Further Examination of Isolated Versus Combined Contingencies in Functional Analyses

By

Kathleen M. Holehan

M.A., University of Kansas, 2019
M.A., Western Michigan University, 2014
B.A., Lynchburg College, 2007

Submitted to the graduate degree program in The Department of Applied Behavioral Science and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Chairperson Claudia L. Dozier, Ph.D.

Pamela L. Neidert, Ph.D.

Florence D. DiGennaro Reed, Ph.D.

Kathryn J. Saunders, Ph.D.

Kathleen L. Lane, Ph.D.

Date Defended: 26 July 2021

Further Examination of Isolated Versus Combined Contingencies in Functional Analyses

____

Chairperson Claudia L. Dozier, Ph.D.

Date approved: 26 July 2021

Abstract

Although functional analysis (FA) methodology is the gold standard for determining the function of problem behavior, a major challenge in practice is the safety and efficiency of FAs (Betz & Fisher, 2011; Hanley, 2012; Iwata & Dozier, 2008). To address this, researchers have proposed various procedural and methodological refinements to FAs. A recent methodological refinement to address safety and efficiency involves synthesized (i.e., combined) contingency analyses (SCAs) based on the outcomes of other functional behavioral assessment methods (Hanley et al., 2014). We replicated and extended Holehan et al. (2020) by comparing the outcome of isolated versus synthesized contingencies in functional analyses of precursor behavior and target problem behavior while using a reversal design to replicate the effects, as well as to analyze potential iatrogenic effects (Retzlaff et al., 2020) for four young children. In addition, we collected data on other topographies of problem behavior mentioned in the indirect assessment to see if these behaviors occurred in the same conditions as precursor behavior or target problem behavior or in other conditions to infer a maintaining variable. Furthermore, we examined within-session analyses of FA data to assess under what context precursor behavior or target problem behavior occurred (i.e., establishing operation on, establishing operation off) for isolated and synthesized contingencies. Next, we extended Tsami and Lerman (2019) by evaluating the extent to which FCT+EXT under synthesized contingencies generalized to the different isolated contingencies that were shown to maintain precursor behavior or target problem behavior for two participants from Study 1. Additional extensions of Tsami and Lerman included addressing variables not assessed in their study (i.e., combined variables other than escape and tangible), addressing limitations by removing the establishing operation for tangibles during isolated escape test sessions, conducting longer isolated test phases, and examining within-session analyses for synthesized FCT+EXT and isolated test conditions. Results showed that synthesized contingencies were not necessary to show functional relations between precursor behavior or target problem behavior and environmental events for three of four participants. Additionally, intervention results showed that synthesized FCRs did not generalize to all isolated variables.

Acknowledgements

To my advisor, Dr. Claudia Dozier, thank you for your constant guidance and support throughout this study and my graduate career. To my lab mates, research assistants, and colleagues, thank you for your valuable input and time developing and conducting this project. Finally, to my family and friends, thank you for continuously encouraging me. I am grateful for your presence in my life during this journey.

Table of Contents

Further Examination of Isolated Versus Combined Contingencies in Functional Analyses

Functional behavioral assessment (FBA) is an umbrella term used to describe several methods for identifying environmental events associated with the occurrence of problem behavior for the purpose of deriving intervention and potential prevention procedures (Hanley, 2012; Hanley et al., 2003; Iwata & Dozier, 2008). The most reliable and valid FBA method is the functional analysis (FA; Iwata et al., 1982/1994), which allows clinicians and researchers to identify cause-effect relations between the occurrence of problem behavior and environmental conditions, which can lead to the design of effective, function-based interventions (Beavers & Iwata, 2013; Hagopian et al., 2013; Hanley et al., 2003; Iwata et al., 1982/1994; Iwata & Dozier, 2008). In fact, researchers have suggested FAs are a critical step in the assessment and effective intervention of problem behavior (Beavers et al., 2013; Hanley et al., 2003; Slaton & Hanley, 2018).

Functional analyses involve direct observation and measurement of the occurrence of target behavior while manipulating relevant antecedent and consequences under at least one test condition and a control condition (Iwata & Dozier, 2008). Often, information from indirect and descriptive observations are used to determine antecedents and consequences that are manipulated in FA conditions (Dracobly et al., 2018; Neidert et al., 2013b; Rooker et al., 2013). During a test condition, a potential reinforcement contingency is programmed for target problem behavior. Specifically, test conditions include (a) an establishing operation (EO) programmed to increase the value of the putative reinforcer, (b) a discriminative stimulus (S^d) that signals the availability of the putative reinforcer, and (c) the delivery of the putative reinforcer contingent on the occurrence of target problem behavior (Hanley et al., 2003; Iwata & Dozier, 2008). During a control condition, the potential reinforcement contingency is absent. That is, the EO, S^d, and putative reinforcer are not present (Iwata et al., 1982/1994; Iwata & Dozier, 2008; Thompson & Iwata, 2005). Higher levels of problem behavior in a test condition as compared to a control condition suggest there is a functional relationship between the environmental event manipulated in the test condition and the occurrence(s) of target problem behavior. The advent of FA methodology has allowed clinicians to derive more effective and socially valid interventions and reduce reliance on punishment procedures and pharmacological interventions (Axelrod, 1987; Kahng et al., 2002; Mace et al., 1991). That is, once the function of a target behavior is determined via an FA, function-based interventions can be derived to (a) decrease the motivation to engage in the problem behavior, (b) eliminate the reinforcer for the problem behavior, or (c) provide the reinforcer for an alternative response (Ala'i-Rosales et al., 2019; Carr & Durand, 1985).

Due to the success of the first systematic FA methodology developed by Iwata et al. (1982/1994), many researchers have replicated and extended this "standard" FA methodology and suggested procedural and methodological refinements for advancing the methodology (see Beavers et al., 2013; Jessel et al., 2020; Hanley et al., 2003 for comprehensive reviews). That is, researchers have shown this methodology to be useful in assessing the function of other problem behavior including physical aggression (e.g. Newcomb et al., 2019), pica (e.g., Lang et al., 2020), property destruction (e.g., Fisher et al., 2013; Fisher et al., 2018), stereotypy (e.g., Rapp & Vollmer, 2005), elopement (e.g., Neidert et al., 2013a), food refusal (e.g., Piazza et al., 2003), inappropriate vocalizations (e.g., Falcomata et al., 2004), and inappropriate sexual behavior (e.g., Dozier et al., 2013). In addition, FAs have shown to be useful in determining the function of problem behavior in various populations including children and adults with IDD and related disabilities (e.g., Iwata et al., 1982/1994; Neidert et al., 2010; Neil & Jones, 2015), children with attention deficit hyperactivity disorder (e.g., Wilder et al., 2001), individuals with Tourette Syndrome (e.g., Banda et al., 2009; Scotti et al., 1994), and individuals with Prader-Willi syndrome (e.g., Hall et al., 2014; Lambert et al., 2019; Stokes & Luiselli, 2009). Finally, FAs have been conducted in various settings including analog settings (e.g., Asmus et al., 2013; Derby et al., 1992), schools or classrooms (e.g., Bloom, et al., 2011; Kodak et al., 2013; Rispoli et al., 2013), homes or residences (e.g., Dwyer-Moore & Dixon, 2007), the community (e.g., Cihak et al., 2007), and to individuals in remote locations using telehealth (e.g., Benson et al., 2018; Gerow et al., 2021; Wacker et al., 2013).

In addition to the generality of FA methodology, research has shown the flexibility of FA methodology in determining the influence of not only common variables manipulated in Iwata et al. 1982/1994 (i.e., attention, escape from demands, and sensory reinforcers) but also various other variables such as access to tangibles (i.e., preferred items and activities, preferred edibles), access to attention within the context of diverted attention antecedent situations (i.e., when attention is delivered to someone else), social escape (i.e., escape from interactions with others), as well as more complex contingencies such as escape to a preferred activity or attention (e.g., conversation about preferred topics), escape to access automatic reinforcement (e.g., ritualistic behavior or stereotypy), access to self-restraint (e.g., Smith et al., 1996), and access to compliance with participant mands (Hanley et al., 2003).

Although the standard FA has been shown to be successful across various populations, target behaviors, environments, and maintaining variables, research has suggested refinements to standard FA methodology, which has culminated in suggestions for best practice, particularly with respect to increasing the efficacy and efficiency of the methodology (Beavers et al., 2013; Hanley et al., 2003). In their extensive review of published FAs, Hanley et al. (2003) suggested best practices for conducting FAs include, which have been supported in various publications. Best practices include (a) limiting the number of response topographies in an FA to reduce the likelihood of masking functional variables (Asmus et al., 2013) and multiple control outcomes (Beavers & Iwata, 2011), (b) programming consequences to be delivered on a fixed-ratio 1 (FR1) schedule to reduce the frequency and severity of problem behavior due to intermittent reinforcement (Hanley, 2012), (c) programming relevant EOs both before and during FA sessions to increase the value of the programmed reinforcer, (d) programming discriminative stimuli (e.g., colored shirts, different experimenters, specific instructions) to aid in discrimination across conditions (Conners et al., 2000), (e) conducting relatively brief (e.g., 5 min or 10 min; Wallace & Iwata, 1999) sessions, (f) including tests to identify behavior maintained by automatic reinforcement, (g) considering relative reinforcement durations when interpreting data, and thus comparing levels of target problem behavior in each test condition to the control condition and not to other test conditions (Fisher & Iwata, 1996), (h) including tests for maintenance by tangible reinforcement only when indirect assessment and/or direct observation suggests there may be a relation (Rooker et al., 2011), (i) starting the FA process with a brief and simple methodology (e.g., start with common test conditions) and progressing toward a more complex methodology, if necessary (Vollmer et al., 1995), and (j) conducting additional or more in-depth indirect assessments and direct observations to determine antecedents or consequences that might influence responding in the everyday environment, and thus programmed in the FA if more complex analyses are needed to determine a function (Hagopian et al., 2013; Roscoe et al., 2015; Schlichenmeyer et al., 2013). In a more recent reviews of the FA literature, Beavers et al. (2013) suggested additional best practices include (a) conducting the standard FA in a fixed sequence (i.e., no interaction/alone, attention, play, then escape) to capitalize on EOs programmed in previous conditions (Hammond et al., 2013) and (b) using a divided attention condition in lieu of a typical attention condition to test for the influence of social positive reinforcement in form of attention (Fahmie et al., 2013a) to program a more effective EO and S^d for evoking attention maintained problem behavior. Finally, Hagopian et al. (2013) suggested a best practice includes deriving stimuli programmed in certain FA conditions (e.g., type of attention, type of demands) from indirect and descriptive FBA methods, as well as from additional systematic assessment procedures (e.g., Kodak et al., 2007).

Safety and Efficiency of FA Methodology

Although FA methodology is the gold standard for determining the function of problem behavior, there are some challenges associated with its use (Desrochers et al., 1997; Ellingson et al., 1999; Oliver et al., 2015; Roscoe et al., 2015; Weber et al., 2005). A major challenge discussed in FA literature is the safety and efficiency of FA methodology. Specifically, although the utility of FA methodology has been shown in hundreds of studies and best practice recommendations for clinicians have been outlined in detail as described above, research suggests clinicians may still avoid conducting FAs due to safety and efficiency concerns with the methodology (Oliver et al., 2015; Roscoe et al., 2015; Weber et al., 2005). That is, clinicians often continue to rely on less reliable and valid FBAs (i.e., indirect assessments, direct observations) or engage in trial-and-error evaluation of behavioral interventions in lieu of conducting FAs. Thus, researchers have attempted to address safety and efficiency challenges to FA methodology by focusing on procedural and methodological refinements to FA methodology.

Safety & FAs

A concern with safety of standard FA methodology is that it may unnecessarily expose individuals (e.g., individual or caregiver) to a higher risk of injury because FAs involve setting up contingencies to evoke and program reinforcers for target problem behavior (Betz & Fisher, 2011). For example, some behavior (e.g., SIB, aggression) may be too dangerous to assess with repeated measures or be too dangerous for researchers to allow to occur (Fisher et al., 2013; Iwata & Dozier, 2008). In addition, a safety concern is that conducting FAs might result in an increase in problem behavior outside the FA (e.g., in the home or classroom; Call et al., 2017). However, most research has not supported this effect (e.g., Shabani et al., 2009), and research on behavioral contrast suggests the opposite effects might be observed (Reynolds, 1961). That is, behavioral contrast suggests that if problem behavior is reinforced on a continuous schedule in the FA, then the rate of problem behavior in the everyday environment should decrease if the schedule of reinforcement for that problem behavior is thinner.

Safety concerns regarding the occurrence of severe problem behavior in FAs are a valid concern. Behaviors that are life threatening or may result in hospitalization or severe harm should be assessed using other FBA methods. Furthermore, modifications to standard FA methodology may need to be addressed to decrease the risk of harm, if it is determined an FA is feasible (see below). Finally, there are various ways to assess and prevent risk of harm prior to conducting FAs (e.g., risk assessment, cost-benefit analysis [Betz & Fisher, 2011; Deochand et al., 2020; Iwata & Dozier, 2008; Wiskirchen et al., 2017] and various safeguards to protect the individual and environment [Betz & Fisher, 2011; Kahng et al., 2015; Iwata & Dozier, 2008]. However, it is important to note that many published studies do not report the use of these risk assessments and safeguards, and thus it is unclear how often each are used (Weeden et al., 2010). Furthermore, this lack of reporting interferes with clinicians being able to identify benefits and risks of various FA procedures and best practices for determining risk and safeguards for conducting FAs (Wiskirchen et al., 2017).

Procedural Modifications to Enhance Safety in FAs

It is important to ensure that FA contexts are safe for everyone involved (participant, experimenters, others around). Thus, the initial step is to determine whether the benefits of an FA for a severe problem behavior outweigh the risks. Various researchers have suggested doing this by conducting a risk assessment (Betz & Fisher, 2011; Deochand et al., 2020; Fisher et al., 2013; Hanley, 2012; Neidert et al., 2013b; Wiskirchen et al., 2017), which involves asking questions about the (a) professionals available for developing and conducting the FA, (b) intensity of the problem behavior (i.e., whether the behavior will result in injury, be likely to increase outside of FA sessions, or be better assessed with other FBA methods), (c) safety of the physical environment for conducting the FA, and (d) the availability of additional staff to assist in conducting the FA. Not only does a risk assessment allow for weighing the costs and benefits of conducting an FA, but it also provides valuable information that can be used to program procedural safeguards to enhance the safety of FAs.

Some important procedural safeguards based on the risk assessment areas above include (a) oversight by appropriate professionals (e.g., medical professionals, Board Certified Behavior Analysts [BCBAs]), (b) the use of formal safety procedures, and (c) blocking or interfering with the occurrence of the severe target behavior (Neidert et al., 2013a). Various professionals should be involved in the design, implementation, and oversight of FAs of severe problem behavior (e.g., severe SIB and physical aggression). First, medical professionals should be contacted prior to conducting an FA of severe problem behavior (Iwata et al., 1982/1994) such that a full medical evaluation can be conducted to rule out a medical condition (e.g., ear infection, migraine, toothache) that may be influencing problem behavior. Additionally, a medical professional should be involved in the design of the FA regarding whether the behavioral assessment should be conducted and criteria to be used to terminate a session or the entire assessment (Kahng et al., 2015). Finally, if possible, a medical professional (e.g., nurse) should be available to provide ongoing evaluation of potential injury or risk throughout the FA (e.g., Iwata et al., 1982/1994). However, the latter may not be feasible in environments other than hospitals and in-patient clinics, thus additional procedural safeguards will be necessary. Second, a BCBA with expertise in FA methodology and function-based intervention should oversee all aspects of developing and implementing an FA. Finally, only individuals who have experience conducting FAs and are well trained in best practices should conduct FA sessions (Hanley, 2012).

In addition to appropriate professional involvement, several formal safety procedures should be considered including (a) modifying the physical environment to increase safety, (b) using a formal system for monitoring and preventing severe injury, and (c) involving trained staff who are able to provide first aid for minor injuries and help ensure other aspects of safety (Iwata & Dozier, 2008; Neidert et al., 2013b). Modifying the physical environment to promote safety might include using soft stimuli (e.g., toys and task materials) and padded floors, walls, and tables to reduce the likelihood of injury or destruction from throwing items and SIB. Using a formal system for monitoring and preventing injury involves ongoing evaluation of injuries throughout the FA process (i.e., prior to sessions, after X number of sessions, after problem behavior occurs in a session). For example, a clinician or researcher might use the Self-Injurious Behavior Trauma (SIT) scale (Iwata et al., 1990) to measure the type, location, and severity of SIB (see Fisher et al., 2013 for more information). Furthermore, the system should include pre-determined session termination criteria to prevent injury. Sessions can be programmed to terminate following minor tissues damage such as reddening or breaking of the skin (Betz & Fisher, 2011) or based on the frequency of target problem behavior that occurs in the session or a period of time during the session (e.g., Iwata et al., 1982/1994). Involving trained staff to provide first aid involves ensuring staff involved in the FA have received training on providing intervention for minor injuries, as well as determining when they should call for medical assistance for more involved injury. Furthermore, additional trained staff may be necessary to help ensure safety and implement crisis management procedures (Kahng et al., 2015).

In addition to the safety procedures described above, clinicians and researchers should consider using response blocking and protective equipment to interfere with the occurrence of problem behavior and prevent injury to the individual or others. Response blocking is a procedural strategy that involves preventing the occurrence of problem behavior by briefly disrupting and physically blocking the potentially harmful response from occurring (Reed et al., 2013). Although response blocking is designed to reduce the likelihood that problem behavior will result in injury, there is a limitation associated with its use. That is, by blocking a response from occurring, the experimenter may inadvertently be providing positive reinforcement or positive punishment, which may result in false-positive or false-negative outcomes (Le & Smith, 2002). Thus, if clinicians or researchers use response blocking during an FA, researchers recommend responses be blocked consistently across all FA conditions (Neidert et al., 2013b).

In addition to response blocking, protective equipment (Fisher et al., 2013) may be used to prevent injury. Protective equipment includes devices (e.g., helmet, arm pads, leg pads) or clothing (e.g., jean jacket, hat) that are to be worn by the individual or the experimenters to reduce the likelihood of either individual being injured. Although protective equipment is designed to reduce the likelihood that the occurrence of problem behavior results in injury, there is a limitation associated with its use. That is, the use of protective equipment may have suppressive effects on the occurrence of problem behavior, thus interfering with determining the function of problem behavior (e.g., automatically maintained problem behavior; Borrero et al., 2002; Le & Smith, 2002). Thus, if clinicians or researchers use protective equipment during an FA, researchers recommend they be used consistently across all FA conditions (Neidert et al., 2013b).

Efficiency Concerns and FAs

Another important concern in conducting FAs is efficiency. That is, if the FA takes considerable time to conduct, it not only delays implementation of intervention but may also be associated with safety concerns. Thus, an important consideration in safety of FAs is the efficiency with which they are conducted. That is, the speed at which an FA determines a functional relation (Jessel et al., 2016; Saini et al, 2020). Roscoe et al. (2015) and Oliver et al. (2015) conducted surveys with practitioners regarding their use of FAs, and results suggested that although practitioners thought FAs were best practice in determining functional variables and deriving effective interventions, most reported they rarely use FAs. One of the most reported challenges to conducting FAs was the lack of time to conduct the FA. Therefore, as outlined in various publications (e.g., Beavers et al., 2013; Saini et al., 2020) researchers have focused on increasing efficiency by reducing the amount of time an FA takes such that an effective function-based intervention may be initiated quickly.

In a recent review, Saini et al. (2020) suggested several additional best practices in standard FA methodology, particularly with respect to enhancing efficiency, and indirectly safety. The authors suggest it is likely that multiple methodological variables likely interact to influence efficiency. The authors reiterated many best practices outlined by Hanley et al. (2003) and Beavers et al. (2013) that likely result in more efficient FAs, and they outlined several additional suggested practices, particularly for the purpose of increasing efficiency. They suggested using structured, ongoing visual inspection (OVI) criteria based on certain visual inspection rules to determine functional relations. They also suggested conducting a series of alone or ignore sessions at the start of the FA to rule in or out an automatic reinforcement function (Querim et al., 2013). They suggested using within-session analyses to evaluate patterns of responding for each session. They suggested incorporating caregivers as experimenters and conducting FA sessions in known settings to evoke problem behavior more readily (e.g., Mueller et al., 2011; Thomason-Sassi et al., 2013). They suggested using trial-based FAs when the goal is to test for isolated functions and using synthesized contingency analyses when the goal is to rule in or out social functions (but not gain information regarding specific social functions). They suggested the use of latency-based measures when warranted (Thomason-Sassi et al., 2011). Finally, they suggested using a control condition that controls for all contingencies presented in test conditions.

