., the time in which it takes to conduct a functional analysis). Furthermore, the performance-based IISCA required a mean of 6 instances of problem behavior to interpret function and inform a function-based treatment whereas the original IISCA required 11 instances problem behavior. Rates of problem behavior were also calculated to determine if the higher number of instances of problem behavior was simply a function of the original IISCA necessitating more time to conduct (see Table 4). It is interesting that the rates of nondangerous problem behavior was comparable in both IISCA formats; however, the rate of dangerous problem behavior was more than three times higher during the original IISCA. This suggests that the performance-based IISCA may reduce the rate of dangerous problem behavior.

The results of the treatment validation are presented in Figs. 8, 9 and 10. All five participants exhibited elevated rates of problem behavior during the initial baseline condition ($M = 1.4$ responses per min [RPM]; $SD = 0.42$) and did not exhibit any target forms of communication. In addition, there were moderate levels of calm behavior observed during this time ($M = 63\%$; $SD = 18$). Once the treatment was introduced reinforcing simple FCRs, problem behavior was eliminated for all participants and the simple FCR began to be emitted at elevated rates ($M = 1.71$ RPM; $SD = 0.17$) with large percentages of calm behavior ($M = 97\%$; $SD = 6$). Following the treatment, the baseline probe was introduced and problem behavior immediately returned ($M = 1.47$ RPM; $SD = 0.45$) whereas the simple FCRs ($M = 0.67$ RPM; $SD = 0.27$) and calm behavior ($M = 60\%$; $SD = 20$) decreased. The reintroduction of treatment resulted in problem behavior decreasing for all participants ($M = 0.02$ RPM; $SD = 0.05$) and the simple FCR returning to high levels ($M = 1.65$ RPM; $SD = 0.09$) along with larger percentages of calm behavior ($M = 98\%$; $SD = 2$). No complex FCRs occurred until the final condition in which the reinforcers were discontinued for the simple FCRs and were then made contingent on the complex FCRs. This resulted in maintained low rates of problem behavior ($M = 0.02$ RPM; $SD = 0.03$), an immediate reduction in the simple FCR ($M = 0.03$ RPM; $SD = 0.06$), maintained levels of calm ($M = 99\%$; $SD = 0.4$), and elevated rates of the complex FCR ($M = 1.65$ RPM; $SD = 0.11$).

Discussion

The results of the performance-based IISCA for the 12 applications across the United States and Brazil were validated in a two-step process. First, for the seven participants who experienced both the performance-based and original IISCA, the analysis outcomes were similarly differentiated. Second, the identified contingency from the performance-based