Methodological Modifications to Enhance Safety and Efficiency in FAs

As mentioned, a major focus of research in FA methodology has involved methodological changes to enhance safety and efficiency in FAs. That is, researchers have developed and evaluated procedures to decrease the occurrence of severe problem behavior in FAs by conducting precursor FAs, which involve programming contingencies for behaviors that are less severe and reliably precede the occurrence of severe problem behavior (e.g., Borrero & Borrero, 2008; Fritz et al., 2013; Hagopian et al., 2005; Herscovitch et al., 2009; Lalli et al., 1995; Najdowski et al., 2008; Smith & Churchill, 2002). Another method to decrease the occurrence of problem behavior in FAs is the latency-based FA, which involves measuring latency to the first occurrence of problem behavior then ending the session (e.g., Jessel et al., 2018; Kamlowsky et al., 2021; Thomason-Sassi et al., 2011). Researchers have also developed and evaluated procedures to decrease the overall duration of FAs. Methods include (a) brief FAs (e.g., Derby et al., 1992; Greer et al., 2020; Kahng & Iwata, 1999; Northup et al., 1991) in which single sessions of each condition is implemented, (b) truncated session duration (e.g., 3 min, 5 min; e.g., Northup et al., 1991; Perrin et al., 2008; Vollmer et al., 1995), and (c) trial-based FAs in which control and test segments for each putative reinforcer is conducted to determine whether more trials of a test condition are associated with problem behavior than the control condition (e.g., Austin et al., 2015; Bloom et al., 2011; Sigafoos & Saggers, 1995). Furthermore, within-session analyses (e.g., Northup et al., 1991; Roane et al., 1999; Vollmer et al., 1995) have been used to clarify the outcomes of FAs by showing patterns of responding within particular sessions and/or conditions to decrease the number of sessions required. Finally, researchers have recently focused on single-function tests (e.g., Fahmie et al., 2013b; Hanley, 2012; Hanley et al., 2014; Iwata & Dozier, 2008; Querim et al., 2013; Vollmer et al., 1995; Vollmer et al., 1994) to decrease the overall duration of FAs.

Single-Function Tests

Iwata and Dozier (2008) and Hanley (2012) suggested one way to decrease FA duration was to engage in hypothesis testing by developing single-function FA tests based on information gained by other FBA methods (i.e., indirect assessments, descriptive assessments). That is, single-function tests should only be used when indirect assessments such as the Functional Analysis Screening Tool (FAST; Iwata et al., 2013), Motivation Assessment Scale (MAS; Durand & Crimmins, 1988), Questions About Behavioral Function (QABF; Matson & Vollmer, 1995), or open-ended interviews (Hanley, 2012) and descriptive assessments such as a structured observation (Fisher et al., 2016) or the structured descriptive assessment (SDA; Freeman et al., 2000) strongly inform a clear hypothesis regarding the functional variable (Iwata & Dozier, 2008). Methodological modifications of FAs that involve single-function tests include (a) a consecutive alone or no interaction analysis (i.e., screening assessment; Querim et al., 2013; Vollmer et al., 1995; Vollmer et al., 1994), (b) a pairwise analysis (Iwata & Dozier, 2008), and (c) a synthesized contingency analysis (Hanley et al., 2014).

Alone or No Interaction Analysis (Screening Assessment)

An alone or no interaction screening assessment is used to rule in or out an automatic reinforcement function (Querim et al., 2013; Vollmer et al., 1995; Vollmer et al., 1994). That is, if information from an indirect or descriptive assessment suggests a hypothesized automatic reinforcement function, repeated alone or no-interaction sessions can be conducted to verify whether the problem behavior continues to occur in the absence of social consequences. If problem behavior maintains during the screening assessment, an automatic reinforcement hypothesis is validated, and a functional variable is determined. Thus, intervention based on an automatic function can be implemented. By contrast, if problem behavior does not maintain (i.e., decreases within or across sessions), it is possible that extinction has occurred, suggesting that problem behavior is maintained by social reinforcement and further analysis is warranted. Vollmer et al. (1994) were the first to propose the use of consecutive alone or no-interaction sessions to clarify outcomes of undifferentiated standard FAs. Results showed that conducting consecutive no-interaction sessions showed that one participant's problem behavior was maintained by automatic reinforcement, and intervention based on this outcome was effective.

Although previous studies showed consecutive no interaction or alone conditions are effective for determining if problem behavior persists in the absence of social variables (e.g., Vollmer et al., 1994; Vollmer et al., 1995), Querim et al. (2013) was the first to systematically evaluate the utility of a single function no interaction or alone condition. This type of evaluation has commonly been referred to as a screening assessment. In this study, 26 individuals yielding a total of 30 cases (two individuals engaged in multiple problem behaviors) whose target problem behavior was stereotypy were briefly exposed to alone or no-interaction sessions. Researchers chose stereotypy as the target problem behavior because the results of several studies (e.g., Piazza et al., 2000; Rapp et al., 1999; Vollmer et al., 1994) have shown that stereotypy is likely to be maintained by automatic reinforcement. Researchers also included other topographies of problem behavior such as aggression and SIB in the screening assessment, given that these behaviors have been shown to be maintained by social reinforcement (e.g., Iwata et al., 1994; Marcus et al., 2001). Screening consisted of a series of 5-min alone (or no interaction) sessions followed by a standard FA as described by Iwata et al. (1982/1994). The results of the alone or no interaction sessions were then compared to the results of the standard FA. Results indicated that the outcomes of the screening assessments accurately predicted the functional variable of problem behavior (either automatic or social reinforcement) in 28 of 30 cases. Furthermore, the mean duration of the screening procedure across participants was 21.5 minutes.

In summary, research suggests screening assessments might be an effective and efficient assessment methodology in clinical environments when indirect assessments and descriptive observations strongly suggest the target behavior is maintained by automatic reinforcement and when it is not possible or practical to implement a full standard FA. However, it is important to note that if problem behavior does not maintain with repeated alone or no-interaction sessions, further analysis with a either a standard FA or an FA specifically testing for social variables is necessary.

Pairwise Analysis

Another type of single-function test involves the use of a pairwise design to test a hypothesis about an isolated functional variable (Fahmie et al., 2013b; Hanley, 2012; Iwata &

Dozier, 2008). In this FA methodology, if information from an indirect assessment and/or direct observation strongly suggest a particular hypothesized social function, then a test condition based on that hypothesis is rapidly alternated with a control condition. If the pairwise FA results show higher levels of problem behavior in the test condition as compared to the control condition, the hypothesis is validated and the results can be used to directly inform intervention; however, if undifferentiated levels of responding are observed, further analysis is required.

The multielement design is more efficient than other designs for evaluating the influences of multiple independent variables, thus it is the most common design used in FA methodology. However, a limitation of FA methodology is the rapid alternation of multiple conditions, which may interfere with discrimination across conditions and produce interaction effects (e.g., sequence effects, carryover) from one condition to another (Higgins Haines & Baer, 1989; Iwata et al., 1982/1994; Iwata et al., 1994). To address the limitations of the multielement design, Iwata et al. (1994) were the first to develop and assess the use of a pairwise design in FA methodology with five individuals diagnosed with developmental disabilities who engaged in SIB. In the pairwise design developed by Iwata et al., the researchers combined features of a multielement and reversal design, thus resulting in sequential, rapid alternation of a single test condition and a control condition (Iwata et al., 1994). Researchers conducted a standard multielement FA and the pairwise FA using standard FA conditions (i.e., attention, escape, alone, play) and compared the outcomes across FAs. Results suggested correspondence between the outcomes of the two FAs (i.e., same functional variables shown to maintain problem behavior) for two of five participants. Furthermore, for two other participants, the standard FA produced somewhat undifferentiated results, whereas the pairwise design produced clearer results. Overall, the authors suggested the pairwise design might be useful for clarifying undifferentiated standard FA results. However, the use of the pairwise design as outlined by Iwata et al., which involved conducting a pairwise analysis phase for each standard FA test condition was less efficient than conducting the multielement FA. The authors also suggested that the pairwise design might be useful in situations in which only one or two potential functional variables need formal analysis. For example, based on information from other FBA sources, a clinician might compare only an escape test and control condition within a pairwise design.

Since the Iwata et al. (1994) publication, researchers have not only used the pairwise design FA methodology to clarify standard FA outcomes (e.g., Greer et al., 2020; Hagopian et al., 2013; Iwata et al., 1994; Piazza et al., 1997), but they have also begun using it in various other ways to enhance efficiency by only evaluating one (or a few) isolated functional variable. First, researchers may use a pairwise design to test one social functional variable as a screening assessment for inclusion in particular studies that are focused on additional analyses for a specific function or intervention for a specific function. For example, researchers might rapidly alternate the attention test condition and a control condition to determine participants who might be included in a study on intervention for attention-maintained problem behavior. Second, researchers have used the pairwise design as an efficient methodology for testing hypotheses regarding particular isolated functions (e.g., Holehan et al., 2020; Strohmeier et al., 2014). For example, Strohmeier et al. (2014) used information from a descriptive assessment to hypothesize that the physical aggression displayed by an adult male with various disabilities was maintained by attention within the context of diverted attention situations. Therefore, the researchers conducted a pairwise analysis to test this hypothesis, which included a diverted attention test condition and condition-specific control condition. Results suggested the pairwise FA validated the hypothesis from the descriptive assessment because higher levels of problem behavior occurred in the diverted attention test condition as compared to the control condition. Furthermore, a functional communication intervention based on the outcome of the FA was effective for reducing physical aggression and increasing communication to access attention.

As the use of the pairwise design to clarify FA outcomes or reduce the overall duration of FAs has grown in popularity, an important question is what are the best control conditions to use for particular test conditions in a pairwise design? Most FAs include an omnibus play condition as the control condition, which controls for all possible variables manipulated in a standard FA. The play condition has been shown to produce low rates of problem behavior in most situations (Fischer et al., 1997); however, it may contain features that produce higher rates of problem behavior in other situations (Kahng & Iwata, 1999). For example, the omnibus play condition shares stimulus features with the demand condition (e.g., experimenters present), which may result in the play condition acquiring discriminative properties associated with the escape test condition, thus evoking escape maintained problem behavior for some individuals. To determine the most effective control conditions for positive and negative reinforcement in the assessment of problem behavior, Fahmie et al. (2013b) conducted a standard FA with eight individuals who engaged in problem behavior, and those individuals whose problem behavior was shown to be maintained by social-positive or social-negative variables were included in the comparison of control conditions. Specifically, the test condition determined to produce the highest level of problem behavior was alternated using a multielement design with an alone (i.e., no experimenter present in room), ignore (i.e., experimenter stood with back toward individual and did not interact), play (i.e., experimenter provided attention on a FT 15-s schedule), and differential reinforcement of other behavior (DRO; i.e., delivery of reinforcer following DRO interval with the absence of problem behavior) control condition such that levels of problem behavior could be compared across the various control conditions. Results indicated problem behavior maintained by positive reinforcement was low in all control conditions with the play condition containing the lowest levels of problem behavior for 7 of 8 participants. Although all control conditions were effective for social-positive functions, the DRO control condition was ineffective for all individuals whose problem behavior was maintained by social-negative reinforcement. This outcome was likely obtained because the DRO control condition presented the EO for escape (i.e., demands). Although DRO interventions have been shown to effectively reduce problem behavior maintained by escape (e.g., Kodak et al., 2003; Vollmer et al., 1995), exposure to these contingencies typically occurs across several sessions as opposed to intermittently in a multielement design. The interspersal of DRO intervention sessions among demand sessions where problem behavior is reinforced likely caused poor discrimination among conditions. Fahmie et al. suggested that the ignore or alone conditions may be the most effective control conditions for problem behavior maintained by social-negative reinforcement. Finally, Fahmie and colleagues stated that although Iwata et al. used an omnibus play condition within the pairwise design as a control condition, a test-specific control (e.g., attention versus continuous attention, demand versus alone or ignore) may be more effective and efficient as a direct comparison can be made between the presence and absence of relevant EOs (Hanley, 2012; Holehan et al., 2020; Strohmeier et al., 2014).

Overall, a few researchers have shown that the pairwise deign is effective at identifying isolated functional variables when indirect and direct assessments produce clear hypotheses (Holehan et al., 2020; Strohmeier et al., 2014). Additionally, interventions based on these analyses have been successful at reducing problem behavior (e.g., Holehan et al., 2020;

Strohmeier et al., 2014). However, additional research is needed to determine the generality of this procedure for determining functional variables and effective interventions that result in maintained and generalized behavior change. Furthermore, given that pairwise FAs are based on information from other FBA methods (i.e., indirect and direct assessments), additional research is needed to increase the reliability and accuracy of these assessment tools. For example, researchers might compare the degree to which closed versus open ended indirect assessments are better for hypothesizing functional variables (Fryling & Baires, 2016). In addition, additional research on best practice for conducting indirect assessments and descriptive assessments that produce valuable information is needed (Scott et al., 2005). Furthermore, more research is needed regarding what information or outcome is necessary in an indirect or descriptive assessment to opt for conducting a pairwise design as compared to other designs to promote efficiency.

In addition to the above considerations, there are some limitations of the pairwise FA. First, because participants may only be exposed to one or a few hypothesized functional variable(s), undifferentiated results provide little to no other information regarding function, warranting further analysis. Similarly, a pairwise analysis may show differentiation but may fail to identify other functions when problem behavior is multiply maintained. Finally, it is still unclear what control conditions are best in pairwise FAs. A control condition like the play condition controls for all potential variables while keeping other stimulus features constant (Thompson & Iwata, 2005). A control condition specific to the test condition in pairwise designs vary across stimulus features (i.e., EO, S^d, consequence; Fahmie et al., 2013b) resulting in a less rigorous control condition. However, it should be noted this limitation is only applicable for pairwise analyses conducted using a design which rapidly alternates multiple pairwise analyses across EOs, S^ds, and consequences and not for pairwise analyses rapidly alternating an isolated test with a condition-specific control condition. None the less, future research should further examine the extent to which particular control conditions influence FA outcomes.

Synthesized Contingency Analysis

Another derivation of the single-function test that has many of the same components as the pairwise design described above is the synthesized contingency analysis (SCA), which has increased with popularity with the development of the FBA process termed the Interview Informed Synthesized Contingency Analysis (IISCA; Hanley et al., 2014; Jessel et al., 2016; Jessel et al., 2018), or most recently the Practical Functional Assessment (PFAs; Ferguson et al., 2020; Hanley & Gover, n.d.). SCAs are similar to pairwise FAs described above because they involve rapid alternation of a single test condition and condition-specific control condition to test a hypothesis based on the outcomes of other FBA methods (i.e., an indirect assessment alone or a combination of information from an indirect assessment and direct observation). However, the main difference between the pairwise FAs discussed above and SCAs is that all contingencies reported to be associated with target problem behavior in the indirect assessment (and sometimes, observation) are synthesized (combined) in one test condition in SCAs, whereas the control condition involves free and continuous access to all reinforcers programmed in the test condition. Thus, SCAs typically include multiple contingencies and assumes interaction or simultaneous control of behavior (Greer et al., 2020; Tiger & Effertz, 2020).

Although isolated contingency FAs have shown to be successful in determining the function of problem behavior in hundreds of studies for 30+ years (Beavers et al., 2013), there have been some instances in which undifferentiated isolated FA outcomes have been clarified when contingencies are combined (i.e., synthesized; e.g., Call et al., 2005; Hagopian et al., 2007;

Payne et al., 2014). Thus, researchers have suggested that when isolated FA outcomes are unclear, one method to clarify their outcomes may be to combine contingencies that may be interacting to evoke and maintain problem behavior (Fisher et al., 2016; Holehan et al., 2020: Tiger & Effertz, 2020). Based on this research, Hanley et al. (2014) developed the IISCA (now commonly referred to as the PFA) as an FBA process, which involves combining (synthesizing) contingencies from the *beginning of the FA process* rather as a means for clarifying isolated FA outcomes. The IISCA involves first conducting an open-ended interview with caregivers to ask questions focusing on the identification of target behavior and precursor behavior, antecedents likely to evoke target behavior, consequences that follow target behavior, as well as participant preferences and communication abilities. Next, the IISCA involves conducting a structured observation to ensure target and precursor behavior identified in the interview occur in the natural environment. However, it is important to note that it is unclear whether or how this information is used to inform SCA conditions across studies; many studies tend to rely solely on the outcome of the open-ended interview. Next, information from the interview (and sometimes the observation) are used to inform variables tested in an SCA. That is, all contingencies reported by caregivers to be associated with problem behavior are included in a synthesized test condition and controlled for in a test-specific control condition. Test and control sessions are typically short in duration (3-5 min) and rapidly alternated using a pairwise design. Specifically, SCA procedures include a combination of S^ds, EOs, and consequences in a single test condition. For example, in a synthesized escape and tangible test condition, the individual is told, “It’s my turn, it’s time to work” (i.e., combined S^d), preferred tangibles are removed and withheld while demands are simultaneously delivered (i.e., combined EO), and contingent on target problem behavior (and precursor behavior, if applicable) demands are removed and preferred tangibles are delivered for a brief duration (i.e., combined consequence). The condition-specific control condition for this test condition would involve continuous access to preferred tangibles and no demands presented. Finally, SCAs often involve synthesizing problem behavior. That is, all classes of problem behavior (including potential precursors) are reinforced.

In their seminal study, Hanley et al. (2014) showed that SCAs based on indirect assessment outcomes and informal direct observation for severe problem behavior of three children with autism resulted in clear differentiation between synthesized test and control conditions. In addition, researchers showed that interventions (i.e., FCT+EXT with delay/denial training) based on the outcomes of the SCA were highly effective for decreasing problem behavior and increasing appropriate behavior further validating the results of the SCA. That is, participants were successfully taught to engage in a an omnibus FCR (i.e., “my way”) to access synthesized contingencies shown to maintain problem behavior in the SCA while problem behavior was on extinction. Intervention outcomes suggested maintained effects when schedules of reinforcement were thinned (i.e., when delayed access and denial training was implemented) and generalized to the natural environment (i.e., home).

Since the introduction of the IISCA methodology outlined by Hanley et al. (2014), studies have shown that SCAs based on the outcome of open-ended interviews (and sometimes direct observation) are an efficient methodology for producing clear outcomes with various individuals in different environments (i.e., differentiation between test and control conditions; see Slaton & Hanley, 2018 for a review). Efficiency of SCAs is likely due to reduction in the number of conditions and the combination of multiple powerful contingencies, resulting in quick differentiation between test and control conditions. In a recent review, Coffey et al. (2020) detailed the efficiency of SCAs by determining the average number and duration of sessions, as well as the overall analysis duration of SCAs from previously published studies. The average number of test and control conditions conducted in SCAs prior to the identification of a functional variable was 5 (range, 5-10), the average session duration was 5 min (range, 3-15 min), and the average overall analysis duration was 25 min (range, 15-100 min). Thus, the efficiency of SCAs is clear. Additionally, because SCAs are typically short in duration and length, the exposure to potentially aversive EOs which evoke problem behavior is reduced, which likely decreases the likelihood of injury to the individual and others (Coffey et al., 2020). Furthermore, within-condition and within-session analyses have suggested that SCAs may be even more efficient by only conducting one test and one control session (e.g., Jessel et al., 2016); however, additional research is needed to support this preliminary evidence.

In addition to efficiency of SCAs, research has shown the generality of SCAs across populations (i.e., very young children to adults), behaviors (e.g., SIB, physical aggression, inappropriate vocalizations), and settings (e.g., home, classroom) (Coffey et al., 2020; Slaton & Hanley, 2018). In addition, research has shown the efficacy of interventions based on SCAs including maintenance and generalization of intervention effects (e.g., Jessel et al., 2018). Furthermore, research has shown various individuals (e.g., caregivers, trained tutors) can implement SCAs and synthesized interventions (e.g., Jessel et al., 2016; Jessel et al., 2018) and they are socially valid (i.e., accepted by caregivers and result in meaningful change in behavior; Hanley et al., 2014; Jessel et al., 2018). For example, Jessel et al. (2016) conducted SCAs for various problem behaviors displayed by 24 participants (ages 1.8 to 30 years), with and without diagnoses who had a range of language abilities. Furthermore, SCAs were conducted in various settings including participant homes, schools, and day programs and conducted by trained caregivers and various personnel in some cases. Although several SCA iterations were needed to produce differentiated results for some participants, overall results showed high rates of problem behavior in the test condition and low rates of problem behavior in the control condition in the 30 SCAs with the 24 participants.

Jessel et al. (2018) replicated and extended Jessel et al. (2016) by showing clear differentiation of SCAs and efficacy of synthesized interventions for 25 participants. Specifically, results showed problem behavior occurred at higher rates in the synthesized test conditions as compared to the control conditions for all participants. Additionally, interventions (i.e., FCT with schedule thinning similar to Hanley et al., 2014) based on SCA results effectively reduced all participants problem behavior by at least 90% within a 1-week period. Other researchers have attempted to further validate the efficacy of SCAs while also demonstrating the generality of their use (e.g., Rose & Beaulieu, 2019; Santiago et al., 2016). For example, Santiago et al. (2016) replicated the assessment and intervention procedures described by Hanley et al.; however, experimenters extended the initial study by (a) conducting SCAs and interventions with severe topographies of problem behavior (i.e., SIB), (b) conducting SCAs and interventions in the participants natural environment (i.e., classroom, home), and (c) training non-experts (i.e., teachers, caregivers) to implement SCAs and interventions. Results showed problem behavior occurred at higher rates in the synthesized test conditions as compared to the control condition for all participants and interventions based on these results were effective at eliminating problem behavior for all participants.

Although research has shown positive outcomes with SCAs, several limitations of the methodology have prompted research and discussion (see Slaton & Hanley, 2018 and Tiger & Effertz, 2020). The main limitation of SCAs is that contingencies are synthesized in test conditions, and thus the extent to which isolated contingencies influence problem behavior is unknown (Fisher et al., 2016; Holehan et al., 2020; Jessel et al., 2016; Tiger & Effertz, 2020). Therefore, the use of synthesized contingencies without first determining the effects of isolated contingencies may lead to interventions based on irrelevant variables that could (a) result in more complex and resource intensive interventions and (b) create additional problems in habilitation and education of individuals (e.g., delivering escape when it is not a maintaining variable for problem behavior may result in less instructional time for the individual; Fisher et al., 2016; Tsami & Lerman, 2019). To date, very few studies have compared the effects of isolated and synthesized contingencies in FAs, and the few studies that have compared the effects have produced different results (Fisher et al., 2016; Holehan et al., 2020; Slaton et al., 2017). Furthermore, even fewer studies have compared the effectiveness of interventions based on the outcomes of isolated and synthesized contingency FAs.

In the first systematic study to compare the outcomes of isolated versus synthesized FAs, Fisher et al. (2016) compared the outcomes of a standard FA (isolated contingencies) as described by Iwata et al. (1982/1994) to the outcomes of an SCA (synthesized contingencies) as described by Hanley et al. (2014) for five individuals diagnosed with intellectual and developmental disabilities who engaged in problem behavior. For the standard FA, stimuli (e.g., items and demands) programmed in sessions were identified by caregiver report or systematic assessments, whereas the SCA was derived by open-ended interview and structured observations. Overall, results showed that differentiated responding occurred in both standard and SCA FAs for four out of five individuals. For one individual, no problem behavior occurred during either FA. For three of the four individuals whose FAs were differentiated, the standard FA in which contingencies were isolated resulted in maintenance by only one variable manipulated in the SCA. Interestingly for all three individuals, that variable was access to tangibles. For the other individual whose FAs were differentiated, the standard FA resulted in maintenance by two variables (access to tangibles and escape) manipulated in the SCA. These data suggest that synthesized contingencies were unnecessary for differentiated responding. Furthermore, based on the outcomes of the standard FAs, the SCAs included one or more irrelevant contingencies for all four individuals (i.e., false positives). A major limitation of this study is that function-based interventions based on FA outcomes were not compared to determine the validity of the different FAs. Therefore, even though some irrelevant contingencies were included in the SCAs, it is possible that interventions based on SCAs may be more effective than those based on isolated contingencies (Slaton & Hanley, 2018). An additional limitation is that for the three participants whose SCA FA produced differentiation, the functional variable identified to maintain problem behavior was access to tangibles. Thus, it was unclear how synthesized contingencies may influence responding under other social positive contingencies (e.g., attention) and social negative contingencies (e.g., escape).

Slaton et al. (2017) replicated and extended Fisher et al. (2016) by comparing the outcomes of standard FAs and SCAs and the outcomes of function-based interventions derived from both FAs. Researchers conducted open-ended interviews and structured observations as described by Hanley et al. (2014) to determine both standard and SCA FA conditions. SCA conditions were conducted prior to standard FA conditions. Standard FA conditions were conducted as described by Iwata et al. (1982/1994) and SCA conditions were conducted as described by Hanley et al. Overall, results of the FA comparison showed that all nine individuals showed differentiated responding in the SCA. However, only four of the nine individuals showed differentiated responding in the initial standard FA, with two more of the remaining five individuals showing differentiated responding once contingencies were placed on precursor behavior(s). However, it is important to note that all standard FAs were conducted after SCAs, which may have influenced outcomes. Furthermore, dense schedules of reinforcement for potentially reinforcing stimuli were included in isolated test conditions (e.g., access to attention in tangible condition), which may have served as an abolishing operation for the programmed reinforcer (Rooker et al., 2013). After completing the FAs, researchers compared the effects of FCT developed from each FA for the four individuals for whom both FA results were differentiated but resulted in different outcomes. Specifically, FCT developed from the SCA FAs involved teaching an omnibus or all-encompassing mand (e.g., “my way”) that produced access to the synthesized reinforcer. FCT+EXT developed from the standard FAs involved teaching an FCR (e.g., “toy”) that produced access to the isolated reinforcer. Overall, results of the intervention comparison showed that FCT+EXT based on the SCA was more effective than FCT+EXT based on the standard FA for two individuals and similarly effective for the other two individuals. However, a limitation of the intervention was the use of a multielement design to compare the effects of the isolated and SCA interventions. That is, the rapid alternation of combined contingencies, particularly those that involve access to preferred items and activities during an escape interval, with those that are not combined (e.g., escape only) may have influenced the efficacy of interventions that did not involve access to those additional reinforcers. Thus, a different experimental design may be more appropriate in comparing these interventions.

Although Fisher et al. (2016) and Slaton et al. (2017) compared outcomes of standard FAs that involve isolated contingencies and SCAs that involve synthesized contingencies, there were multiple other differences across the two FA methodologies that do not allow one to isolate the influence of isolated versus synthesized contingencies on FA outcomes. That is, in both studies the standard FA included multiple test conditions and one omnibus control condition, whereas the SCA included a single test condition with a matched-control condition. In addition, the standard FA involved contingencies placed on target problem behavior only, whereas the SCA involved contingencies placed on both target and precursor behavior. However, in Slaton et al., if the standard FA did not show differentiated responding and precursors were observed to occur, then the researchers conducted the standard FA with the contingencies placed on precursor behavior. Furthermore, the standard FA involved a multielement design in which multiple test conditions and the control condition were rapidly alternated, whereas the SCA involved a pairwise design in which only two conditions (test and control) were rapidly alternated. Finally, the SCA included idiosyncratic variables as determined by interview and observation, whereas the standard FA only included test conditions for general and common functions of behavior.

To address some of the limitations of Fisher et al. (2016) and Slaton et el. (2017), Holehan et al. (2020) compared outcomes of FAs that involved isolated versus synthesized contingencies for problem behavior of five children who engaged in problem behavior while controlling for other differences across FAs (e.g., design, type of control condition, inclusion of precursor behavior). Based on the outcomes of differentiated isolated and synthesized FAs, researchers compared the effects of function-based interventions using a multiple baseline design across functions design. Specifically, researchers compared the outcomes of FAs conducted prior to SCAs using a pairwise design as described by Iwata et al. (1982/1994) to SCAs also conducted using a pairwise design as described by Hanley et al. (2014). Results indicated all individuals isolated FAs were differentiated showing maintenance by one or two variables that were also manipulated in the SCA, suggesting synthesis of the variables was unnecessary to determine a functional relation. Furthermore, for one participant, synthesis of contingencies resulted in undifferentiated outcomes, suggesting that one of the variables maintaining problem behavior (access to tangibles) was suppressed with the addition of a nonfunctional variable (attention). Researchers further compared the effects of interventions based on the functions identified in the isolated and synthesized contingencies for each participant using FCT+EXT. As in Slaton et al., FCT+EXT developed from the SCAs involved teaching an omnibus mand that produced access to the synthesized reinforcer. FCT+EXT developed from the isolated FAs involved teaching an isolated FCR that produced access to the isolated reinforcer. Results suggested there were little to no difference between interventions informed by isolated and synthesized contingency FAs. Although the results of this study are clear, it is possible that an interactive effect or the order in which the contingencies were presented (i.e., isolated before synthesized) resulted in somewhat higher levels of target behavior in the synthesized contingency. Furthermore, FA effects were not replicated across the different FAs, which may provide additional information regarding the validity of the outcomes and potential for iatrogenic effects (i.e., producing an isolated function after a history with a synthesized function; Retzlaff et al., 2020). Finally, intervention effects were not replicated within subjects.

Along these lines, a limitation of SCAs is that conditions are based on the outcomes of interviews and informal direct observations, which have been shown to have poor validity with respect to determining functional variables of problem behavior (Kelley et al., 2011; Thompson & Iwata, 2007). Thus, even though caregivers report that combined antecedents and consequences are associated with the occurrence of problem behavior, it does not mean that those combined contingencies are necessary for maintenance of problem behavior. It is possible that (a) none of those variables maintains problem behavior, (b) only one of those variables maintains problem behavior, or (c) both variables maintain problem behavior (i.e., multiple control; Beavers et al., 2013) but synthesis of them is unnecessary to demonstrate functional control. Additionally, recently researchers have designed SCA conditions based solely on the outcomes of open-ended interviews, skipping the direct observation used to validate interview outcomes (Greer et al., 2020). Thus, research has attempted to address the utility of open-ended indirect assessments and direct observations often used for developing SCAs.

Results of previous studies comparing SCA outcomes to standard FA outcomes showed that SCA contingencies, which are derived from interviews and observations, included irrelevant functional variables (i.e., false positives; e.g., Fisher et al., 2016; Holehan et al., 2020; Slaton et al., 2017). Additionally, many previously examined SCAs involved programming contingencies for all three common social variables found to maintain problem behavior (i.e., escape, attention, and tangible; Greer et al., 2016; Tiger & Effertz, 2020). Thus, these outcomes highlight a major limitation of relying on report and informal observation to derive synthesized FA contingencies. Therefore, to determine the utility of open-ended interview and direct observation outcomes in the design of SCA conditions, Greer et al. (2020) compared the outcomes of a standardized synthesized contingency analysis (SSCA), an SCA, and a standard FA with 12 children who engaged in problem behavior (e.g., SIB, aggression, disruption). That is, Greer et al. evaluated whether the SSCA, which contained contingencies for all three common social variables (and not designed from open-ended interviews and direct observation outcomes) would approximate those SCA contingencies designed from open-ended and direct observation outcomes. Additionally, Greer and colleagues conducted a standard FA as described by Iwata et al. (1982/1994) to further examine the necessity of synthesized contingencies in FAs. Results showed the SSCA produced differentiation for eight out of 12 participants, the SCA produced differentiation for eight out of

12 participants, and the standard FA produced differentiation for 11 out of 12 participants. Thus, differentiation was not more likely with the SCA. Researchers also reported data on false-positive and false-negative functions identified. Specifically, the open-ended interview identified the highest percentage of false positives (46.9% of identified functions) and the structured observation identified the lowest percentage of false-positive functions (21.7% of identified functions). The SCA identified 28% of false positives and the SSCA identified 40% of false positives. The open-ended interview failed to identify 5.6% of identified functional variables by the standard FA, whereas the structured observation failed to identify 22.2% of those same functions. Additionally, the SSCA failed to identify 33.3% of all functionally relevant contingencies identified by the standard FA and the SCA failed to identify 16.7% of those same functions. Overall, results of this study replicated those of Fisher et al. and others, specifically indicating SCAs were unnecessary to identify a functional variable(s). Additionally, results indicated SCAs are likely to include an irrelevant contingency (i.e., false positive); however, they are unlikely to leave out a functionally relevant contingency (i.e., false negative). Overall, these results suggest open-ended interviews and observations may not be necessary if an SCA is to be conducted. That is, it may be more efficient to forgo the interview and observation and begin SCAs by combining common social variables found to maintain problem behavior or forgo the SCA altogether and evaluate the efficacy of an intervention based on the three common social variables (Tiger & Effertz, 2020). However, additional research is needed to provide more information regarding these suggestions. Furthermore, it may be beneficial to conduct research on (a) the psychometric properties of open-ended interviews (Saini et al., 2020), (b) best practices for conducting open-ended interviews to provide the most valuable information, and (c) efficient ways to train caregivers to more accurately report potential functional variables such

that outcomes of indirect assessments may be more likely to provide relevant information (and less likely to suggest all common social variables).

Another potential limitation of SCAs is the potential for iatrogenic effects (induction of a novel function) when non-functional variables are included in SCAs. Retzlaff et al. (2020) examined the degree to which combining a functional reinforcer (e.g., escape) with a nonfunctional but highly preferred stimulus (e.g., tangible) may induce a novel function (i.e., iatrogenic effect). To do so, Retzlaff et al. conducted a translational study consisting of standard FAs and SCAs with six children diagnosed with autism. That is, participants were assigned one of the three common social functions (i.e., tangible, escape, attention) and a progressive-prompt delay procedure was used to teach participants to engage in a surrogate destructive behavior (i.e., touching a cushion) to access the programmed social stimulus (i.e., access to preferred tangibles, escape from demands, or access to attention). Training of the surrogate behavior ended once participants independently engaged in the response producing reinforcement at 90% accuracy for two consecutive sessions. Following training sessions, a standard FA was conducted using the procedures described by Iwata et al. (1982/1994). That is, occurrences of surrogate destructive behavior resulted in the delivery of the programmed reinforcer. SCAs were conducted following standard FAs in which all three common functional variables (i.e., escape, attention, tangible) were combined. Following SCAs, participants were once again exposed to a standard FA such that potential iatrogenic effects could be evaluated. Results indicated the surrogate destructive behavior was successfully trained in all six children (i.e., two escape functions, two tangible functions, two attention functions). Furthermore, the standard FA identified the specific assigned function for all six participant’s surrogate behavior and did not show iatrogenic effects in the form of an induction of a new function(s). However, following occurrences of the surrogate behavior contacting a synthesized contingency in the SCA, three of the six participants showed an iatrogenic effect in the form of a new function emerging. Specifically, two of the three participants who showed an iatrogenic effect showed induction of a tangible function and one of the three participants showed the induction of an escape function. These results show validity for the standard FA, but not the SCA. That is, because a specific function was assigned to each participant's surrogate behavior prior to beginning either FA, researchers could state the true function of each participants behavior prior to exposure to the standard or SCA FAs. The standard FA correctly identified the true (i.e., assigned) function for all participants surrogate behavior, whereas the SCA identified irrelevant contingencies for three of the six participants. Additionally, these results verify SCAs may be more susceptible to iatrogenic effects. That is, when an isolated contingency maintains problem behavior and problem behavior is exposed to a combination of the maintaining variable with a nonfunctional but preferred variable (i.e., synthesis), the nonfunctional variable has a likelihood of becoming a new functional variable. A limitation of this translational study is the lack of external validity, thus future research might involve determining whether similar outcomes are obtained during clinical analysis. That is, analysis of potential iatrogenic effects during standard FAs as compared to SCAs within-subjects would promote external validity of these findings.

Although research to date has suggested synthesized contingencies are not necessary for determining functions of problem behavior for most participants (e.g., Fisher et al., 2016; Holehan et al., 2020; Slaton & Hanley, 2018), it is possible that additional analyses may provide important information in comparisons between isolated versus synthesized contingencies. That is, researchers have begun to further examine the role of nonfunctional and irrelevant variables identified via SCAs by using within-session analyses (e.g., Call & Lomas Mevers, 2014; Hanley et al., 2014; Ward et al., 2021). It is possible that following exposure to SCAs, problem behavior occurs when an isolated contingency is presented but does not cease when the isolated contingency is removed. For example, an individual may engage in problem behavior when demands are presented and continue engaging in problem behavior when demands are removed, and a break is provided. This finding would suggest the EO responsible for evoking problem behavior did not decrease problem behavior once it was removed and another variable may be influencing responding (Call & Lomas Mevers, 2014). Call and Lomas Mevers (2014) suggested the use of within-session analyses for examining the influence of EOs. Specifically, following the completion of a standard FA (i.e., Iwata et al., 1982/1994) with one child with disabilities, Call and Lomas Mevers conducted a demand analysis in which two conditions were evaluated. That is, in one condition, demand with items, problem behavior resulted in access to a break with a preferred tangible; in the second condition, demand without items, problem behavior resulted in access to a break without a preferred tangible item. Additionally, experimenters examined the rate of problem behavior that occurred when the isolated EO was present (i.e., demands) and when the isolated EO was absent (i.e., no demands) in the standard FA. Results of the standard FA suggested problem behavior was maintained by both the isolated escape and isolated tangible contingencies; however, the demand analysis suggested that problem behavior occurring in the isolated escape contingency was also influenced by the isolated tangible contingency as problem behavior persisted during the isolated break period. Experimenters then conducted FCT+EXT for both isolated variables (i.e., experimenters taught, “break, please” to get access to a break and “trains, please” to get access to preferred tangibles). Reinforcers were not combined (i.e., break and tangibles) unless both isolated mands were emitted (i.e., they did not train an omnibus mand). Results from the demand analysis were further verified with the implementation of

FCT+EXT as mands for tangibles were quickly acquired and mands for escape were only acquired once they included access to tangibles (i.e., synthesis). Additionally, problem behavior persisted during the isolated escape EO-off periods. That is, contingent on the emittance of "break please," access to a break alone did not suppress problem behavior. The results of this study confirm problem behavior may persist in EO-off periods if the contingency does not include all relevant maintaining variables. Additionally, it is possible isolated FCRs that produce access to one of the maintaining variables (i.e., without the other maintaining variable) will not effectively suppress problem behavior during the EO-off periods. Overall, results suggest within-sessions analyses should be conducted when comparing isolated and synthesized contingencies to provide further validation of FA and intervention outcomes.

The main reason for conducting FAs is to determine effective interventions, thus demonstrating an intervention based on outcomes of the assessment is more effective than ones not based on the assessment provides additional support for the FA (i.e., predictive validity; Tiger & Effertz, 2020). Therefore, although research has suggested synthesized interventions based on the outcomes of SCAs are effective in various situations, it is important to compare outcomes of isolated and synthesized treatments to determine the conditions under which one may be more or less effective. Furthermore, it is important to note that although synthesized interventions may be more effective than interventions based on isolated functions, this does necessarily provide support for maintenance by synthesized contingencies (Tiger & Effertz, 2020). In fact, various studies have shown that treatment of problem behavior maintained by escape may be more effective when positive reinforcers are provided to increase compliance or when positive reinforcers are provided during the escape interval, thereby reducing the motivation for escape maintained problem behavior (Payne & Dozier, 2013).

Another consideration in synthesized treatments is the degree to which those interventions would maintain and generalize across various situations. Specifically, if an omnibus mand is taught to an individual, it is important to determine whether that response will generalize to situations that involved isolated contingencies, which are likely to occur in the natural environment. Although preliminary research suggests that omnibus mands (to access synthesized reinforcers) can be taught in conjunction with specific mands (mands to access isolated reinforcers; Boyle et al., 2019) and omnibus mands might not preclude later teaching and acquisition of specific mands (Ward et al., 2020), it is unknown whether omnibus mands would generalize to isolated situations (Slaton & Hanley, 2018). A recent study by Tsami and Lerman (2019) provide preliminary information suggesting generalization may not occur. The researchers attempted to evaluate whether the effects of a combined intervention programmed for problem behavior that was multiply controlled would transfer (generalize) to the isolated contingencies maintaining problem behavior of five children diagnosed with autism. All participants' problem behavior was shown to be multiply controlled by isolated escape and tangible contingencies during a pre-intervention functional analysis with isolated contingencies. That is, contingencies were not combined or synthesized in the FA. However, after the standard FA, participants were taught to emit an omnibus mand (i.e., exchange a communication card) to gain access to the synthesized contingency of a break and preferred tangibles. Once participants acquired the omnibus mand, they were exposed to the isolated contingencies (i.e., either one or multiple) in which emittance of the omnibus mand resulted in access to the specific isolated reinforcer (e.g., escape from demands or access to tangibles). If problem behavior remained low and FCRs remained high in the isolated test condition, participants were again exposed to the synthesized contingency in which the reinforcement schedule was thinned to an individually determined terminal goal by gradually increasing the amount of time the participant had to wait before requesting a tangible or increasing the required number of completed demands before requesting a break. If problem behavior re-emerged and FCRs decreased in the isolated test condition, participants were again exposed to the synthesized contingency until problem behavior decreased and FCRs increased to previous levels. Once problem behavior decreased and FCRs re-emerged, the participant was again exposed to the isolated contingencies in which emittance of the omnibus mand resulted in access to the specific isolated reinforcer. If generalization effects still did not occur, experimenters conducted isolated FCT and schedule thinning for that isolated contingency. Results indicated synthesized intervention effects transferred to isolated contingencies for only one out of five participants suggesting that when contingencies are synthesized during FCT+EXT, intervention effects may not transfer to isolated contingencies. Additionally, problem behavior remained low and FCRs remained high for only two out of the five participants with the implementation of schedule thinning following isolated FCT+EXT. Specifically, for the other three participants, levels of problem behavior and independent mands were variable as the reinforcement schedule was thinned suggesting intervention effects may not maintain with longer delays or additional task requirements. Although the results of this study are clear, there are a few limitations. First, all participants problem behavior was shown to be maintained by multiple control of the isolated escape and isolated tangible contingencies. Thus, it is unknown if these findings will generalize to problem behavior that is maintained by other multiple social contingencies (e.g., access to a break and preferred attention, access to preferred attention and tangibles). Second, it is possible that the EO for tangible reinforcement was present during the isolated escape test sessions. Specifically, problem behavior may have increased during isolated escape sessions because contingent on the omnibus mand the participant received a break without access to tangibles. Third, the length of the generalization phase for isolated test sessions was relatively short (i.e., 1-4 sessions) to determine if effects would emerge or maintain over time. Fourth, the current study only evaluated the extent to which an omnibus mand generalizes to an isolated contingency. Thus, the extent to which a specific or isolated mand generalizes to a synthesized contingency is unknown.

Although various researchers are attempting to evaluate and further refine the role of synthesized contingencies in FAs and interventions, there are several areas warranting more research. The first major area warranting further evaluation is the specific role and necessity of synthesized contingencies in functional analyses. Specifically, future research is needed to determine the conditions under which synthesized contingency FAs may be useful or more useful as compared to isolated contingency FAs. For example, it is possible that SCA FAs reduce the overall duration of FAs, thus making them a safer and more efficient methodology as compared to standard FAs. However, it is also possible that exposure to a nonfunctional variable in SCAs may produce an iatrogenic effect, thus creating a new function. More research is needed on iatrogenic effects and how combining functional and non-functional variables influence problem behavior. Additionally, more research is needed regarding the inclusion of precursor behavior(s) when conducting SCAs. For example, it would be interesting to determine if the outcomes of isolated versus synthesized FAs are influenced by the occurrence of precursors or the degree to which precursors occur in FAs. Finally, additional research is needed regarding combining and reinforcing all topographies of problem behavior in SCAs. For example, it is possible that the topographies are not members of the same response class, and thus only one of the topographies shows sensitivity during the SCA (i.e., only one of the multiple target behaviors is observed); however, intervention is developed based on these results for all topographies resulting in a potentially ineffective intervention (Warner et al., 2020). Furthermore, there have been no studies examining the extent to which synthesized contingency analyses examine behavior hypothesized to be maintained by automatic reinforcement. Future research could examine how behavior sensitive to this type of functional variable responds to synthesized contingences.