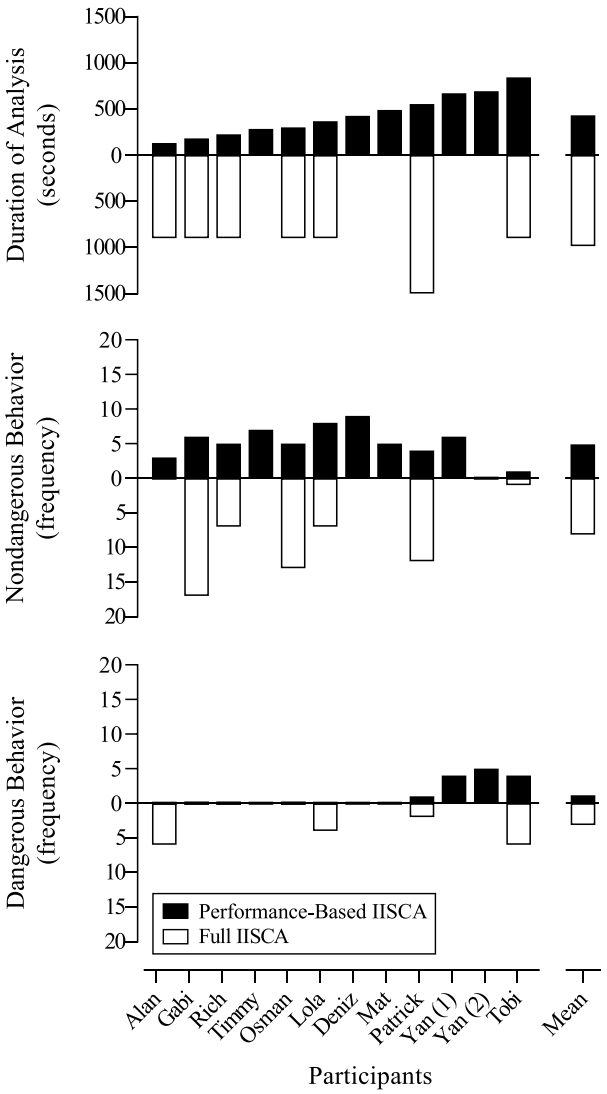

Fig. 7 Summary of duration of analyses and frequency of problem behavior

IISCA was used to inform an efficacious, function-based treatment for all cases in which a treatment was evaluated (5 of the original 12 applications). This form of treatment validity is important to consider when evaluating functional assessments because it helps to advise clinicians of pragmatic boundaries of the use of particular methods or formats (Hayes et al., 1987; Kratochwill & Shapiro, 2000; Slaton et al., 2017). That is to say, the improvement in efficiency when conducting the performance-based IISCA does not necessarily come at the expense of potential positive treatment outcomes. In addition, the performance-based IISCA reduced exposure to dangerous problem behavior in comparison to the original IISCA and maintained consistent levels of calm behavior. Therefore, it seems a clinician can rely on the performance-based IISCA—one of the first functional analysis formats to explicitly describe incorporating a trauma-informed framework—as an effective means of analyzing problem behavior prior to its treatment.

It is important to point out that many commitments to a trauma-informed framework can be applied to any functional analysis format and is not exclusive to the performance-based IISCA. For example, limiting exposure to dangerous problem behavior when conducting functional analyses may improve overall safety and avoid worsening trauma by averting escalation to emotional bursts of problem behavior, which would necessitate the need for intrusive physical management. It seems that most researchers, regardless of the specific functional analysis format employed, will typically use an open contingency including nondangerous topographies in the same response class to reduce the occurrence and reinforcement of the dangerous topographies (Jessel et al., 2020). Although this may require making inferences regarding response class membership when only nondangerous behavior occurs during the functional analysis, interpretations are unlikely to be negatively affected (Warner et al., 2020). Warner et al. conducted a consecutive case series including 10 participants who exhibited multiple topographies of problem behavior. The authors progressively exposed each topography of the caregiver-reported problem behavior to extinction and found that the nondangerous and dangerous behavior were often sensitive to the same reinforcers. Thus, strong inferences regarding the function of dangerous behavior can be made when including nondangerous, caregiver-reported behavior in an open-contingency class.

This is not to say that using an open-contingency class will inevitably improve safety for everyone because some participants may still exhibit dangerous problem behavior. In a collection of 22 applications of the original IISCA, Jessel et al. (2021) found that, although nondangerous problem behavior tended to occur more often for the majority of participants, 68% (15 of 22) still engaged in dangerous problem behavior at some point during the functional analysis. It is interesting that dangerous problem behavior was only observed in 33% of the applications of the performance-based IISCA in the current study. Therefore, the performance-based IISCA may have the added benefit of improving safety further; however, future research may want to include direct measures of injury to support these assertions. Comparing direct measures of injury could help to identify functional analysis formats that best embody trauma-informed commitments to ensuring an individual's safety and trust.

Table 4 Count and rate comparison between the performance-based and original IISCA