The second major area warranting further evaluation is the specific role and necessity of synthesized contingencies in interventions. Specifically, as with FAs, future research is needed to determine the conditions under which interventions based on SCA outcomes may be more effective as compared to interventions developed from standard FAs. For example, it is possible that interventions including synthesized contingencies are more effective in the everyday environment and for maintenance of behavior change, particularly under thin reinforcement schedules. However, it is also possible that using synthesized contingencies, when only isolated contingencies maintain target behavior, result in (a) more difficult to implement interventions, (b) interventions that impede habilitation and education goals of the individual, or (c) preclude the development of isolated FCRs (i.e., effects do not maintain or generalize). Thus, future research is needed to determine whether this is the case. Additionally, research could be conducted to determine the integrity with which interventions based on synthesized versus isolated contingencies are implemented. Furthermore, research could be conducted on the degree to which interventions, particularly synthesized contingencies that involve escape but do not show maintenance by isolated escape may result in slower acquisition or a decrease in meeting various goals of the individual. Finally, social validity of interventions based on synthesized versus isolated contingencies should be conducted. That is, determining the degree to which caregivers and individuals prefer isolated versus synthesized interventions is important.

In summary, the SCA has been shown to be effective at demonstrating differentiation in FAs and interventions based on these outcomes quickly reduce problem behavior. However, these analyses have not been shown to identify non-reinforcers or, more specifically, variables that do not maintain problem behavior (Tiger & Effertz, 2020), which is the hallmark of valid assessment procedures. Furthermore, although interventions based on synthesized contingencies have been shown to be effective for quickly reducing problem behavior, it is not clear if these results are valid as interventions may include both functional and non-functional variables (Tsami & Lerman, 2019). Given these concerns, researchers suggest that SCAs be used to clarify undifferentiated results obtained in a standard FA when a synthesis of variables is hypothesized to maintain problem behavior as opposed to starting the assessment with this analysis.

Purpose

Although SCAs have been shown to be effective for the identification of functional variables and interventions based on these outcomes have been shown to quickly reduce problem behavior, there are some limitations to this methodology. First, the necessity of synthesized contingencies in FAs is still unknown. That is, the extent to which SCAs identify non-reinforcers as variables maintaining problem behavior (i.e., false positive) and how this may impact intervention effects is unknown. Second, the extent to which SCAs induce a new function (i.e., iatrogenic effect) is unknown. That is, it is possible that combining a functional reinforcer with a nonfunctional but highly preferred stimulus may result in the occurrence of problem behavior when the previously nonfunctional EO is presented in isolation. Finally, although preliminary evidence by Tsami and Lerman (2019) suggest intervention effects that involve combining isolated functional variables may not generalize to isolated contingency situations, these outcomes require replication and extension to synthesized intervention arrangements. That is, it is possible that following a history of an omnibus communication response resulting in access to two or more variables, participants will not emit the same omnibus response to access one of those variables in isolation, thus eliminating the efficiency of interventions based on SCAs.

The purpose of Study 1 was to replicate and extend Holehan et al. (2020) by comparing the outcome of isolated versus synthesized contingencies in functional analyses of precursor behavior and target problem behavior while using a reversal design to replicate the effects, as well as to analyze potential iatrogenic effects (Retzlaff et al., 2020) with four participants. In addition, we collected data on other topographies of problem behavior mentioned in the indirect assessment (i.e., interview) as one way to see if these behaviors occurred in the same conditions as target behavior or in other conditions, which allowed us to infer whether they were maintained by the same variable(s) (Warner et al., 2020). Furthermore, we conducted an additional analysis of the FA data. That is, we examined within-session analyses to assess under what context precursor behavior or target problem behavior occurred (i.e., EO on, EO off) for isolated and synthesized contingencies. The purpose of Study 2 was to replicate and extend Tsami and Lerman (2019) by evaluating the extent to which FCT+EXT under synthesized contingencies generalized to the different isolated contingencies that were shown to maintain precursor behavior or target problem behavior in Study 1 with two participants. Additional extensions of Tsami and Lerman included addressing variables not assessed in their study (i.e., combined variables other than escape and tangible), addressing limitations by removing the establishing operation for tangibles during isolated escape test sessions, and conducting longer isolated test phases to determine if generalization outcomes developed and/or maintained over time. Additionally, we examined within-session analyses to assess under what context precursor behavior or target problem behavior occurred (i.e., EO on, EO off) for synthesized FCT+EXT and isolated test conditions.

Study 1 Method: Synthesized versus Isolated Contingency FA

Participants

Participants were four children, two who attended a university-based early intensive behavioral intervention (EIBI) program and two who attended a university-based preschool, referred for the assessment and treatment of problem behavior that occurred multiple times per day. Riley, a 2-year-old girl with no known diagnoses, was referred for tantrum behavior (i.e., flopping, screaming, foot stomping). She communicated using sentences containing five or more words. Madeline a 5-year-old girl diagnosed with ASD, was referred for physical aggression (i.e., headbutting, hairpulling, pushing, hitting). She communicated using three- to four-word phrases. Emmett, a 5-year-old boy with no known diagnoses, was referred for elopement. He communicated using four- to five-word phrases. Owen, a 5-year-old boy diagnosed with ASD, was referred for elopement. He communicated using four- to five-word phrases. Table 1 lists the specific characteristics for each participant. Additionally, COVID-specific consent was obtained from participants caregivers via an informed consent and Health Insurance Portability and Accountability Act (HIPAA) authorization form (see Appendix A) prior to inclusion in the current study.

Setting and Materials

Trained graduate students conducted all FA sessions in the participant's classroom (Riley, Madeline) or a session room (Owen, Emmett). Riley's sessions were conducted during free play or outside time within the context of her typical preschool classroom schedule. Riley's classroom was staffed with one to two teachers and either a lead teacher or graduate student supervisor. During the free play period, various areas were set up in which she could play, which included dramatic play, cars/racetrack, library, and manipulative areas. During the outside play period, various items and activities were present including playground equipment (e.g., teeter totter, climbing structures) and outdoor play items (e.g., bikes, balls, bubbles). Madeline's sessions were conducted during free play or individual instruction time within the context of her EIBI classroom. Madeline's EIBI classroom included three to four child-specific workstations (i.e., booths created from section dividers), chairs, and various leisure (e.g., library area with books, toys on shelves) and instructional items (e.g., program stimuli, program binders, data sheets) found in an EIBI program. Session rooms were barren (i.e., no table or chairs) and contained a padded floor and walls to ensure Emmett and Owen's safety due to their other problem behavior which included self-injury (Emmett) and forcefully flopping to the ground (Owen). Additionally, the session room contained two doors; one was located in the front room and was used to enter and exit the session room, and one located on the back wall of the front room and was used to access an adjoining room. Given that Emmett and Owen's target behavior was elopement, the door to the adjoining room was left open and an experimenter sat in front of the enter and exit door during all sessions to enhance safety (i.e., participant could only elope to adjoining room). Materials for conducting sessions included iPods for data collection and videoing, as well as any necessary materials needed to conduct participant-specific test and matched-control sessions (as identified via indirect assessment and observation). In addition, condition-specific discriminative stimuli (i.e., different colored shirts) were used to aid in discrimination across conditions. Finally, for all sessions, COVID-specific procedures (see Appendices B & C) approved by the Human Research Protection Program (HRPP) were followed to enhance safety.

Response Measurement, Data Analysis, and Interobserver Agreement

During all isolated and synthesized FAs, trained observers collected data using software on iPods. For all FAs, the main dependent variable was the occurrence of the target problem behavior alone or a combination of the target problem behavior and precursor behavior (for Madeline only). Target problem behavior for a participant was the most problematic class of problem behavior (e.g., elopement, physical aggression) rather than combined classes of problem behavior. Additionally, for all participants we collected data on other problem behavior reported for each participant in the IA. Observers collected data on precursor behavior, target problem behavior, and other problem behavior separately; however, as mentioned above, for Madeline target problem behavior and precursor behavior were combined and graphed as target behavior for data analysis. Table 2 lists the precursor behavior (Madeline only), target problem behavior, and other problem behavior with their respective definitions for each participant.

For Riley and Madeline, data collectors measured precursor behavior (if applicable), target problem behavior, and other problem behavior using a frequency or duration measure and converted those data to a percent-interval measure by dividing the number of 10-s intervals in which the precursor behavior, target problem behavior, or other behavior was scored by the total number of session intervals. For Emmett and Owen, data collectors scored the first occurrence of target problem behavior (elopement) and other problem behavior that occurred in each session and calculated the latency in seconds to the first occurrence of the behavior. Specifically, for Emmett and Owen, elopement was defined as any instance or attempt of their body passing through the threshold of the adjoining room door. Additionally, for Emmett and Owen, we also calculated the occurrence of their other problem behavior that occurred prior to the first occurrence of target problem behavior using a percent-interval measure by dividing the number of 10-s intervals in which the other problem behavior was scored by the total number of session intervals. Data collectors also scored participant compliance during test sessions in which demands were delivered. Compliance was defined as a correct response (or approximation of the response) after a vocal-verbal or model prompt. From compliance data, percent compliance was calculated by dividing the number of instances of compliance after the verbal only or verbal-model prompt by the number of verbal-only instructions delivered.

Data collectors scored experimenter behavior, which included frequency of experimenter demands during test sessions in which demands were delivered and duration of experimenter delivery of programmed stimulus events (e.g., attention, tangible, escape). Demands were defined as the initial vocal-verbal only instruction delivered by experimenters. The frequency of vocal-verbal demands was collected for experimenters to calculate percent compliance as described above. Attention was defined as delivery of the type of attention that was reported to be provided in the indirect assessment and/or observed to occur following target behavior during informal observations for each participant (e.g., reprimands and rationales). Tangible was defined as the delivery of preferred tangible items that were reported in the indirect assessment for each participant. Escape was defined as the removal of demands and materials that were reported to evoke problem behavior in the indirect assessment for each participant. The duration of delivery of these stimulus events was scored such that retrospective analyses (e.g., within-session analysis) could be conducted.

We conducted within-session analyses of data collected in FAs to assess under what context precursor behavior, target problem behavior, and other problem behavior occurred (i.e., EO on, EO off) for isolated and synthesized contingencies. Within-session analyses were examined and depicted for all FA test sessions for Riley and Madeline's precursor behavior (if applicable), target problem behavior, and other problem behavior. Within-session analyses were not examined or depicted for Emmett and Owen's target problem behavior or other problem behavior as sessions were terminated following the first occurrence of elopement (i.e., limited

EO-on and EO-off periods). For Riley and Madeline, we compared the occurrence of precursor behavior (if applicable), target problem behavior, and other problem behavior during the EO-on (e.g., tangibles removed, preferred attention diverted to others, demands delivered) and EO-off (e.g., access to tangibles, continuous delivery of preferred attention, no demands delivered/break) periods across FAs. These data are depicted as percent occurrence. To calculate the percent occurrence in which behavior occurred during EO-on periods, the number of instances in which precursor behavior (if applicable), target problem behavior, or other problem behavior occurred in the EO-on period was summed and divided by the total number of instances of that behavior and multiplied by 100%. To obtain the percent occurrence in which precursor behavior, target problem behavior, or other problem behavior occurred in the EO-off period, the number of instances in which precursor behavior, target problem behavior, or other problem behavior occurred in the EO-off period was summed and divided by the total number of instances of that behavior and multiplied by 100%.

A second observer simultaneously but independently collected data during 42.1% (range, 40%-44%) of sessions across phases with all participants. Interobserver agreement (IOA) was calculated using the interval method for behaviors scored using percent-interval measures (i.e., precursor behavior, target problem behavior, other problem behavior) or duration measures (i.e., precursor behavior, target problem behavior, other problem behavior, delivery of stimulus events events). That is, the session was divided into 10-s intervals, and observer records were compared on an interval-by-interval basis. Specifically, the number of intervals with agreement was divided by the total number of intervals and multiplied by 100%. An agreement was defined as both observers scoring the occurrence of the specific response within a specific interval. IOA was calculated using proportional agreement method for behaviors scored using frequency measures (i.e., demands, compliance, precursor behavior, target problem behavior, other problem behavior). That is, the session was divided into 10-s intervals, and observer records were compared on an interval-by-interval basis. If exact agreement occurred (i.e., both observers scored the same number of occurrences), a score of 1 was given for that interval. For any disagreements, the smaller score was divided by the larger score in the interval. The interval scores for each session were summed, divided by the total number of intervals, and multiplied by 100%. IOA was calculated using a total method for behaviors scored using latency measures (i.e., target problem behavior). That is, the shorter latency was divided by the longer latency and multiplied by 100%. Mean IOA for Riley, Madeline, Emmett, and Owen was 99.1% (range, 80%-100%), 98.9% (range, 76%-100%), 99.4% (range, 80%-100%), and 98.5% (range, 0%-100%), respectively. For the few sessions in which IOA was below 80%, observers were retrained on the definitions of each behavior to ensure understanding and to minimize observer drift. For example, IOA for one of Owen's sessions was 0% because one data collector scored a flop while the other data collector did not. After this session, data collectors were provided with retraining on the flopping definition.

Procedural integrity data were calculated during 38.2% (range, 31%-48%) of sessions across phases with all participants. Procedural integrity was calculated by dividing the number of correct reinforcers delivered within 5 s of the onset of precursor behavior (if applicable) and target problem behavior by the total number of occurrences of precursor behavior or target problem behavior. For the purpose of analyzing procedural integrity data, instances of precursor behavior or target problem behavior that co-occurred within a 3 s period were defined as one instance of target behavior. Mean procedural integrity for all participants was 100%.

Pre-Assessment Procedures

Prior to conducting FAs, the lead experimenter, who is a master's level Board Certified Behavior Analyst (BCBA), interviewed classroom supervisors for each participant. Specifically, the experimenter conducted the same 20-question, open-ended indirect assessment (IA) used by Hanley and colleagues in their implementation of the IISCA (Hanley et al., 2014; see Appendix D) using the PDF version via telehealth (i.e., HIPPA-compliant Zoom platform). Training for the lead experimenter to administer the IA consisted of a Board Certified Behavior Analyst Doctoral level (BCBA-D) modeling how to conduct the IA for the lead experimenter. That is, the BCBA-D conducted an IA with the lead experimenter as the respondent. Additionally, this IA was taped for future review by the lead experimenter. Following the completion of the IA, the lead experimenter practiced conducting an IA with the BCBA-D as the respondent. The BCBA-D provided feedback and required additional practice until the lead experimenter displayed competence.

For each participant, the lead experimenter conducted the IA with two or three classroom supervisors who (a) were doctoral students in a behavior analysis program, (b) had supervised training in the assessment and treatment of problem behavior, and (c) had worked for at least three months in the classroom in which the participant attended. Questions focused on identification of precursor behavior, target problem behavior, other problem behavior, antecedents likely to evoke precursor behavior and target problem behavior, consequences that followed precursor behavior or target problem behavior, as well as participant preferences and communication abilities. The experimenter asked the supervisors each question from the IA and recorded each response. Supervisors were interviewed at the same time to allow for discussion of each question and their respective answers (Hanley et al., 2014). If discrepancies in answers occurred, the experimenter asked additional questions to determine if different contingencies across situations and contexts affected behavior. Each interview lasted approximately 40 min.

Once the lead experimenter conducted an IA for a participant, it was reviewed to determine the conditions to be conducted in subsequent FAs. That is, the outcomes were used to determine participant (a) precursor behavior, (b) target problem behavior, (c) other problem behavior, (d) high preferred items, (e) low preferred demands or tasks, and (f) forms of attention or interactions to be used in subsequent FAs. Furthermore, the outcomes were used to conduct a risk assessment for all participants. That is, experimenters completed a cost-benefit analysis for conducting FAs and determined various safeguards to protect the participant, experimenter, and environment. Specifically, the risk assessment suggested a padded room should be used for Owen and Emmett given their other problem behavior of flopping (Owen) and SIB (Emmett). Additionally, Emmett's outcomes suggested a blocking mat should be used during sessions contingent on occurrences of SIB across all conditions. Madeline and Riley's risk assessment did not suggest additional safeguards were necessary.

Once the interviews were complete, the lead experimenter and other doctoral students conducted structured observations to gain additional information regarding precursor behavior (if applicable), target problem behavior, and environmental events. The structured observations were similar to the structured observation used by Greer et al. (2020). Specifically, structured observations were conducted such that the experimenter modified establishing operations (EOs) and putative reinforcers every 4 min during a 40-min observation session. The specific segments and sequence of establishing operations presented for all participants was (a) ignore, (b) attention, (c) noncontingent attention, (d) attention, (e) escape, (f) ignore, (g) escape, (h) tangible, (i) noncontingent tangible, (j) tangible. That is, in the ignore segment, experimenters provided participants access to moderately preferred items and did not provide attention. Precursor behavior (if applicable) or target problem behavior resulted in no programmed consequences. In the attention segment, experimenters provided participants access to preferred attention, removed it, and contingent on precursor behavior (if applicable) or target problem behavior, delivered preferred attention for 30 s. In the noncontingent attention segment, experimenters provided participants continuous access to preferred attention. Precursor behavior (if applicable) or target problem behavior resulted in no programmed consequences. In the escape segment, experimenters delivered demands using a three-step prompting procedure. Contingent on precursor behavior (if applicable) or target problem behavior, demands were removed for 30 s. In the tangible segment, experimenters provided participants access to preferred tangibles or activities, removed access, and contingent on precursor behavior (if applicable) or target problem behavior, delivered access to preferred tangibles or activities for 30 s. In the noncontingent tangible segment, experimenters provided participants continuous access to preferred tangibles. Precursor behavior (if applicable) or target problem behavior resulted in no programmed consequences. Although the specific segments and sequence were identical across participants, the contingencies presented were individualized based on the IA to include participant-specific forms of attention, tangibles, and demands.

Functional Analyses

Based on the IA and structured observations for each participant, experimenters conducted two to three isolated contingency FAs and one synthesized contingency FA (see Table 3 for conditions conducted for each participant). For the two participants whose target problem behavior was elopement, we conducted a latency-based FA (Thomason-Sassi et al., 2011) due to the difficulty of resetting the EO following its occurrence. For two other participants, we conducted a repeated measures FA that was 5 min in duration. During test conditions in all FAs, experimenters placed contingencies on both precursor behavior (when applicable) and target problem behavior. We used a pairwise design for Riley and Madeline and a combination of a pairwise and a reversal design for Emmett and Owen to demonstrate experimental control in the FAs. In the pairwise design for each FA, experimenters rapidly alternated each test condition (isolated or synthesized) with a condition-specific control condition. That is, during control conditions, the contingency or contingencies programmed for precursor behavior or target problem behavior in the test condition were provided noncontingently. Isolated FAs were conducted prior to synthesized FAs, and each test versus control comparison was conducted using the following order: control, test, control, test, test (Hanley et al., 2014). For the reversal design for Emmett and Owen, experimenters conducted consecutive test and control sessions for a potential functional variable in an attempt to clarify the isolated FA outcomes. Following the synthesized contingency FA, we replicated all conditions (i.e., isolated and synthesized) to demonstrate experimental control and further examine the influence of synthesized contingencies in isolated FAs. The only difference between the FAs was whether contingencies suggested to influence precursor behavior (if applicable) or target problem behavior in the IA were isolated in one FA (e.g., escape only) and synthesized in the other FA (e.g., escape and tangible). In addition, experimenters wore different color t-shirts across conditions to aid in discrimination.

Riley

Results of Riley's IA suggested her most problematic behavior that would serve as her target problem behavior was tantrum behavior (i.e., flopping, foot stomping, screaming) and she did not display a precursor behavior to tantrum behavior. Other problem behavior reported in the IA were property destruction and SIB. Furthermore, the IA suggested Riley's tantrum behavior was evoked when preferred tangibles (e.g., dolls, music toys, grocery toys, bubbles) were removed or denied and when difficult demands (e.g., clean up demands, specific instructions, “Give me” instructions) were delivered. Results of Riley’s structured observation suggested her tantrum behavior was evoked when difficult demands were delivered. Therefore, we conducted an isolated tangible FA, an isolated escape FA, and a synthesized tangible and escape FA with Riley.

Riley’s isolated tangible FA was similar to the one conducted with Madeline with a few exceptions. First, because sessions were conducted in the classroom, Riley had access to items that were available during the ongoing classroom activity during all sessions. Additionally, high-preferred tangibles were manipulated in addition to any tangibles or activities available in the classroom in which Riley was engaged (i.e., when removing tangibles, the experimenter removed not only the high-preferred tangibles, but also any other tangible with which Riley was engaged at the time). Second, prior to isolated tangible sessions, the experimenter told classroom teachers they may briefly interact with Riley should she approach them, but high-preferred attention should be withheld. Finally, Riley’s preferred tangibles were used in this FA.

During the isolated escape FA, an escape test condition and a condition-specific control condition were rapidly alternated. Prior to the test and control sessions, experimenters told classroom teachers they may briefly interact with Riley should she approach them while on a break, but high-preferred attention should be withheld, and no attention should be provided when demands were being given. Experimenters began the session by stating, “It’s time to work” and immediately delivering difficult demands using a three-step prompting procedure. Contingent on compliance, the experimenter delivered praise (e.g., “I love how you cleaned up!”). However, contingent on tantrum behavior, the experimenter said, “Ok you don’t have to,” and provided escape from demands (i.e., no longer delivered demands and removed task materials) for 30 s. After 30 s elapsed the experimenter said, “It’s time to work,” and presented difficult demands. The condition-specific control condition consisted of no demands and access tangibles typically found in the classroom.

During the synthesized tangible and escape FA, a combined tangible and escape condition and a condition-specific control condition were rapidly alternated. Prior to the test and control conditions, experimenters told classroom teachers they may briefly interact with Riley should she approach them while on a break with tangibles, but high-preferred attention should be withheld, and no attention should be provided when demands were being given. Prior to the test condition, the experimenter presented Riley with a bin of preferred tangibles for 1 min. Next, the experimenter began the session by stating, “It’s my turn, it’s time to work,” removing the preferred tangibles and any tangibles or activities in which Riley was engaged, and immediately delivering difficult demands. Contingent on compliance, the experimenter delivered praise (e.g., “I love how you cleaned up!”). However, contingent on tantrum behavior, the experimenter said, “Ok you don’t have to, you can have it,” provided escape from demands (i.e., no longer delivered demands and removed task materials), and provided access to preferred tangibles and any other tangibles or activities previously removed for 30 s. After 30 s elapsed, the experimenter again removed the preferred tangibles and any tangibles or activities in which Riley was engaged, said, “It’s my turn, it’s time to work,” and presented difficult demands. The condition-specific control condition consisted of continuous access to preferred tangibles and no demands.

Madeline

Results of Madeline's IA suggested her most problematic behavior that would serve as her target problem behavior was physical aggression and her precursor behavior to physical aggression was foot stomping, screeching, and negative vocalizations. For Madeline, we refer to her combined occurrences of precursor behavior and target problem behavior as target behavior as contingencies were placed on the occurrence of either behavior. Other problem behavior reported in the IA was SIB. Furthermore, the IA suggested that Madeline's target behavior was evoked when preferred tangibles (e.g., marble maze, bubbles, iPad) were removed or denied and when preferred attention (e.g., singing, dance party, back rubs, hugs) was diverted from her and delivered to other peers or adults. Results of Madeline's structured observation suggested her target behavior was evoked when access to tangibles was removed or denied. Therefore, we conducted an isolated tangible FA, an isolated diverted-attention FA, and a synthesized tangible and diverted-attention FA with Madeline.

During the isolated tangible FA, a tangible test condition and a condition-specific control condition were rapidly alternated. Prior to test sessions, the experimenter told classroom teachers not to interact with Madeline during the session, and the experimenter provided Madeline with her preferred tangibles for 1 min. At the beginning of the session, the experimenter said, "It's my turn" and removed the preferred tangibles. Contingent on target behavior (i.e., physical aggression or precursor behavior), the experimenter provided preferred tangibles to Madeline for 30 s. After 30 s elapsed, the experimenter again said, "It's my turn" and removed the preferred tangibles. During the control condition, Madeline had continuous access to the same high-preferred tangibles used in the tangible test condition.

During the isolated diverted-attention FA, a diverted-attention test condition and a condition-specific control condition were rapidly alternated. Prior to test sessions, the experimenter told classroom teachers not to interact with Madeline during the session, and the experimenter provided Madeline with her preferred attention for 1 min. At the beginning of the session, the experimenter began the session by stating, “I have to talk to your friends right now, but you can play with these” and directed her to moderately preferred tangibles (e.g., sand, playdoh) and delivered Madeline’s preferred attention to peers or adults in her area. Contingent on target behavior (i.e., precursor behavior or target problem behavior), the experimenter provided preferred attention to Madeline for 30 s. After 30 s elapsed, the experimenter again removed their attention and provided Madeline’s preferred attention to peers or adults in her area. During the control condition, the experimenter provided continuous preferred attention to Madeline while she had access to the same moderately preferred tangibles used in the test condition.

During the synthesized tangible and diverted-attention FA, a combined tangible and diverted-attention test condition and a condition-specific control condition were rapidly alternated. Prior to test sessions, the experimenter told classroom teachers not to interact with Madeline during the session, and the experimenter provided Madeline with preferred attention and tangibles for 1 min. At the beginning of the session, the experimenter said, “It’s my turn, I can’t talk right now, I have to talk with your friends, but you can play with these,” then directed her to moderately preferred tangibles (e.g., sand, playdoh) and delivered Madeline’s preferred attention to peers or adults in her area. Contingent on target behavior (i.e., precursor behavior or target problem behavior), the experimenter provided preferred attention and access to preferred tangibles to Madeline for 30 s. After 30 s elapsed, the experimenter again removed the tangibles, and said, “It’s my turn, I can’t talk right now, I have to talk with your friends, but you can play with things in this area,” then directed her to moderately preferred tangibles and delivered

Madeline’s preferred attention to peers or adults in her area. During the control condition, the experimenter provided continuous preferred attention to Madeline while she had access to preferred tangibles.

Emmett

Results of Emmett’s IA suggested his most problematic behavior that would serve as his target problem behavior was elopement and that he did not display a precursor behavior to elopement. Other problem behavior reported in the IA were SIB and physical aggression. Furthermore, the IA suggested Emmett’s elopement was evoked when preferred tangibles (e.g., cooking set and toys, electric car, stickers) were remove or denied, difficult demands (e.g., fine motor imitation, coloring, structured art activity) were presented, and when preferred attention (e.g., rough and tumble play, conversation) was removed. Additionally, results suggested a padded room and blocking mat be used given his other problem behavior of SIB. Results of Emmett’s structured observation suggested elopement was evoked when difficult demands were presented and access to tangibles were removed or denied. Therefore, we conducted an isolated tangible latency-based FA, an isolated escape latency-based FA, an isolated attention latency-based FA, and a synthesized escape and attention latency-based FA with Emmett. As with Owen, given Emmett’s target behavior was elopement (i.e., any instance or attempt of his body passing through the threshold of the adjoining room door), which made it difficult to reset the EO following its occurrence, all sessions (i.e., test and control) ended after the experimenter delivered the programmed reinforcer for 30 s contingent on the first occurrence of elopement.

During the isolated tangible FA, a tangible test condition and a condition-specific control condition were rapidly alternated. Prior to test sessions, the experimenter presented Emmett with a bin of high-preferred tangibles for 1 min. Next, the experimenter began the session in the front room by saying, "It's my turn," removing the tangibles, and placing them in the adjoining room and returning to the original room. Contingent on elopement the experimenter said, "You can have it" from the original room and allowed Emmett to access to the tangibles in the other room for 30 s. After 30 s elapsed, the experimenter terminated the session. The condition-specific control condition consisted of continuous access to the same high-preferred tangibles used in the tangible test condition. Contingent on elopement, the experimenter remained in the original room. That is, the experimenter did not follow Owen into the adjoining room and terminated the session. Additionally, following occurrences of elopement in either the isolated tangible test or the control condition, the next session began in the room the participant was currently located. For example, if the session began in the front room with an isolated tangible control session and Emmett engaged in elopement, the experimenter would terminate the session from the front room, allow a minimum of 30 s to elapse (i.e., as to not provide additional attention), would enter the adjoining room (no attention provided to Emmett), and begin the isolated tangible test session.

Emmett's isolated escape FA was similar to the one conducted with Owen with a few exceptions. First, after observing short latencies to elopement in the isolated escape control conditions, we modified the condition by providing continuous access to moderately preferred tangibles (e.g., airplane, books, blocks) and delivering neutral attention (e.g., "I like how you are playing," "Nice job hanging out") every 30 s. This modification was made as we hypothesized the elopement may have been occurring because there was no opportunity to engage in a more appropriate behavior and was very different from any situations he experienced in the natural environment. Second, Emmett's difficult demands (e.g., fine motor imitation, coloring, structured art activity) were used in this FA. Furthermore, Emmett's isolated attention FA was similar to the one conducted with Owen except that Emmett's preferred attention (e.g., rough and tumble play, conversation) was used in this FA.

During the synthesized tangible, escape, and attention FA, a combined tangible, escape, and attention test condition and a condition-specific control condition were rapidly alternated. During the test condition, the experimenter began the session by stating, "We can't talk right now, it's my turn, and it's time to work," removing the tangibles and placing them in the adjoining room, returning to the original room, and delivering difficult demands using a three-step prompting procedure. Contingent on compliance, the experimenter provided praise (e.g., "Nice job picking up the poof ball!"). However, contingent on elopement, the experimenter said, "Ok you don't have to" and provided escape from demands (i.e., no longer delivered demands and removed task materials) for 30 s; access to tangibles for 30 s (i.e., the tangibles were out and available for Emmett to access contingent on elopement); and preferred attention by chasing after him into the other room, providing a reprimand or rationale (e.g., "No, we need to go back over here," "We are staying in this room"), and physically redirecting him back to the previous room. Specifically, access to tangibles occurred for 30 s before the experimenter physically redirected him back to the other room. Once Emmett was back in the previous room, the experimenter terminated the session. The condition-specific control condition consisted of access to high-preferred tangibles, no demands, and the experimenter providing continuous preferred attention to Emmett. However, if elopement occurred, the experimenter remained in the original room. Additionally, following occurrences of elopement in the synthesized tangible, escape, and attention control condition, the next session began in the room the participant was currently located.

Owen

Results of Owen's IA suggested his most problematic behavior that would serve as his target problem behavior was elopement and that he did not display a precursor behavior to elopement. Other problem behavior reported in the IA were flopping, physical aggression, and property destruction. Furthermore, the IA suggested that elopement (target problem behavior) was evoked when difficult demands (e.g., gross motor imitation, following multiple-step instructions, articulation) were presented and when preferred attention (e.g., rough and tumble play, spinning around, chase) was removed. Additionally, as mentioned, results suggested a padded room be used given his other problem behavior of forcefully flopping to the ground. Results of Owen's structured observation suggested elopement was evoked when preferred attention was removed. Therefore, we conducted an isolated escape latency-based FA, an isolated attention latency-based FA, and a synthesized escape and attention latency-based FA with Owen. Latency-based FAs were conducted with Owen given his target behavior was elopement (i.e., any instance or attempt of his body passing through the threshold of the adjoining room door), which made it difficult to reset the EO following its occurrence. Specifically, all sessions (i.e., test and control) ended after the experimenter delivered the programmed reinforcer for 30 s contingent on the first occurrence of elopement. Additionally, it is important to note that Owen was our first participant, and thus procedures were somewhat different than with other participants. That is, we did not replicate the isolated escape FA or isolated attention FA before conducting the synthesized escape and attention FA with Owen.

During the isolated escape FA, an escape test condition and a condition-specific control condition were rapidly alternated. During the test condition, the experimenter began the session in the front room by saying, "It's time to work" and delivering difficult demands using a three-step prompting procedure. Contingent on compliance, the experimenter provided praise (e.g., “Nice listening!”). However, contingent on elopement, the experimenter said, “Ok you don’t have to” and provided escape (i.e., no longer delivered demands and removed task materials) for 30 s. Following occurrences of elopement, the experimenter remained in the original room. That is, the experimenter did not follow Owen into the adjoining room. After 30 s elapsed, the experimenter terminated the session. The condition-specific control condition consisted of no demands and access to moderately preferred tangibles (e.g., magnet letters, blocks, play food). Specifically, because Owen’s IA suggested access to tangibles was not a functional variable, access to moderately preferred tangibles was provided such that Owen had an alternative behavior to engage in. However, if elopement occurred, the experimenter remained in the original room. Additionally, following occurrences of elopement in either the isolated escape test or the control condition, the next session began in the room the participant was currently located. For example, if the session began in the front room with an isolated escape control session and Owen engaged in elopement, the experimenter terminated the session from the front room, allowed a minimum of 30 s to elapse (i.e., as to not provide additional attention), entered the adjoining room, and began an isolated escape test session.

During the isolated attention FA, an attention test condition and a condition-specific control condition were rapidly alternated. During the test condition, the experimenter began the session in the front room by stating, “Here are some things you can play with, I can’t talk to you right now, I have some work to do” and providing access to moderately preferred tangibles while removing their attention and pretending to work while remaining in the same room as Owen. Contingent on elopement, the experimenter delivered attention by chasing after him into the other room, providing a reprimand or rationale (e.g., “No, we need to go back over here,” “We are staying in this room”) and physically redirecting him back to the previous room for approximately 30 s. Once Owen was back in the previous room, the experimenter terminated the session. The condition-specific control condition consisted of the experimenter providing continuous preferred attention to Owen, which included rough and tumble play, spinning around, and chase. However, if elopement occurred, the experimenter remained in the original room. Additionally, following occurrences of elopement in the isolated attention control condition, the next session began in the room the participant was currently located.

During the synthesized escape and attention FA, a combined escape and attention test condition and a condition-specific control condition were rapidly alternated. During the test condition, the experimenter began the session in the front room by stating, “We can’t talk right now and it’s time to work” and delivering difficult demands using a three-step prompting procedure. Contingent on compliance, the experimenter provided praise (e.g., “Nice listening!”). However, contingent on elopement, the experimenter said, “Ok you don’t have to” and provided escape (i.e., no longer delivered demands and removed task materials) and delivered preferred attention by chasing after him into the other room, providing a reprimand or rationale (e.g., “No, we need to go back over here,” “We are staying in this room”), and physically redirecting him back to the previous room for 30 s. Once Owen was back in the previous room, the experimenter terminated the session. The condition-specific control condition consisted of no demands and the experimenter providing continuous preferred attention to Owen. However, if elopement occurred, the experimenter remained in the original room. Additionally, following occurrences of elopement in the synthesized escape and attention control condition, the next session began in the room the participant was currently located.

Study 1 Results

Figure 1 depicts results obtained from Riley’s FA of tantrum behavior as percent interval (top panel) and the percent occurrence during the EO-on and EO-off periods (bottom panel) across isolated tangible, isolated escape, and synthesized tangible and escape conditions. Results showed tantrum behavior occurred at higher levels during the test conditions as compared to the control conditions in all FAs. Additionally, results showed tantrum behavior occurred exclusively during EO-on periods across all FAs. These results were replicated with the addition of a new experimenter, providing additional support for these outcomes. Overall, these results suggest Riley's tantrum behavior is maintained by isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention.

Figure 2 depicts the percent interval of combined other problem behavior (top panel) and the percent occurrence of combined other problem behavior during EO-on and EO off periods (bottom panel) across FAs. Other problem behavior for Riley included SIB and property destruction. Results showed other problem behavior occurred infrequently and exclusively in the EO-on periods.

Figure 3 depicts results obtained from Madeline's FA of target behavior as percent interval (top panel) and the percent occurrence during the EO-on and EO-off periods (bottom panel) across isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention conditions. Target behavior for Madeline included her precursor behavior (foot stomping, screeching, negative vocalizations) and target problem behavior (physical aggression). Results showed target behavior occurred at higher levels during the test conditions as compared to the control conditions in all three FAs. These results were replicated providing additional support for these outcomes. Additionally, EO-on and EO-off results showed target behavior initially occurred exclusively during EO-on periods in the isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention FA conditions; however, following exposure to the synthesized tangible and diverted-attention contingency, target behavior began occasionally occurring in EO-off periods of the isolated tangible and isolated diverted-attention FAs. Overall, these results suggest Madeline's target behavior is maintained by isolated tangible, isolated diverted attention, and synthesized tangible and diverted attention.

Figure 4 depicts the percent interval of combined precursor behavior (top panel) and the percent occurrence during EO-on and EO-off periods (bottom panel) across isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention FA conditions. Results showed precursor behavior occurred at higher levels during the test condition as compared to the control condition in the initial isolated tangible FA. Additionally, results showed precursor behavior occurred infrequently in the initial isolated diverted-attention and synthesized tangible and diverted-attention FA. Following the synthesized tangible and diverted-attention FA, precursor behavior occurred in all FAs. Additionally, when precursor behavior occurred, it consisted primarily of negative vocalizations. Additional results showed precursor behavior occurred exclusively during EO-on periods in the isolated tangible, isolated diverted-attention, and synthesized tangible and diverted attention conditions However, following exposure to the synthesized tangible and diverted-attention FA, precursor behavior occurred in both the EO-on and EO-off periods of the isolated tangible and isolated diverted-attention FAs.

Figure 5 depicts results obtained from Emmett's latency-based FA of elopement. For Emmett, experimenters conducted an isolated tangible FA, an isolated escape FA, an isolated attention FA, and a synthesized tangible, escape, and attention FA. Experimenters began Emmett's FA using a pairwise design. Results of the initial isolated tangible FA showed shorter latencies to elopement in the test condition relative to the control condition. However, elopement did occur in some control sessions. During initial sessions, experimenters noted that Emmett sometimes engaged in elopement during the isolated tangible control condition to gain access to the blocking mat located just across the adjoining room door. Therefore, experimenters removed the mat; however, results showed he continued to sometimes engage in elopement during control sessions. In the initial isolated escape FA, results initially showed elopement occurred at relatively similar short latencies in both the test and control condition. Therefore, experimenters provided continuous access to a moderately preferred tangible and noncontingent attention every 30 s in control sessions. After this change, results showed elopement continued to occur at short latencies in the test condition and longer latencies in the control condition. In the initial isolated attention FA, results showed elopement occurred at short latencies in the test condition as compared to the control condition; however, occurrences of elopement were variable.

Given that elopement occurred in control conditions in isolated tangible and escape FAs for Emmett, we conducted a reversal design in which we presented sequential test and control sessions (i.e., 5 test sessions, then 5 control sessions) in our replication of FAs. As with Owen, we chose to do this to attempt to address possible discrimination problems across conditions due to a lack of repeated exposure to programmed contingencies in using a latency FA methodology. Results of the sequential presentation evaluation showed shorter latencies to elopement in test conditions as compared to control conditions in both isolated FAs. Results of the subsequent pairwise synthesized FA showed short latencies to elopement in the test condition as compared to no elopement in the control condition. These outcomes were replicated in subsequent sequential presentation evaluations for all isolated and synthesized FAs. Overall, these results suggest Emmett's elopement is maintained by isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention.

Figure 6 depicts the results of Emmett's combined other problem behavior (i.e., SIB and physical aggression) as latency (top panel) and percentage of intervals (bottom panel). Results showed other problem behavior infrequently occurred across the isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention pairwise FAs: however, when it did occur, it was most frequently in the test conditions of the FAs. Furthermore, other problem behavior occurred even less frequently in the sequential test and control FAs. Additionally, when other problem behavior occurred, it consisted primarily of physical aggression.

Figure 7 depicts results obtained from Owen's latency-based FA of elopement. For Owen, experimenters conducted an isolated escape FA, an isolated attention FA, and a synthesized escape and attention FA. During the initial FAs, experimenters used a pairwise design. During the initial escape FA, elopement did not occur. During the initial attention FA, elopement occurred at relatively short latencies in several test and control sessions; however, these outcomes did not maintain over time. During some of the initial control conditions, Owen would attempt to play hide and seek with the experimenter, which would sometimes result in him running in the other room. Therefore, playing this game with him was removed as a preferred form of attention during the noted control session for the remainder of the FA. In the initial synthesized escape and attention FA, results showed that over time elopement occurred at shorter latencies in the test condition as compared to the control condition. We then attempted to replicate results of the FAs using the same pairwise design.

In the isolated escape FA following the synthesized FA, results showed shorter latencies to elopement in the test condition as compared to the control condition. These results maintained with the addition of a new experimenter due to a semester change and COVID policies (i.e., the first experimenter was no longer be in the classroom or research "bubble"). However, it is important to note that some elopement occurred at relatively short latencies in some control sessions. In the isolated attention FA following the synthesized FA, results showed short latencies to elopement in both the test and control conditions. Given that elopement occurred in control conditions across these isolated escape and attention FAs, we hypothesized that Owen's behavior was not discriminating the contingencies across test and control conditions. This may have been likely because sessions were terminated following the occurrence of elopement, and thus Owen was not repeatedly exposed to the contingencies in each condition. Thus, we conducted a reversal design in which we presented sequential test and control sessions for isolated attention, isolated escape, and synthesized attention and escape (i.e., five test sessions, then five control sessions). Results of the sequential presentation showed consistently shorter latencies to elopement in test sessions as compared to control sessions across all FAs. Overall, these results suggest Owen's elopement was maintained by isolated escape, isolated attention, and synthesized escape and attention.

Figure 8 depicts Owen's other combined problem behavior (i.e., flopping, property destruction, and physical aggression) as latency (top panel) and percentage of intervals (bottom panel). Results showed other problem behavior occurred infrequently across the isolated escape, isolated attention, and synthesized pairwise FAs; however, when it did occur, it was most frequently in the test conditions of FAs. Furthermore, shorter latencies to other problem behavior and a high percentage of intervals in which other problem behavior occurred were observed in the sequential test and control synthesized escape and attention FA. Additionally, when other problem behavior occurred, it consisted primarily of flopping and physical aggression.

Study 2 Method: FCT+EXT and Synthesized Generalization Tests

Participants, Setting, and Materials

The participants, setting, and materials for Study 2 were the same as those used in Study 1 except discriminative stimuli were not used during FCT+EXT or isolated test sessions.

Response Measurement and Interobserver Agreement

During all intervention evaluation sessions, trained observers collected data on the same variables in Study 1 including target problem behavior, precursor behavior, other problem behavior, compliance, and experimenter behavior (i.e., delivery of vocal-only instruction, duration or frequency of reinforcer delivery) for Riley and Madeline. For Emmett and Owen, all variables except for target problem behavior (elopement) were the same. That is, for Emmett and Owen, during FCT+EXT (isolated and synthesized) and isolated test sessions, data were collected, analyzed, and depicted for elopement not only using a latency measure (as in Study1) but also and frequency measure, which was converted to rate. As in Study 1, the main dependent variable was either target problem behavior alone (Riley, Emmett, Owen) or a combination of target problem behavior and precursor behavior (termed target behavior; Madeline). Additionally, for intervention evaluation sessions in which demands were presented, percent compliance was calculated as in Study 1.