Participants	Performance-Based IISCA			Original IISCA		
	Nondangerous Behavior	Dangerous Behavior	Total	Nondangerous Behavior	Dangerous Behavior	Total
Alan	3 (1.35)	0 (0)	3 (1.35)	0 (0)	6 (0.67)	6 (0.67)
Rich	5 (1.32)	0 (0)	5 (1.32)	7 (0.78)	4 (0.44)	11 (1.22)
Lola	8 (1.3)	0 (0)	8 (1.3)	7 (0.78)	4 (0.56)	11 (1.22)
Tobi	1 (0.07)	4 (0.28)	5 (0.36)	1 (0.11)	6 (0.67)	7 (0.78)
Gabi	6 (1.98)	0 (0)	6 (1.98)	17 (1.89)	0 (0)	17 (1.89)
Osman	5 (0.9)	0 (0)	5 (0.9)	13 (1.44)	0 (0)	13 (1.44)
Patrick	4 (0.43)	1 (0.11)	5 (0.54)	12 (1.22)	2 (0.2)	14 (1.4)
Timmy	7 (1.47)	0 (0)	7 (1.47)	--	--	--
Deniz	9 (1.27)	0 (0)	9 (1.27)	--	--	--
Mat	5 (1.05)	0 (0)	5 (1.05)	--	--	--
Yan (1)	6 (0.54)	4 (0.36)	10 (0.89)	--	--	--
Yan (2)	0 (0)	5 (0.43)	5 (0.43)	--	--	--
Mean	***4.92 (0.97)***	***1.17 (0.1)***	***6.08 (1.07)***	***8.14 (0.89)***	***3.14 (0.36)***	***11.29 (1.23)***

Note. Numbers in parentheses represent rate. Dashes indicate the participant did not experience the original IISCA

The indices of calm behavior included in the current study may help in obtaining direct measures of social validity during behavioral assessment and treatment procedures, much like that of indices of happiness or unhappiness (Dillon & Carr, 2007). Although not a defining feature of the original IISCA or FCT, we incorporated measures of calm to maintain a level of comparison with the performance-based IISCA, which required the measure as a criterion for reinforcement termination. We found that participants were relatively calm during the entire assessment and treatment process; however, the highest levels were observed during the (1) RPIs of the performance-based IISCA; (2) control condition of the original IISCA; and (3) FCT phase of the treatment validation. Incorporating indices of calm or happiness may be a relevant consideration for future researchers and clinicians attempting to further the framework of trauma-assumed care to ensure that our behavioral technology is satisfactory and preferred. Doing so would also allow for the selection of more socially acceptable treatment procedures when multiple effective options are available.

Indices of calm are one of many potential measures that align with a trauma-informed framework (e.g., positive interactions, safety signals, open communication) that can be used as comparisons with other functional analysis formats. Not to mention other procedures that were not incorporated into the assessment process of the