Observers also collected data on the frequency of prompted and independent functional communication responses (FCRs) during intervention and isolated test phases. Functional communication responses were individually defined for participants based on the individual's communication repertoire and skill set (see below). Prompted FCRs were defined as FCRs that occurred within 5 s of an experimenter prompt. Independent FCRs were defined as FCRs that occurred after the EO was presented and without an experimenter prompt. Additionally, within-session analyses were analyzed and depicted as described in Study 1 for all sessions for Riley, Emmett, and Madeline and for all sessions except baseline for Owen. Within-session analyses were not conducted during baseline phases for Owen as elopement was measured using latency only and sessions were terminated following the first occurrence of elopement. However, during intervention and isolated test sessions, within-session analyses were conducted because sessions lasted for 5 min and multiple instances of elopement could occur within session.

A second observer simultaneously, but independently, collected data during 35.7% (range, 30%-40%) of sessions across phases with all participants. As in Study 1, IOA was calculated using the percent-interval method for behaviors scored using a percent-interval measure (i.e., precursor behavior, target problem behavior, other problem behavior) and delivery of stimulus events. For a frequency measure (i.e., precursor behavior, target problem behavior, other problem behavior, demands, prompted and independent FCRs), IOA was calculated using the proportional agreement method. Mean IOA for Riley, Madeline, Emmett, and Owen and was 95.7% (range, 80%-100%), 99.3% (range, 76%-100%), 98.3% (range, 42%-100%), and 97.1% (range, 0%-100%), respectively. For the few sessions in which IOA was below 80%, observers were retrained on the definitions of each behavior to ensure understanding and to minimize observer drift. For example, IOA for one of Madeline's sessions was 76% because one data collector scored more occurrences of physical aggression than the other data collector. After this session, data collectors were provided with retraining on the physical aggression definition and measurement.

As in Study 1, procedural integrity data were calculated during 32.3% (range, 30%-38%) of sessions across phases with all participants. In baseline sessions, procedural integrity data were calculated by dividing the number of reinforcers delivered within 5 s of the onset of precursor behavior or target problem behavior by the total number of occurrences of precursor behavior or target problem behavior. For the purpose of analyzing procedural integrity data, instances of precursor behavior or target problem behavior that co-occurred within a 3-s period was defined as one instance of behavior. In intervention sessions, procedural integrity data were calculated by dividing the number of reinforcers delivered within 5 s of the emittance of a prompted or independent FCR by the total number of occurrences of FCRs. For the purpose of analyzing procedural integrity data, instances of FCRs that co-occurred within a 3-s period was defined as one FCR. Additionally, for the purpose of analyzing procedural integrity data, instances of FCRs that occurred during the EO-off period (i.e., participant already had access to the reinforcer[s]) were not factored into the equation. Mean procedural integrity for Riley, Madeline, Emmett, and Owen was 100%, 100%, 99.5% (range, 83%-100%), and 100% respectively.

Procedure

For all participants, intervention and isolated test sessions were 5 min in duration and were conducted by a trained graduate student (i.e., same graduate student who conducted FA sessions in Study 1). Furthermore, a reversal design was used for experimental control with both participants. Additionally, Owen was our first participant and his methodology was different than those used for Riley, Madeline, and Emmett.

For all participants, experimenters implemented synthesized FCT+EXT for contingencies identified as a maintaining variable in the FA. The purpose of synthesized FCT+EXT sessions was to teach participants to engage in an omnibus mand (i.e., FCR) to gain access to the synthesized reinforcer while simultaneously reducing precursor behavior (Madeline only) or target problem behavior. Prior to beginning synthesized FCT+EXT sessions, experimenters conducted two pre-session prompts for all participants in which the evocative situation was presented, and a second experimenter used the least intrusive prompt to get the participant to engage in the FCR, which resulted in 10 s access to the synthesized reinforcer. All Synthesized FCT+EXT sessions involved contingencies similar to those programmed in the synthesized FA test condition; however, emittance of the FCR resulted in 30 s access to the synthesized reinforcer and occurrences of precursor behavior (Madeline only) or target problem behavior resulted in no programmed consequence (i.e., extinction). During sessions, FCRs were individualized and trained using a time delay procedure in which the experimenter presented the synthesized evocative situation, and a second experimenter prompted the FCR at the current time delay until the response was emitted by the participant. The time delay increased following two consecutive sessions at a current delay regardless of the occurrence of precursor behavior or target problem behavior (e.g., following two sessions at a 0 s delay, the delay increased to 5 s) and was thinned as followed: 0, 5, 10, 30 s. Once the participant was reliably emitting independent FCRs, synthesized FCT+EXT intervention sessions continued until there were little to no occurrences of precursor behavior or target problem behavior and high rates of independent FCRs.

After the effects of FCT+EXT to access synthesized reinforcers were observed, experimenters implemented isolated test sessions for participants. The purpose of isolated test sessions was to assess generalization of the omnibus mand previously acquired in the Synthesized FCT+EXT phase to the isolated contingency(ies) shown to maintain precursor behavior (if applicable) and target problem behavior while maintaining low levels of precursor behavior and target problem behavior. If a participant's FAs showed precursor behavior and target problem behavior was maintained by multiple isolated contingencies (e.g., escape in isolation, tangible in isolation), these variables were rapidly alternated using a multielement design. Additionally, to decrease the EO for tangibles in sessions that did not include access to tangibles, all sessions were conducted in an area free of tangibles (e.g., session room, classroom booth) or an area with limited tangibles that could be easily blocked (e.g., classroom library, motor room). Specifically, the experimenter began isolated test sessions by presenting the isolated evocative situation (e.g., demands). Contingent on the participant emitting the omnibus mand (e.g., "my way"), the experimenter delivered 30 s access to the isolated reinforcer (e.g., break). Additionally, precursor behavior or target problem behavior resulted in no programmed consequences (i.e., extinction). Once 30 s elapsed, the experimenter again presented the isolated evocative situation. If precursor behavior or target problem behavior remained low and FCRs remained high, suggesting that the omnibus mand generalized to isolated contingencies, the participant completed the current study (Riley). However, if precursor behavior or target problem behavior increased and FCRs decreased, suggesting the omnibus mand did not generalize to isolated contingencies, experimenters either implemented isolated FCT+EXT sessions for those contingencies (Madeline, Emmett) or began reinforcing previously trained isolated FCRs (Owen).

The purpose of isolated FCT+EXT sessions was to teach participants to engage in an isolated or specific FCR to gain access to the isolated reinforcer(s) shown to maintain precursor behavior (if applicable) and target problem behavior while simultaneously reducing precursor behavior and target problem behavior. For Madeline, isolated FCT+EXT sessions were conducted similar to synthesized FCT+EXT sessions except the experimenter presented an isolated evocative situation (i.e., diverted attention), prompted an isolated FCR (i.e., "talk to me"), and delivered an isolated reinforcer (i.e., preferred attention) for any prompted or independent FCR emitted by the participant. For Emmett, isolated FCT+EXT sessions were conducted similar to synthesized FCT+EXT sessions except the experimenter presented an isolated evocative situation (i.e., demands), required the emittance of the synthesized FCR (i.e., "my way"), prompted an isolated FCR (i.e., "toys, please," "talk to me"), and delivered an isolated reinforcer (i.e., preferred tangibles, preferred attention) for any prompted or independent FCR. For Owen, experimenters reinforced certain isolated FCRs in various phases given his history with relevant isolated FCRs and the initial outcomes of the isolated test phase (see below).

Riley

For Riley, baseline sessions were conducted with maintaining variable(s) (i.e., isolated or synthesized) identified in Study 1 using a multielement design. That is, experimenters rapidly alternated between isolated and synthesized, quasi-randomly using the procedures described in Study 1. Specifically, a round of each of the conditions (i.e., isolated and synthesized) was conducted in a session block. To determine the order of conditions to be conducted, the experimenter pulled a number out of a cup associated with each of the conditions. Based on the outcomes of Riley's FAs, we conducted baseline sessions for isolated tangible, isolated escape, and synthesized tangible and escape contingencies.

Next, we evaluated the effects of synthesized FCT+EXT for the synthesized tangible and escape contingency. During synthesized tangible and escape intervention sessions, procedures were similar to synthesized tangible and escape baseline sessions except Riley was taught to emit the FCR "my way" to gain access to high-preferred tangibles and a break from demands. Specifically, every time Riley said, "my way" the experimenter said, "Ok, you can have it and you don't have to work" and provided her access to high-preferred tangibles and a break from demands for 30 s. In addition, occurrences of tantrum behavior no longer resulted in access to high-preferred tangibles or a break from demands.

Next, we evaluated whether the effects of synthesized FCT+EXT would generalize to the isolated tangible and isolated escape contingencies by conducting test sessions in which we rapidly alternated two conditions using a multielement design. During isolated test sessions, procedures were similar to isolated tangible and isolated escape baseline conditions except contingent on Riley saying, "my way" the experimenter delivered the programmed contingency. That is, in isolated tangible sessions, the experimenter said, "Ok you can have it" and provided access to high-preferred tangibles for 30 s. In isolated escape sessions, the experimenter said, "You don't have to" and provided access to a break from demands for 30 s. In addition, occurrences of tantrum behavior no longer resulted in access to high-preferred tangibles or preferred attention. Because the synthesized FCR generalized to isolated tangible and isolated escape test sessions, we did not have to teach Riley an isolated FCR.

Madeline

For Madeline, baseline sessions were conducted with maintaining variable(s) (i.e., isolated or synthesized) identified in Study 1 using a multielement design. That is, experimenters rapidly alternated between isolated contingencies and synthesized contingencies, quasi-randomly using the procedures described in Study 1. Specifically, a round of each of the conditions (i.e., isolated and synthesized) was conducted in a session block. To determine the order of conditions to be conducted, the experimenter pulled a number out of a cup associated with each of the conditions. Based on the outcomes of Madeline's FAs, we conducted baseline sessions for isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention contingencies.

Next, we evaluated the effects of synthesized FCT+EXT for the synthesized tangible and diverted-attention contingency. During synthesized tangible and diverted-attention intervention sessions, procedures were similar to synthesized tangible and diverted-attention baseline sessions except Madeline was taught to emit the FCR “my way” to gain access to high-preferred tangibles and preferred attention. Specifically, every time Madeline said, “my way” the experimenter said, “Ok, you can have it and we can talk” and provided her access to high-preferred tangibles and preferred attention for 30 s. In addition, occurrences of target behavior (i.e., precursor behavior and target problem behavior) no longer resulted in access to high-preferred tangibles or preferred attention.

Next, we evaluated whether the effects of synthesized FCT+EXT would generalize to the isolated tangible and isolated diverted-attention contingencies by conducting test sessions in which we rapidly alternated two conditions using a multielement design. During isolated test sessions, procedures were similar to isolated tangible and isolated diverted-attention baseline conditions except contingent on Madeline saying, “my way” the experimenter delivered the programmed contingency. That is, in isolated tangible sessions, the experimenter said, “Ok you can have it” and provided access to high-preferred tangibles for 30 s. In isolated diverted-attention sessions, the experimenter said, “I can talk to you” and provided preferred attention for 30 s. In addition, occurrences of target behavior no longer resulted in access to high-preferred tangibles or preferred attention.

Because the synthesized FCR did not generalize to isolated divided-attention test sessions for Madeline, we implemented FCT+EXT for the isolated diverted-attention contingency. During isolated diverted-attention FCT+EXT sessions, procedures were similar to isolated diverted-attention baseline conditions except Madeline was taught to emit the FCR “talk to me” to gain access to preferred attention. Specifically, every time Madeline said, “talk to me” the experimenter said, “I can talk to you” and provided preferred attention for 30 s. In addition, occurrences of target behavior no longer resulted in access to preferred attention.

Emmett

For Emmett, baseline sessions were conducted with maintaining variable(s) (i.e., isolated or synthesized) identified in Study 1 using a multielement design. That is, experimenters rapidly alternated between isolated contingencies and synthesized contingencies, quasi-randomly using the procedures described in Study 1. Specifically, a round of each of the conditions (i.e., isolated and synthesized) was conducted in a session block. To determine the order of conditions to be conducted, the experimenter pulled a number out of a cup associated with each of the conditions. Based on the outcomes of Emmett’s FAs, we conducted baseline sessions for isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention contingencies.

Next, we evaluated whether the effects of synthesized FCT+EXT would generalize to the isolated tangible, isolated escape, and isolated attention contingencies by conducting test sessions in which we rapidly alternated two conditions using a multielement design. During isolated test sessions, procedures were similar to isolated tangible, isolated escape, and isolated attention baseline conditions except contingent on Emmett saying, “my way” the experimenter delivered the programmed contingency. That is, in isolated tangible sessions, the experimenter said, “Ok you can have it” and provided access to high-preferred tangibles for 30 s. In the isolated escape sessions, the experimenter said, “Ok you don’t have to” and provided a break from demands for 30 s. In isolated attention sessions, the experimenter said, “I can talk to you” and provided preferred attention for 30 s. In addition, occurrences of elopement no longer resulted in access to high-preferred tangibles, a break from demands, or preferred attention.

Because the synthesized FCR did not generalize to isolated escape test sessions for Emmett, we implemented FCT+EXT for the isolated escape contingency with some modifications. First, because Emmett was emitting the synthesized FCR in the isolated escape condition to get access to a break from demands; however, was continuing to elope during the EO-off period, we taught him to request attention or tangibles in the escape condition using a multielement design. That is, during isolated escape FCT+EXT sessions, procedures were similar to the synthesized FCT+EXT conditions except Emmett was taught to emit the FCR "toys please" to gain access to preferred tangibles or "talk to me" to gain access to preferred attention during the break from demand period. Specifically, Emmett first had to emit the synthesized FCR of "my way" to get access to a break from demands then contingent on an isolated tangible FCR of "toys please" in the tangible escape sessions, access to preferred tangibles was delivered for the remainder of the 30 s break from demands period. Additionally in the attention escape sessions, Emmett first had to emit the synthesized FCR to get access to a break then contingency on an isolated attention FCR of "talk to me," access to preferred attention was provided for the remainder of the 30 s break from demands period. In addition, occurrences of target behavior no longer resulted in access to a break from demands, preferred tangibles, or preferred attention.

Furthermore, because of the outcomes in the escape tangible sessions, we taught Emmett to emit both the isolated tangible and isolated attention FCR during the escape FCT+EXT condition. Specifically, Emmett first had to emit the synthesized FCR of "my way" to get access to a break from demands then contingent on an isolated tangible FCR of "toys please," access to preferred tangibles was delivered for the remainder of the 30 s break from demands period. Additionally, following the emittance of a synthesized and isolated tangible FCR, Emmett was taught to emit the isolated attention FCR to get access to preferred attention in conjunction with access to preferred tangibles for the remainder of the 30 s break from demands period.

Owen

Based on the outcomes of Owen's FAs, we evaluated the effects of FCT+EXT for isolated escape, isolated attention, and synthesized escape and attention contingencies in a sequential fashion and compared the effects to those in the relevant baseline conditions, which were data from relevant FA conditions. That is, we did not conduct new baseline sessions for all contingencies found as maintaining variables in his FA. Rather, we used session data from his final FA conditions for these variables as his initial three baseline phases by which to compare the effects of FCT+EXT for each of the variables (isolated and synthesized). Thus, for Owen, we taught isolated FCRs prior to teaching synthesized FCRs. After replication of the effects of the synthesized FCT+EXT intervention, we then tested to see whether synthesized or isolated FCRs would occur under relevant isolated test conditions. Finally, additional modifications were made to isolated test conditions based on Owen's history with relevant isolated FCRs and the initial outcomes of the isolated test phase (see below).

During the isolated escape intervention sessions, procedures were similar to isolated escape baseline sessions except Owen was taught to emit the FCR "I want a break" to gain access to escape from demands. Specifically, every time Owen said, "I want a break" the experimenter said, "Ok, you don't have to" and provided escape from demands for 30 s. In addition, occurrences of elopement no longer resulted in escape from demands. During the isolated attention intervention sessions, procedures were similar to isolated attention baseline sessions except Owen was taught to emit the FCR "play with me" to gain access to preferred attention. Specifically, every time Owen said, "play with me" the experimenter said, "I can play with you" and provided preferred attention for 30 s. In addition, occurrences of elopement no longer resulted in access to preferred attention. During the synthesized escape and attention intervention sessions, procedures were similar to the synthesized escape and attention baseline sessions except Owen was taught to emit the FCR "my way" to gain access to preferred attention and escape from demands. Specifically, every time Owen said, "my way" the experimenter said, "Ok, you don't have to, I can play with you" and delivered preferred attention and escape from demands for 30 s. In addition, occurrences of elopement no longer resulted in access to preferred attention or escape from demands. Additionally, for Owen, if intervention effects were obtained in the isolated FCT+EXT or synthesized FCT+EXT condition, the experimenter reversed to baseline then back to the isolated or synthesized FCT+EXT condition for experimental control. If intervention effects were not obtained in the isolated or synthesized FCT+EXT conditions, the experimenter progressed to the next condition.

Next, we evaluated whether the effects of synthesized FCT+EXT would generalize to the isolated escape and isolated attention contingencies, as well as whether previously taught isolated FCRs (for attention or escape) would occur. During isolated test sessions, procedures were similar to isolated escape and isolated attention baseline conditions except contingent on Owen saying, "my way" the experimenter delivered the programmed contingency. That is, in isolated tangible sessions, the experimenter said, "Ok you can have it" and provided access to high-preferred tangibles for 30 s. In the isolated attention sessions, the experimenter said, "I can play with you" and provided preferred attention for 30 s. In addition, occurrences of elopement no longer resulted in access to high-preferred tangibles or escape from demands.

Furthermore, because of outcomes in initial isolated test sessions, and because we taught Owen isolated escape and isolated attention FCRs prior to teaching the synthesized FCR, we made some modifications to the different isolated test sessions. First, in isolated attention sessions, we modified the contingencies such that the experimenter provided preferred attention contingent on the synthesized FCR or the isolated attention FCR. That is, if Owen said either, “my way” or “play with me,” the experimenter said, “I can play with you” and provided preferred attention for 30 s. Second, in isolated escape sessions, we modified the contingencies such that the experimenter provided access to escape from demands contingent on the synthesized FCR then preferred attention contingent upon the isolated attention FCR during the escape period. That is, if Owen said, “my way,” the experimenter said, “Ok you don’t have to” and delivered escape from demands for 30 s; however, if during the 30 s escape period Owen said, “play with me,” the experimenter said, “I can play with you” and delivered preferred attention for the remainder of the 30 s duration. Finally, we later made an additional modification prior to further isolated escape sessions in in which the experimenter provided pre-session prompts to teach Owen to emit the synthesized FCR for escape from demands then the isolated attention FCR for preferred attention. Additional information regarding reasons why these modifications were made are included in the results section as we discuss patterns of responding.

Study 2 Results

Figure 9 depicts tantrum behavior data as percent interval (top panel) and the percent occurrence during EO-on and EO-off periods (bottom panel) for Riley’s intervention evaluation. Tantrum behavior for Riley consisted of flopping, screaming, and foot stomping. The graph depicts FCT+EXT under the isolated tangible, isolated escape, and synthesized tangible and escape conditions. Results showed moderate levels of tantrum behavior across all conditions in baseline. With the implementation of synthesized FCT+EXT sessions, tantrum behavior decreased and high rates of independent synthesized FCRs occurred. In the isolated test phase, target behavior decreased and independent synthesized FCRs occurred at high rates under both isolated conditions. Additionally, in the isolated escape test sessions, Riley sometimes emitted an isolated tangible FCR during the EO off period. With the return to baseline, tantrum behavior increased across all conditions. With the re-implementation of synthesized FCT+EXT sessions, tantrum behavior decreased and independent synthesized FCRs increased. In the second isolated test phase, tantrum behavior again decreased and independent synthesized FCRs occurred at high rates under both isolated conditions. Additionally, EO-on and EO-off results showed tantrum behavior occurred most frequently during the EO-on period across all conditions.

Figure 10 depicts other problem behavior combined as percent interval (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel), respectively. Other problem behavior for Riley consisted of property destruction and self-injury. Results showed other problem behavior infrequently occurred across conditions. Additionally, EO-on and EO-off results showed when other problem behavior occurred, it occurred exclusively during the EO-on period.

Figure 11 depicts target behavior (i.e., precursor behavior and target problem behavior) data as percent interval (top panel) and the percent occurrence during EO-on and EO-off periods (bottom panel) for Madeline's intervention evaluation. Precursor behavior for Madeline consisted of foot stomping, screeching, and negative vocalizations. Target problem behavior for Madeline consisted of physical aggression. The graph depicts FCT+EXT under the isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention conditions. Results showed moderate levels of target behavior across all conditions in baseline. With the implementation of synthesized FCT+EXT sessions, target behavior decreased and high rates of independent synthesized FCRs occurred. In the isolated test phase, target behavior decreased and independent synthesized FCRs occurred at high rates when the isolated tangible EO was presented; however, target behavior increased and independent isolated FCRs infrequently occurred when the isolated diverted-attention EO was presented. Additionally, Madeline did not emit any isolated FCRs for tangibles (e.g., "iPad, please") or attention (e.g., "talk to me") in the initial isolated test condition. With the return to baseline, target behavior increased across all conditions. With the re-implementation of synthesized FCT+EXT sessions, target behavior decreased and independent synthesized FCRs increased. In the second isolated test phase, target behavior again decreased and independent synthesized FCRs occurred at high rates when the isolated tangible EO was presented. Target behavior increased and synthesized FCRs infrequently occurred when the isolated diverted-attention EO was presented. Additionally, Madeline did not emit any isolated FCRs for tangibles (e.g., "iPad, please") or attention (e.g., "talk to me") in the second isolated test condition. With the implementation of isolated diverted-attention FCT+EXT sessions, target behavior decreased and isolated diverted-attention FCRs were acquired and occurred at moderate rates. These results were replicated in a reversal design. Additionally, EO-on and EO-off results showed target behavior occurred most frequently during the EO-on period when the synthesized tangible and diverted-attention EO was presented in baseline; however, in the initial baseline phase, target behavior occurred during the EO-on and EO-off periods when the isolated tangible and isolated diverted-attention EO was presented. Additionally, in the isolated test phase, target behavior occurred exclusively during the EO-on period of the isolated diverted-attention sessions and exclusively during the EO-off period of the isolated tangible sessions.

Figure 12 depicts combined precursor behavior as percent interval (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel) for Madeline's intervention evaluation. Precursor behavior for Madeline consisted of foot stomping, screeching, and negative vocalizations. Results showed low levels of precursor behavior across all conditions in baseline. With the implementation of synthesized FCT+EXT sessions, precursor behavior decreased over time. In the isolated test phase, low levels of precursor behavior occurred when the isolated tangible EO was presented; however, moderate levels of precursor behavior occurred with the isolated diverted-attention EO was presented. With the return to baseline, no occurrences of precursor behavior were observed. With the re-implementation of synthesized FCT+EXT sessions, precursor behavior rarely occurred. In the second isolated test phase, precursor behavior occurred at high levels when the isolated diverted-attention EO was presented. Precursor behavior occurred at the same level as the initial isolated test phase when the isolated tangible EO was presented. With the implementation of isolated diverted-attention FCT+EXT sessions, precursor behavior did not occur. These results were replicated with a reversal design. Additionally, EO-on and EO-off results showed precursor behavior occurred exclusively during the EO-on period in baseline. Additionally, precursor behavior occurred exclusively during the EO-on period of the isolated diverted-attention test condition and exclusively during the EO-off period of the isolated tangible test condition.

Figure 13 depicts elopement data for Emmett's intervention evaluation (split across two panels). The top panel depicts baseline, synthesized FCT+EXT, and isolated test conditions. Results showed short latencies to elopement across all baseline conditions. With the implementation of synthesized FCT+EXT sessions, elopement did not occur and high rates of independent synthesized FCRs occurred. In the isolated test phase, the synthesized FCR occurred across all conditions, and elopement did not occur in the isolated attention and isolated tangible sessions; however, elopement did occur during the isolated escape sessions. With the return to baseline, elopement occurred at short latencies across all conditions. With the re-implementation of synthesized FCT+EXT sessions, elopement did not occur and independent synthesized FCRs increased. In the second isolated test phase, elopement occurred at short latencies in the isolated escape sessions and did not occur in the isolated attention or isolated tangible sessions. With the implementation of escape FCT+EXT sessions, elopement did not occur in the attention sessions; however, continued to occur at variable latencies in the tangible sessions. Additionally, high rates of synthesized, isolated attention, and isolated tangible FCRs occurred. Because elopement continued to occur in the tangible sessions, experimenters began providing both access to preferred tangibles and access to preferred attention during the break from demand period contingent on the emittance of both isolated FCRs following the emittance of the synthesized FCR at session #90. Results showed elopement did not occur and high rates of synthesized, isolated tangible, and isolated attention FCRs occurred.

Figure 14 depicts elopement data for Emmett as a rate measure (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel). Results showed elopement occurred at high rates in all baseline conditions. With the implementation of synthesized FCT+EXT sessions, no elopement occurred. With the implementation of isolated test sessions, elopement occurred at low rates during the isolated attention and isolated tangible sessions; however, occurred at moderate to high rates in the isolated escape sessions. With the implementation of escape FCT+EXT, elopement occurred at moderate rates in the tangible sessions until we began providing access to tangibles and attention contingent on isolated FCRs. Following this change, elopement occurred once at a moderate rate then did not occur in following sessions. Additionally, EO-on and EO-off results showed elopement mostly occurred in EO-on periods across conditions in baseline. In the isolated test phase, elopement occurred primarily in the EO-off period of the isolated escape test sessions.

Figure 15 depicts other problem behavior combined as percent interval (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel), respectively. Other problem behavior for Emmett consisted of physical aggression and self-injury. Results showed other problem behavior occurred at low percentages across all conditions; however most frequently occurred during the isolated escape and isolated tangible sessions. Additionally, EO-on and EO-off results showed other problem behavior occurred during both the EO-on and EO-off periods of the isolated escape and isolated tangible conditions.

Figure 16 depicts elopement data for Owen's intervention evaluation (split across two panels). The top panel depicts baseline and FCT+EXT phases for isolated escape, isolated attention, and synthesized escape and attention contingencies. Results showed short latencies to elopement across all baseline conditions. With the implementation of isolated escape and isolated attention FCT+EXT sessions, high rates of independent isolated FCRs occurred; however, elopement continued to occur at variable latencies across conditions. With the implementation of synthesized escape and attention FCT+EXT sessions, elopement did not occur and high levels of independent synthesized FCRs occurred. These results were replicated using a reversal design (first two phases of bottom panel).

Although Owen had already been taught isolated escape and isolated attention FCRs, following the final synthesized FCT+EXT condition, experimenters evaluated whether the synthesized FCR would generalize to the isolated escape and isolated attention condition. Additionally, experimenters were interested in whether previously trained isolated FCRs would occur in these sessions. Therefore, experimenters conducted an isolated test phase (bottom panel) with Owen. Results showed high rates of synthesized FCRs; however, elopement continued to occur at variable latencies across isolated test conditions. Additionally, Owen emitted the isolated attention FCR in both the isolated escape and isolated attention conditions. Therefore, experimenters began providing preferred attention for both synthesized FCRs and isolated attention FCRs at session #66 of the isolated attention condition. Results of this change showed high rates of synthesized FCRs across both isolated escape and attention conditions, no occurrences of isolated attention FCRs in the isolated attention condition, and high rates of isolated attention FCRs in the isolated escape condition. Additionally, elopement did not occur in the isolated attention conditions; however, did continue to occur at variable latencies in the isolated escape condition. Because, in the isolated escape condition, Owen was emitting the synthesized FCR to get access to a break then emitting the isolated attention FCR in an attempt to get access to preferred attention from the experimenter, experimenters began providing preferred attention for isolated attention FCRs that occurred during the EO-off period at session #70. That is, Owen had to first emit the synthesized FCR to escape demands then emit the isolated attention FCR to receive access to preferred attention during the escape period. Results showed high rates of synthesized FCRs maintained during the isolated escape and isolated attention conditions; however, Owen did not emit any isolated attention FCRs in either condition and continued to engage in elopement during the isolated escape condition. Elopement did not occur in the isolated attention condition. Experimenters hypothesized Owen was no longer emitting the isolated attention FCR in the isolated escape conditions as their emittance had previously not resulted in reinforcement. Therefore, experimenters conducted pre-session prompts prior to the isolated escape condition. That is, prior to beginning session #74 of the isolated test escape condition, experimenters presented the evocative situation, and a second experimenter immediately (i.e., 0 s delay) prompted the synthesized FCR of “my way.” Contingent on Owen saying, “my way,” escape from demands was provided and the second experimenter immediately (i.e., 0 s delay) prompted the isolated attention FCR of "play with me." Experimenters increased the time delay within pre-session following two consecutive EO presentations at the current delay and was thinned as followed: 0, 5, 10 s. Once Owen was reliably emitting independent synthesized FCRs and independent isolated attention FCRs, isolated test sessions resumed. After this change, results showed high rates of synthesized FCRs maintained and moderate to high rates of isolated attention FCRs occurred across both conditions. Additionally, elopement infrequently occurred and when it did, latencies were much longer than in baseline conditions.

Figure 17 depicts elopement data for Owen as a rate measure (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel). Results showed elopement occurred at low rates across all conditions excluding baseline. That is, Owen's baseline data came from his latency-based FAs thus the rate of elopement in baseline conditions is not depicted. Additionally, EO-on and EO-off results showed elopement occurred during both the EO-on and EO-off periods of the isolated escape and isolated attention FCT+EXT conditions; however, following exposure to the synthesized escape and attention contingency, elopement occurred primarily during the EO-off periods of the isolated test condition.

Figure 18 depicts other problem behavior combined as percent interval (top panel) and percent occurrence during EO-on and EO-off periods (bottom panel), respectively. Other problem behavior for Owen consisted of flopping, property destruction, and physical aggression. Results showed other problem behavior occurred at high percentages in the isolated escape and isolated attention FCT+EXT conditions. Additionally, EO-on and EO-off results showed other problem behavior occurred during both the EO-on and EO-off periods of the isolated escape condition and primarily during the EO-on period of the isolated attention condition.

Discussion

The current study replicated the results of Holehan et al. (2020) with regard to the necessity of synthesized contingencies in FAs. In addition, we evaluated the extent to which synthesized contingencies in FAs resulted in iatrogenic effects and examined within-session analyses of FA outcomes. Finally, we evaluated the efficacy of interventions based on the outcomes of isolated and synthesized contingency FAs and extended previous research (Tsami & Lerman, 2019) by evaluating the generalization of synthesized functional communication responses under isolated contingencies. Results of Study 1 suggested that all four participants FAs were differentiated in at least one of their initial (i.e., prior to exposure to the synthesized contingency) two or three isolated FAs. Synthesized FAs were differentiated for all four participants. That is, for Riley, the initial isolated tangible and isolated escape FAs showed differentiated responding. For Madeline, the initial isolated tangible and isolated diverted-attention FAs showed differentiated responding. For Emmett, the initial isolated tangible, isolated escape, and isolated attention FAs showed differentiated responding. For Owen, the initial isolated attention FA showed differentiated responding. Furthermore, in Study 2 synthesized FCT+EXT was effective for increasing FCRs and decreasing target behavior for all participants; however, the synthesized FCR did not generalize to isolated contingencies for three of the four participants. That is, for Riley intervention effects of synthesized FCT+EXT did generalize to both the isolated tangible and isolated escape test conditions. For Madeline, the effects of synthesized FCT+EXT did generalize to the isolated tangible contingency; however, did not generalize to the isolated diverted-attention contingency. For Emmett, the effects of synthesized FCT+EXT did generalize to the isolated tangible and isolated attention test conditions; however, not the isolated escape test condition. For Owen, intervention effects of synthesized FCT+EXT did not generalize to either the isolated escape or isolated attention contingency.

Results of the comparison of isolated and synthesized FAs were similar to the results of Holehan et al. (2020) in that at least one isolated FA showed differentiated responding. Thus, although we showed differentiated responding in the synthesized FA for all four participants, the results replicated previous research suggesting that synthesized contingencies were not necessary to produce differentiated responding in FAs. For example, for Riley, Madeline, and Emmett it is possible that their target behavior is maintained by multiple control (i.e., tangible, escape, attention; tangible, diverted attention; tangible, escape) but synthesizing those contingencies is not necessary. For Owen, it is possible his target behavior was only maintained by one isolated variable and synthesizing that variable with other variables that may occur in the natural environment is not necessary.

Holehan et al. (2020) is one of the few synthesized FA articles to report reinforcing both precursor behavior and target problem behavior in isolated and synthesized FAs. To further expand the literature on precursor behavior in synthesized FAs, the current study involved reinforcing both precursor and target problem behavior in isolated and synthesized FAs; however, only one of our participants' IAs (Madeline) identified precursor behavior. Our results suggested that Madeline initially engaged in more precursor behavior in the isolated tangible and isolated diverted-attention FAs; however, during the synthesized FA she engaged in more target problem behavior. Additionally, following the initial synthesized FA Madeline engaged in similar levels of precursor behavior and target problem behavior across FAs. Specifically, precursor behavior and target problem behavior typically co-occurred (e.g., negative vocalization and aggression occurred at the same time). Given minimal participants IAs identified precursor behavior in Holehan al. (2020) and in the current study, research is still needed to determine the prevalence of precursor behavior found via IAs, as well as the degree to which precursors occur during FAs. Future research might also determine if the outcomes of isolated versus synthesized FAs are influenced by the occurrence of precursors or the degree to which precursors occur in FAs.

In the current study, results of the IAs were used to inform structured observations and FA conditions for each participant. Specifically, experimenters were interested in examining the degree to which results of structured observations (Greer et al., 2020) coincide with the results of IAs and FAs. Across participants, the structured observation correctly identified four of the nine (44.4%) relevant contingencies from the IA. That is, for all four participants, the structured observation showed differentiated responding (i.e., correspondence) in only one of the isolated contingencies identified in the IA. Additionally, results of the structured observation correctly identified four of the eight (50%) relevant contingencies from the FA. For Riley, Madeline, and Emmett the structured observation showed correspondence with one of the two or three isolated contingencies identified as a maintaining variable in the FA. For Owen, the structured observation showed exact correspondence with the results of the initial isolated FA. Interestingly, the results of the current study suggest there was a higher correspondence between the IA and FA outcomes. That is, across participants, the IA correctly identified eight out of the nine (88.8%) maintaining variables identified in the FA. Specifically, Riley, Madeline, and Emmett's IAs correctly identified all relevant isolated contingencies shown to maintain precursor behavior (when applicable) and target problem behavior in the FA; however, Owen's IA identified one relevant isolated variable and one irrelevant isolated variable (i.e., false-positive) shown to maintain elopement in his FA. These data suggest it may be more efficient to forgo a structured observation and design FA conditions solely based on IA outcomes. Although forgoing a structured observation may be more efficient, one limitation of the Greer et al. methodology is that participants are only exposed to each segment of the analysis twice and for a relatively short period of time. Although, structured observations are meant be relatively short, it is possible their results do not produce high correspondence with FA results due to limited exposure to the contingency. Future research might evaluate the degree to which various structured observation methodologies (e.g., session duration, repeated exposure) produce correspondence with IA and FA outcomes.

The current study provided additional information regarding the occurrence of precursor behavior, target problem behavior, and other problem behavior identified in the IA. That is, although contingencies were not placed on other problem behavior identified in the IA, we collected data on any other problem behavior identified to gain additional information regarding a response class. That is, if other problem behavior occurred at higher levels in isolated or synthesized test conditions as compared to the control condition, a functional variable could be hypothesized. Although Riley and Madeline's IAs identified other problem behavior, these behaviors occurred infrequently in their FAs. It is possible that Riley and Madeline's other problem behavior typically occurs in a hierarchy or chain following occurrences of precursor behavior or target problem behavior. For example, Riley's IA suggested property destruction and SIB as her only other problem behavior; however, we observed only one occurrence of property destruction and no occurrences of SIB across FAs. It is possible because we reinforced her target problem behavior of tantrums, other problem behavior did not occur. Madeline's IA suggested SIB as her only other problem behavior; however, we observed no occurrences of SIB across FAs. It is possible because we reinforced her precursor behavior (negative vocalizations, foot stomping, or screeching) and her target behavior of physical aggression, we never saw self-injury because the less effortful and less severe precursor behavior and target problem behavior resulted in reinforcement. Emmett's IA identified physical aggression as one type of other problem behavior he engaged in. Emmett's FA results suggested physical aggression occurred at shorter latencies and a higher percentage of intervals in the initial isolated escape and isolated attention FAs suggesting a potential functional variable. Furthermore, flopping was identified as one type of other problem behavior in Owen's IA. Owen's FA results suggested flopping occurred at shorter latencies and a higher percentage of intervals in the synthesized escape and attention FA suggesting a potential functional variable. Additionally, experimenters noted flopping occurred primarily during the full physical prompt back to the previous room following target behavior. Future research might determine the prevalence of other problem behavior found via IAs, the degree to which other problem behavior occurs during FAs, and the degree to which results of FAs in which contingencies were not placed on other problem behavior match the results of FAs in which contingencies are placed on other problem behavior. Future research might also determine if the outcomes of isolated versus synthesized FAs are influenced by the occurrence of other problem behavior or the degree to which other problem behavior occurs in FAs.

One interesting aspect of Study 1 is that it compared isolated and synthesized FAs for two participants who engaged in elopement which has been addressed in few published studies (e.g., Boyle et al., 2020; Jessel et al., 2018). Results of the current study did not match the results of Boyle et al. (2020) or Jessel et al. (2018). That is, in both previous studies, occurrences of elopement only occurred in the synthesized test condition as compared to the control condition. In the current study, Emmett eloped only in the synthesized test condition as compared to the control condition, whereas Owen eloped in both the synthesized test and control conditions.

Additionally, for Owen, elopement occurred in both the test and control conditions in the isolated attention and isolated escape FAs. Given that elopement occurred in control conditions across these isolated escape and attention FAs, we hypothesized that Owen's behavior was not discriminating the contingencies across test and control conditions. This may have been likely because sessions were terminated following the occurrence of elopement, and thus Owen was not repeatedly exposed to the contingencies in each condition. Thus, we conducted a reversal design in which we presented sequential test and control conditions for isolated attention, isolated escape, and synthesized attention and escape (i.e., five test sessions, then five control sessions). For Emmett, elopement occurred in both the test and control conditions in the isolated escape and isolated tangible conditions. Given the isolated escape control condition presents similarly to the isolated attention test condition (e.g., no attention, no alternative or appropriate behavior to engage in), we added moderately preferred tangibles and delivered noncontingent neutral attention every 30 s in Emmett's isolated escape control condition. Following this change, elopement continued to occur in isolated escape control conditions therefore, we made changes to Emmett's methodology by presenting sequential test and control conditions for isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention. These results suggest the limitations a condition-specific control condition may present especially when conducting a latency-based FA assessing behavior such as elopement. For example, an isolated attention condition-specific control condition may present as an isolated attention or ignore test condition. That is, because attention is removed and there is no opportunity to engage in a more appropriate or alternative behavior, the isolated attention EO may be in place. Additionally, with a latency-based FA sessions terminate following the first occurrence of elopement; therefore, participants are not repeatedly exposed to session contingencies which may result in poor discrimination across conditions. Future research might examine the conditions under which an omnibus control condition (i.e., all social variables) or a condition-specific control condition are appropriate in FAs.

Results from our isolated and synthesized contingency FAs were similar to Retzlaff et al. (2020) suggesting an iatrogenic effect. That is, by combining a functional reinforcer with a nonfunctional, but highly preferred stimulus a novel function may be induced. Specifically, Owen did not engage in elopement in the initial isolated escape FA; however, following differentiated responding in the synthesized escape and attention FA, Owen engaged in short latencies to elopement in subsequent isolated escape FAs. Specifically, Owen's results suggested the addition of the nonfunctional, but preferred consequence (i.e., escape) to the pre-existing contingency of attention which was shown to maintain short latencies to elopement ensured elopement came in to frequent contact with the new, nonfunctional, but preferred stimulus of escape from demands. The multiple response-reinforcer contact created by synthesized contingencies increased the likelihood a new function of isolated escape would be induced (Retzlaff et al., 2020). These results support the notion that synthesized contingencies may be more susceptible to iatrogenic effects when an isolated contingency maintains the target behavior and the analysis exposes that target behavior to one or more additional putative reinforcement contingencies (i.e., synthesized contingency; Retzlaff et al., 2020; Rooker et al., 2011; Shirley et al., 1999; Tiger & Effertz, 2020). Although Owen's data suggest an iatrogenic effect occurred, there is a limitation with his FA. That is, we did not replicate Owen's isolated FAs prior to the synthesized FA, thus we cannot determine whether a history of the synthesized escape and tangible contingency influenced the occurrence of elopement in the subsequent isolated escape FAs. This limitation resulted in changing our methodology to include a reversal design to replicate the effects of isolated contingencies prior to conducting the synthesized contingency FA for the remaining participants when relevant. However, given that three of our four participants showed differentiated responding in all isolated FAs prior to the synthesized FA, the possibility of an iatrogenic effect could not be assessed. Future research is needed on the notion of iatrogenic effects in synthesized FAs. Additionally, future research might examine the degree to which iatrogenic effects occur in isolated FAs. For example, it is possible prolonged exposure to isolated contingencies result in an iatrogenic effect (e.g., tangible).

We conducted within-session analyses for Riley and Madeline's FAs to examine the degree to which results suggested the importance of synthesized contingencies (e.g., Call & Lomas Mevers, 2014; Roane et al., 1999). That is, if precursor behavior or target problem behavior persisted in the EO-off periods of isolated contingency FAs but ceased in the EO-off periods of synthesized contingency FAs, it would suggest the combination of the two isolated contingencies (i.e., synthesis) was maintaining precursor behavior or target problem behavior. Within-session analysis results for Riley and Madeline showed precursor behavior or target problem behavior occurred exclusively during the EO-on period of the initial isolated and synthesized FAs. However, following exposure to the synthesized contingency Madeline's within-session analysis results showed target behavior occurred during the EO-on and EO-off periods of the subsequent isolated tangible and isolated diverted-attention FAs. These data suggest following exposure to the synthesized contingency, access to preferred tangibles in isolation or the delivery of preferred attention in isolation no longer resulted in target behavior ceasing which provide additional support for the notion of an iatrogenic effect. That is, prior to the synthesized tangible and diverted-attention FA, only an isolated EO was present for the tangible and diverted-attention contingencies. Specifically, target behavior ceased when isolated tangibles or isolated attention was provided. However, following the synthesized tangible and diverted-attention FA, target behavior no longer ceased when tangibles or diverted attention was provided in isolation. Although Madeline's results are clear, we were only able to conduct within-session analyses for two of our four participants given the topography of target problem behavior and FA methodology used. Future research might continue to examine the degree to which within-session analysis results suggest the importance of synthesized contingencies and the possibility of iatrogenic effects.