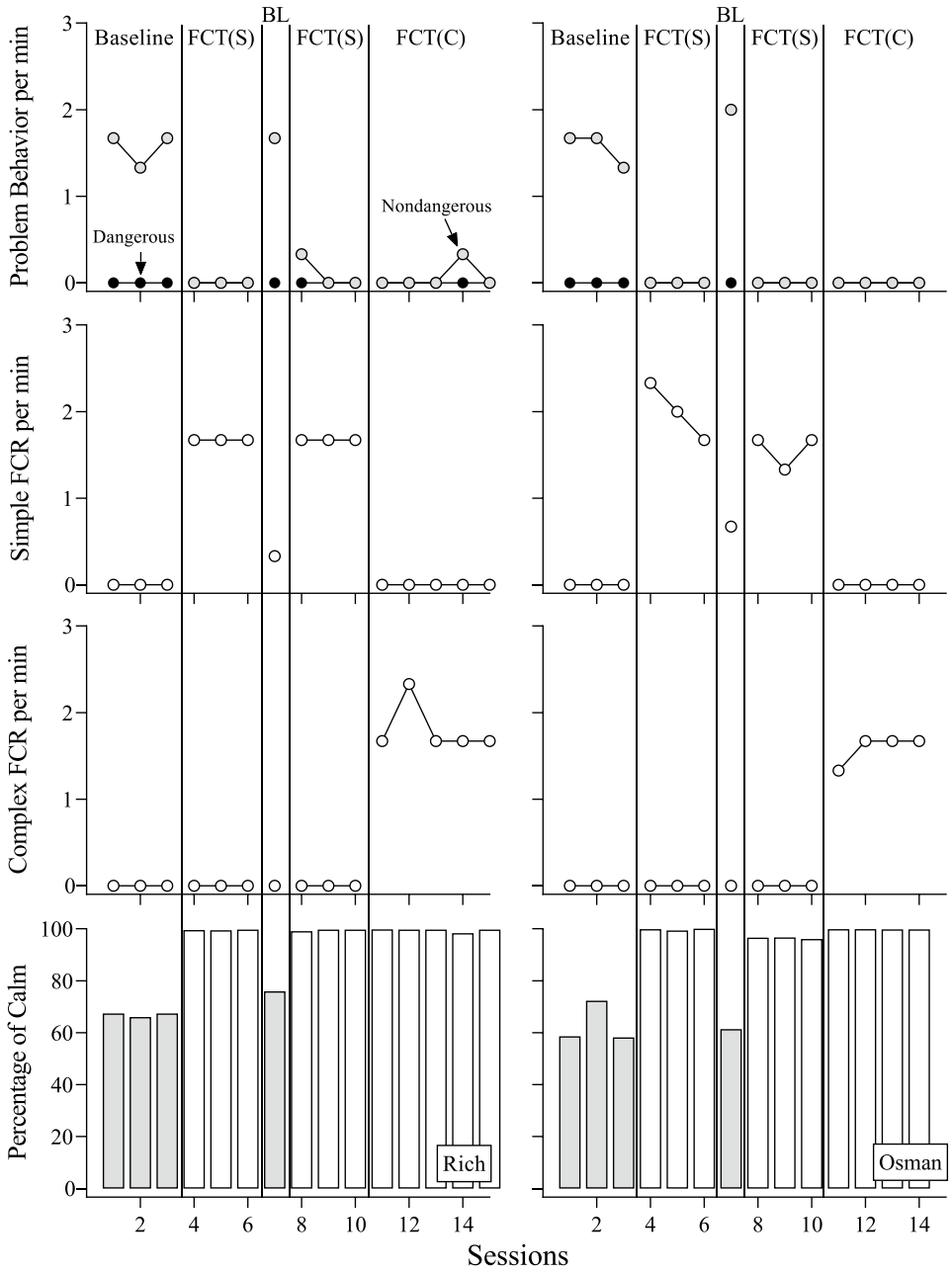

Fig. 8 Treatment validity results for Rich and Osman

performance-based such as describing assent procedures and termination criteria to the individual before session begins or debriefing clients with postsession access to preferred play with the implementer. That is to say, Iovino et al. (2022) attempted to incorporate elements of trauma-informed care into the development of the performance-based IISCA but this is by no means an all-encompassing set of functional analysis procedures. Future researchers may want to consider developing some form of a checklist for determining the number of trauma-informed features a functional analysis format has in order to compare and contrast any limitations to the trauma-informed framework. It is our hope that the performance-based IISCA becomes one of many functional analysis formats in the future that acknowledges trauma and that practitioners will be able to choose the most effective and trauma-informed set of practices.

Although we were able to evaluate the performance-based IISCA in a two-step process, the treatment validation was limited by the fact that we focused on treatment efficacy and not treatment effectiveness (Ghaemmaghami et al., 2021). In other words, we conducted a

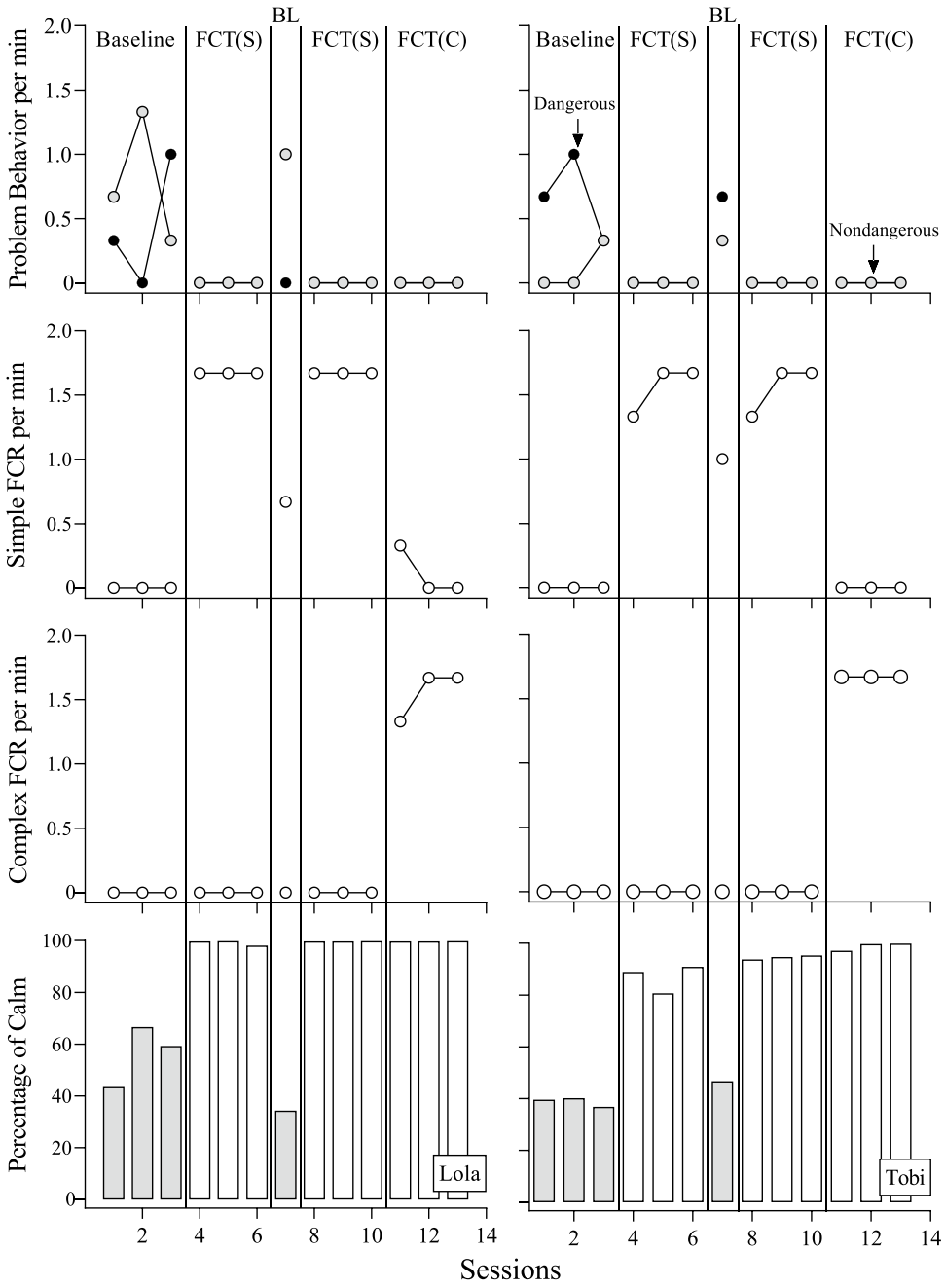

Fig. 9 Treatment validity results for Lola and Tobi

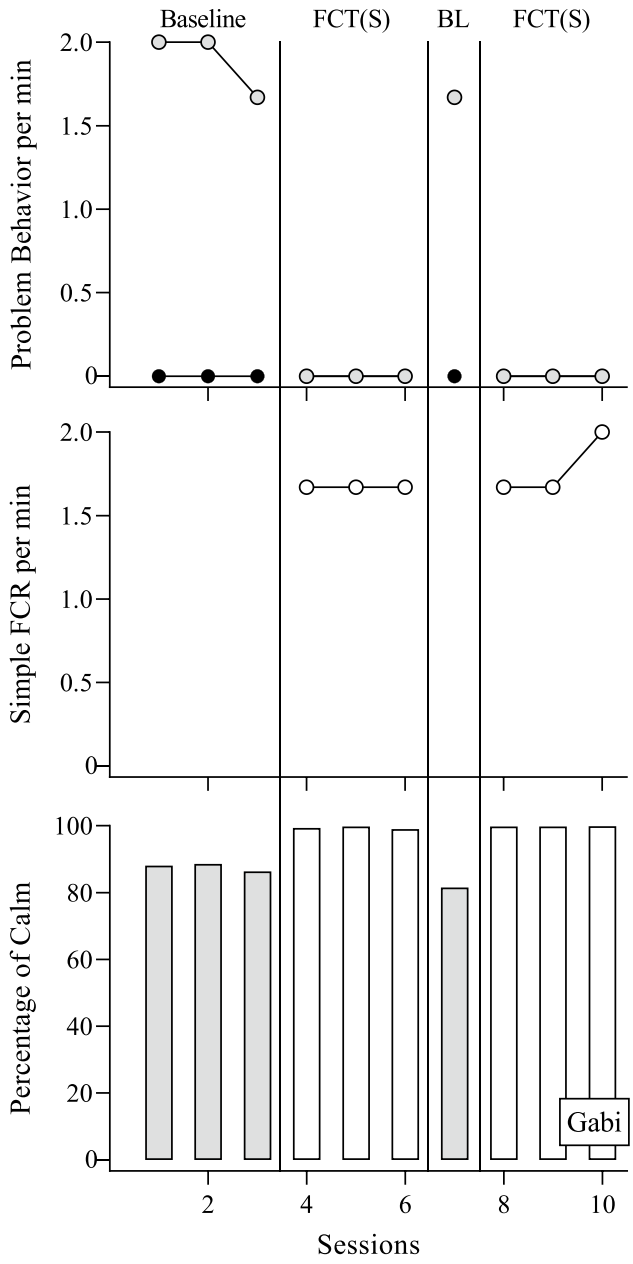

Fig. 10 Treatment validity results for Gabi

brief function-based treatment teaching communication skills without thinning reinforcement or incorporating caregivers. Considering the overall correspondence with the original IISCA and the generalized outcomes that have been obtained during more comprehensive treatment strategies following the original IISCA (e.g., Coffey et al., 2021; Hanley et al., 2014; Jessel et al., 2018; Rose & Beaulieu, 2019; Santiago et al., 2016; Taylor et al., 2018), it may be likely for the performance-based IISCA to reflect similar positive findings. However, future researchers should more directly evaluate this assumption through replications of socially validated treatment effects informed by the performance-based IISCA across extended periods of time with natural change agents and settings. We were particularly limited in the current study without the inclusion of social validity among implementers across two very culturally distinct countries. This would have given us the opportunity to evaluate the generality of the cultural acceptability and appropriateness of the procedures.

Another limitation is that very little information is obtained regarding trauma from the caregiver and participant perspectives throughout the entire assessment and treatment process. Questions can be presented specifically addressing any (1) previous exposure to trauma when completing the open-ended interview; (2) observable responses to trauma; and (3) current exposure to trauma during therapy sessions by introducing opportunities to report any adverse experiences. Evaluating the effectiveness of a treatment may not be entirely complete, and we potentially risk retraumatizing the at-risk populations we serve, without appealing to trauma-informed care.

Being more informed of the potential history of trauma and external cues of current exposure to trauma may better help in avoiding retraumatization; however, some risk may always be present considering that a functional analysis inherently involves creating conditions that evoke problem behavior. Furthermore, it is not always possible for the practitioner to identify all triggers associated with trauma and some behavioral responses to trauma may be internal. Jennett et al. (2011) conducted a functional analysis for the severe SIB exhibited by an autistic individual who likely experienced trauma in her past and required restraints to maintain her safety throughout the day. It is interesting that the authors measured the participant's heart rate and noticed that the beats per minute were well over her resting heart rate not only when the restraints were removed and she was able to engage in SIB, but even during any preceding signals of the impending removal before she was able to physically engage in the SIB. Thus, observable measures of problem behavior may not always be indicative of states of negative arousal and researchers may want to consider other supplemental measures of internal events.

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Declarations

Conflicts of interest Tess Fruchtman declares no conflict of interest. Natasha Raghunauth-Zaman declares no conflict of interest. Aaron Leyman declares no conflict of interest. Felipe M. Lemos declares no conflict of interest. Henrique Costa Val declares no conflict of interest. Monica Howard declares no conflict of interest.

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