Results of our FCT+EXT evaluation in Study 2 also support the notion that synthesis was not necessary for three of the four participants for which differentiated responding was observed in the synthesized contingency. That is, Riley's synthesized FCT+EXT was effective for all isolated contingencies. Madeline's synthesized FCT+EXT was similarly effective as her diverted-attention FCT+EXT. Emmett's synthesized FCT+EXT was only effective in the isolated attention and isolated tangible test sessions and not in the isolated escape test sessions. Owen's synthesized FCT+EXT was only effective in synthesized FCT+EXT and not in the escape FCT+EXT or attention FCT+EXT. Given the differing results of the current study and that only a few studies have compared interventions based on isolated contingencies to those based on synthesized contingencies, additional evaluations are necessary and would add to the current literature.

Our intervention analysis also replicated and extended Tsami and Lerman (2019) by examining the extent to which synthesized intervention effects generalize to situations with isolated establishing operations, discriminative stimuli, and consequences. For three of our four participants, results showed synthesized FCRs did not generalize to all isolated variables. That is, for Riley, following the synthesized FCT+EXT condition, she continued to emit synthesized

FCRs in the isolated tangible and isolated escape sessions suggesting the FCR did generalize. For Madeline, following the synthesized FCT+EXT condition, she continued to emit synthesized FCRs in the isolated tangible sessions and target behavior decreased suggesting the synthesized FCR generalized to the isolated tangible contingency. However, Madeline did not emit synthesized FCRs in the isolated diverted-attention sessions and target behavior reemerged suggesting the synthesized FCR did not generalize to the isolated diverted-attention contingency. Furthermore, we only saw intervention effects for the isolated diverted-attention contingency when an isolated diverted-attention FCR was taught in the diverted-attention FCT+EXT condition. For Emmett, following the synthesized FCT+EXT condition, he continued to emit synthesized FCRs to get access to preferred tangibles, escape from demands, and preferred attention in the isolated test phase; however, he also engaged in short latencies and high rates of elopement in the isolated escape sessions. Furthermore, we only saw intervention effects for the isolated escape contingency when we provided access to preferred tangibles and preferred attention contingent on the isolated tangible and isolated attention FCRs during the escape from demand period in the isolated escape session. For Owen, following the synthesized FCT+EXT condition, he continued to emit synthesized FCRs to get access to escape from demands and preferred attention in the isolated test phase; however, he also engaged in short latencies to and high rates of elopement in the isolated escape and isolated attention sessions. Furthermore, we only saw intervention effects for the isolated escape and isolated attention contingencies when we provided access to preferred attention contingent on the synthesized FCR or the isolated attention FCR and when we provided access to preferred attention contingent on the isolated attention FCR during the escape from demand period in the isolated escape sessions. These data suggest synthesizing contingencies during FCT+EXT might establish restricted stimulus control leading to a decrease in alternative communication responses and an increase in target behavior when isolated contingencies are presented (Tsami & Lerman, 2019).

We conducted within-session analyses for all participants intervention evaluation to examine the degree to which results suggested the importance of synthesized contingencies (e.g., Call & Lomas Mevers, 2014; Roane et al., 1999). That is, if precursor behavior or target problem behavior persisted in the EO-off periods of isolated contingency intervention but ceased in the EO-off periods of synthesized contingency intervention, it would suggest the combination of the two isolated contingencies (i.e., synthesis) was maintaining precursor behavior and/or target problem behavior. Within-session analysis results for Riley showed tantrum behavior occurred exclusively during the EO-on periods of all conditions suggesting a synthesized contingency was not necessary for Riley. Within-session analysis results for Madeline showed target behavior occurred primarily during the EO-on periods of the synthesized FCT+EXT. However, in the isolated test tangible and diverted-attention sessions, target behavior occurred exclusively during the EO-on period of diverted-attention sessions and exclusively during the EO-off period of tangible sessions suggesting an isolated diverted-attention FCR be taught or that synthesis is necessary. Within-session analysis results for Emmett showed elopement occurred during the EO-on and EO-off periods of the escape and tangible FCT+EXT conditions. However, following exposure to synthesized FCT+EXT, Emmett's within-session analysis results showed elopement occurred during primarily during the EO-off periods of the isolated test escape and tangible sessions suggesting access to escape from demands or preferred tangibles in isolation does not terminate elopement. Owen showed elopement occurred during the EO-on and EO-off periods of the escape and attention FCT+EXT conditions. However, following exposure to synthesized FCT+EXT, Owen's within-session analysis results showed elopement occurred during primarily the EO-off periods of the isolated test escape and attention sessions suggesting synthesis was necessary to produce intervention effects.

Although the results of our study are clear, there are some limitations worth mentioning. One limitation is that due to COVID-19, the University paused all in-person research delaying the start of the study therefore, we have only included a small number of participants in the current study. Furthermore, the second limitation of the current study is that Owen was our initial and pilot participant, therefore his FA and intervention procedures were different from the other participants making it difficult to compare his results and make assumptions regarding his data. Finally, we did not conduct a social validity assessment for our FA or intervention procedures. That is, it would be interesting to examine caregiver and stakeholder perspectives regarding the utility, practicality, and preferred methodology (i.e., isolated or synthesized) for FAs and interventions.

In summary, results of the current study suggest that although responding was differentiated in synthesized FAs for all four participants, synthesized contingencies were not necessary to show functional relations between target behavior and environmental events for three of the four participants and potentially the fourth (Owen); however, for Owen, his data suggest that elopement is either only maintained by isolated attention, maintained by synthesized escape and attention, or likely to happen in isolated escape contexts because they are discriminative for access to attention. Additionally, it is possible exposure to synthesized contingencies may induce a new function. Furthermore, synthesized FCT+EXT effects did not generalize to isolated contingencies for four out of the nine isolated maintaining variables across two participants. Thus, future research is needed to determine the conditions under which synthesized FAs and interventions may be most useful.

References

Ala'i-Rosales, S., Cihon, J. H., Currier, T. D. R., Ferguson, J. L., Leaf, J. B., Leaf, R., McEachin, J., & Weinkauf, S. M. (2019). The big four: Functional assessment research informs preventative behavior analysis. *Behavior Analysis in Practice, 12*(1), 222–234. https://doi.org/10.1007/s40617-018-00291-9

Asmus, J. M., Franzese, J. C., Conroy, M. A., & Dozier, C. L. (2013). Clarifying functional analysis outcomes for disruptive behaviors by controlling consequence delivery for stereotypy. *School Psychology Review, 32*(4), 624-630. https://doi.org/10.1080/02796015.2003.12086225

Austin, J. L., Groves, E. A., Reynish, L. C., & Francis, L. L. (2015). Validating trial-based functional analyses in mainstream primary school classrooms. *Journal of Applied Behavior Analysis, 48*(2), 274-288. https://doi.org/10.1002/jaba.208

Axelrod, S. (1987). Functional and structural analyses of behavior: Approaches leading to reduced use of punishment procedures? *Research in Developmental Disabilities, 8*(2), 165–178. https://doi.org/10.1016/0891-4222(87)90001-1

Banda, D. R., McAfee, J. K., & Hart, S. L. (2009). Decreasing self-injurious behavior in a student with autism and tourette syndrome through positive attention and extinction. *Child & Family Behavior Therapy, 31*(2), 144-156. https://doi.org/10.1080/07317100902910602

Beavers, G. A., & Iwata, B. A. (2011). Prevalence of multiply controlled problem behavior. *Journal of Applied Behavior Analysis, 44*(3). https://doi.org/10.1901/jaba.2011.44-593

Beavers, G. A., Iwata, B. A., & Lerman, D. C. (2013). Thirty years of research on the functional analysis of problem behavior. *Journal of Applied Behavior Analysis, 46*(1), 1-21. https://doi.org/10.1002/jaba.30

Benson, S. S., Dimian, A. F., Elmquist, M., Simacek, J., McComas, J. J., & Symons, F. J. (2018). Coaching parents to assess and treat self□injurious behaviour via telehealth. *Journal of Intellectual Disability Research, 62*(12), 1114–1123. https://doi.org/10.1111/jir.12456

Betz, A. M., & Fisher, W. W. (2011). Functional analysis: History and methods. In W. W. Fisher, C. C. Piazza, & H. S Roane (Eds.), *Handbook of Applied Behavior Analysis*. New York, NY: The Gulford Press.

Bloom, S. E., Iwata, B. A., Fritz, J. N., Roscoe, E. M., & Carreau, A. B. (2011). Classroom application of a trial-based functional analysis. *Journal of Applied Behavior Analysis, 44*(1), 19-31. https://doi.org/10.1901/jaba.2001.44-19

Borrero, C. S., & Borrero, J. C. (2008). Descriptive and experimental analyses of potential precursors to problem behavior. *Journal of Applied Behavior Analysis, 41*(1), 83-96. https://doi.org/10.1901/jaba.2008.41-83

Borrero, J. C., Vollmer, T. R., Wright, C. S., Lerman, D. C., & Kelley, M. E. (2002). Further evaluation of the role of protective equipment in the functional analysis of self-injurious behavior. *Journal of Applied Behavior Analysis, 35*(1), 69-72. https://doi.org/10.1901/jaba.2002.35-69

Boyle, M. A., Bacon, M. T., Brewer, E. M., Carton, S. M., Gaskill, L. A. (2020). Evaluating a treatment without extinction for elopement maintained by access to stereotypy. *Journal of Applied Behavior Analysis, 53*(3), 1531-1541. https://doi.org/10.1002/jaba.682

Boyle, M. A., Stamper, S. M., Donaldson, E. A., Curtis, K. S., Forck, K. L., Shrimplin, M. A., Barsness, A. C., & Oller, C. (2019). Functional communication training for multiple reinforcers: An evaluation of isolated control following a synthesized context. *Behavior Analysis in Practice, 12*(3), 592–599. https://doi.org/10.1007/s40617-018-00320-7

Call, N. A., Reavis, A. R., Clark, S. B., Parks, N. A., Cariveau, T., Muething, C. S. (2017). The effects of conducting a functional analysis on problem behavior in other settings: A descriptive study on potential interaction effects. *Behavior Modification, 41*(5), 609-625. https://doi.org/10.1177/0145445517696052

Call, N. A., & Lomas Mevers, J. E. (2014). The relative influence of motivating operations for positive and negative reinforcement on problem behavior during demands. *Behavioral Interventions, 29*(1), 4-20. https://doi.org/10.1002/bin.1374

Call, N. A., Wacker, D. P., Ringdahl, J. E., & Boelter, E. W. (2005). Combined antecedent variables as motivation operations within functional analyses. *Journal of Applied Behavior Analysis, 38*(3), 385-389. https://doi.org/10.1901/jaba.2005.51-04

Carr, E. G., & Durand, V. M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis, 18*(2), 111–126. https://doi.org/10.1901/jaba.1985.18-111

Cihak, D., Alberto, P. A., & Fredrik, L. D. (2007). Use of brief functional analysis and intervention in public settings. *Journal of Positive Behavior Interventions, 9*(2), 80-93. https://doi.org/10.1177/10983007070090020501

Coffey, A. L., Shawler, L. A., Jessel, J., Nye, M. L., Bain, T. A., & Dorsey, M. F. (2020). Interview-informed synthesized contingency analysis (IISCA): Novel interpretations and future directions. *Behavior Analysis in Practice*, *13*(1), 217–225. https://doi.org/10.1007/s40617-019-00348-3

Conners, J., Iwata, B. A., Kahng, S. W., Hanley, G. P, Worsdell, A. S., & Thompson, R. H. (2000). Differential responding in the presence and absence of discriminative stimuli during multielement functional analyses. *Journal of Applied Behavior Analysis, 33*(3), 299-308. https://doi.org/10.1901/jaba.2000.33-299

Deochand, N., Eldridge, R. R., & Peterson, S. M. (2020). Toward the development of a functional analysis risk assessment decision tool. *Behavior Analysis in Practice, 13*(4), 978–990. https://doi.org/10.1007/s40617-020-00433-y

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northrup, J., Cigrand, K., & Asmus, J. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis, 25*(3), 713-721. https://doi.org/10.1901/jaba.1992.25-713

Desrochers, M. N., Hile, M. G., & Williams-Mosely, T. L. (1997). Survey of functional assessment procedures used with individuals who display mental retardation and severe problem behaviors. *American Journal on Mental Retardation, 101*(5), 535-546.

Dozier, C. L., Iwata, B. A., Wilson, D. M., Thomason-Sassi, J. L., & Roscoe, E. M. (2013). Does supplementary reinforcement of stereotypy facilitate extinction? *Journal of Applied Behavior Analysis, 46*(1), 242–255. https://doi.org/10.1002/jaba.15

Dracobly, J., Dozier, C., Briggs, A., & Juanico, J. (2018). Reliability and validity of indirect assessment outcomes: Experts versus caregivers. *Learning and Motivation*, *62*, 77-90. https://doi.org/10.1016/j.lmot.2017.02.007

Durand, V. M., & Crimmins, D. B. (1988). Identifying the variables maintaining self-injurious behavior. *Journal of Autism and Developmental Disorders, 18*(1), 99-117. https://doi.org/10.1007/BF02211821

Dwyer□Moore, K.J., & Dixon, M.R. (2007). Functional analysis and treatment of problem behavior of elderly adults in long-term care. *Journal of Applied Behavior Analysis, 40*(4), 679-683. https://doi.org/10.1901/jaba.2007.679-683

Ellingson, S. A., Miltenberger, R. G., & Long, E. S. (1999). A survey of the use of functional assessment procedures in agencies serving individuals with developmental disabilities. *Behavioral Interventions, 14*(4), 187-198. https://doi.org/10.1002/(SICI)1099-078X(199910/12)14:4<187::AID-BIN38>3.0.CO;2-A

Fahmie, T. A., Iwata, B. A., Harper, J. M., & Querim, A. C. (2013a). Evaluation of the divided attention condition during functional analyses. *Journal of Applied Behavior Analysis, 46*(1)*,*71-78. https://doi.org/10.1002/jaba.20

Fahmie, T. A., Iwata, B. A., Querim, A. C., & Harper, J. M. (2013b). Test-specific control conditions for functional analyses. *Journal of Applied Behavior Analysis, 46*(1), 61-70. https://doi.org/10.1002/jaba.9

Falcomata, T. S., Roane, H. S., Hovanetz, A. N., Kettering, T. L., & Keeney, K. M. (2004). An evaluation of response cost in the treatment of inappropriate vocalizations maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 37*(1), 83-87. https://doi.org/10.1901/jaba.2004.37-83

Ferguson, J. L., Leaf, J. A., Cihon, J. H., Milne, C. M., Leaf, J. B., McEachin J., Leaf, R. (2020). Practical functional assessment: A case study replication and extension with a child diagnosed with autism spectrum disorder. *Education and Treatment of Children.* https://doi.org/10.1007/s43494-020-00015-1

Fischer, S. M., Iwata, B. A., & Worsdell, A. S. (1997). Attention as an establishing operation and as reinforcement during functional analyses. *Journal of Applied Behavior Analysis, 30*(2), 335-338. https://doi.org/10.1901/jaba.1997.30-335

Fisher, W.W., Greer, B. D., Fuhrman, A. M., Saini, V., & Simmons, C. A. (2018). Minimizing resurgence of destructive behavior using behavioral momentum theory. *Journal of Applied Behavior Analysis, 51*(4), 831-853. https://doi.org/10.1002/jaba.499

Fisher, W. W., Greer, B. D., Romani, P. W., Zangrillo, A. N., & Owen, T. M. (2016). Comparison of synthesized and individual reinforcement contingencies during functional analysis. *Journal of Applied Behavior Analysis, 49*(3), 596-616. https://doi.org/10.1002/jaba.314

Fisher, W., & Iwata, B. (1996). On the function of self-restraint and its relationship to self-injury. *Journal of Applied Behavior Analysis, 29*(1), 93–98. https://10.1901/jaba.1996.29-93

Fisher, W. W., Rodriguez, N. M., Luczynski, K. C., & Kelley, M. E. (2013). The use of protective equipment in the management of severe behavior disorders. In D. D. Reed, F. D. DiGennaro Reed, & J. K. Luiselli (Eds.), *Handbook of crisis intervention for individuals with developmental disabilities* (pp. 87-105). New York: Springer.

Freeman, K. A., Anderson, C. M., & Scotti, J. R. (2000). A structured descriptive methodology: Increasing agreement between descriptive and experimental analyses. *Education and Training in Mental Retardation and Developmental Disabilities, 35*(1), 55-66. http://www.jstor.org/stable/23879707

Fritz, J. N., Iwata, B. A., Hammond, J. L., & Bloom, S. E. (2013). Experimental analysis of precursors to severe problem behavior. *Journal of Applied Behavior Analysis, 46*(1), 101-129. https://doi.org/10.1002/jaba.27

Fryling, M. J., & Baires, N. A. (2016). The practical importance of the distinction between open and close-ended indirect assessments. *Behavior Analysis in Practice, 9*, 146-151. https://doi.org/10.1007/s40617-016-0115-2

Gerow, S., Radhakrishnan, S., Davis, T.N., Zambrano, J., Avery, S., Cosottile, D.W., & Exline, E. (2021). Parent□implemented brief functional analysis and treatment with coaching via telehealth. *Journal of Applied Behavior Analysis, 54*(1), 54-69. https://doi.org/10.1002/jaba.801

Greer, B. D., Mitteer, D. R., Briggs, A. M., Fisher, W. W., & Sodawasser, A. J. (2020). Comparisons of standardized and interview-informed synthesized reinforcement contingencies relative to functional analysis. *Journal of Applied Behavior Analysis, 53*(1), 82–101. https://doi.org/10.1002/jaba.601

Hagopian, L. P., Bruzek, J. L., Bowman, L. G., & Jennett, H. K. (2007). Assessment and treatment of problem behavior occasioned by interruption of free-operant behavior. *Journal of Applied Behavior Analysis, 40*(1), 89-103. https://doi.org/10.1901/jaba.2007.63-05

Hagopian, L. P., Contrucci Kuhn, S. A., Long, E. S., & Rush, K. S. (2005). Schedule thinning following communication training: Using competing stimuli to enhance tolerance to decrements in reinforcer density. *Journal of Applied Behavior Analysis, 38*(2), 177-193. https://doi.org/10.1901/jaba.2005.43-04

Hagopian, L. P., Dozier, C. L., Rooker, G., & Jones, B. A. (2013). Assessing and treating severe problem behavior. In G. J. Madden (Ed.), *APA handbook of behavior analysis* (pp. 353 -386). Washington, DC: APA.

Hall, S. S., Hustyi, K. M., Chui, C., Hammond, J. L. (2014). Experimental functional analysis of severe skin-picking behavior in Prader–Willi syndrome. *Research in Developmental Disabilities, 35*(10), 2284-2292. https://doi.org/10.1016/j.ridd.2014.05.025

Hammond, J. L., Iwata, B. A., Rooker, G. W., Fritz, J. N., & Bloom, S. E. (2013). Effects of fixed versus random condition sequencing during multielement functional analyses. *Journal of Applied Behavior Analysis, 46*(1), 22-30. https://doi.org/10.1002/jaba.7

Hanley, G. P. (2012). Functional assessment of problem behavior: Dispelling myths, overcoming implementation obstacles, and developing new lore. *Behavior Analysis in Practice, 5*(1), 54-72. https://doi.org/10.1007/BF03391818

Hanley, G. & Gover, H. (n.d.) *Practical functional assessment: Understanding problem behavior prior to its treatment*. Practical Functional Assessment. https://practicalfunctionalassessment.com/

Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003). Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis, 36*(2), 147-185. https://doi.org/10.1901/jaba.2003.36-147

Hanley, G. P., Jin, C. S., Vanselow, N. R., & Hanratty, L. A. (2014). Producing meaningful improvements in problem behavior of children with autism via synthesized analyses and treatments. *Journal of Applied Behavior Analysis, 47*(1), 16-36. https://doi.org/10.1002/jaba.106

Hersovitch, B., Roscoe, E. M., Libby, M. E., Bourret, J. C., & Ahearn, W. H. (2009). A procedure for identifying precursors to problem behavior. *Journal of Applied Behavior Analysis, 42*(3), 697-702. https://doi.org/10.1091/jaba.2009.42-697

Higgins Hains, A., & Baer, D. M. (1989). Interaction effects in multielement designs: Inevitable, desirable, and ignorable. *Journal of Applied Behavior Analysis, 22*(1), 57-69. https://doi.org/10.1901/jaba.1989.22-57

Holehan, K. M., Dozier, C. L., Diaz de Villegas, S. C., Jess, R. L., Goddard, K. S., & Foley, B. A. (2020). A comparison of isolated and synthesized contingencies in functional analyses. *Journal of Applied Behavior Analysis, 53*(3), 1559-1578. https://doi.org/10.1002/jaba.700

Iwata, B. A., DeLeon, I. G., & Roscoe, E. M. (2013). Reliability and validity of the functional analysis screening tool. *Journal of Applied Behavior Analysis, 46*(1), 271-284. https://doi.org/10.1002/jaba.31

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1982/1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27*(2), 197-209. https://doi.org/10.1901/jaba.1994.27-197

Iwata, B. A., & Dozier, C. L. (2008). Clinical application of functional analysis methodology. *Behavior Analysis in Practice, 1*(1), 3–9. https://doi.org/10.1007/BF03391714

Iwata, B. A., Duncan, B. A., Zarcone, J. R., Lerman, D. C., & Shore, B. A. (1994). A sequential, test-control methodology for conducting functional analyses of self-injurious behavior. *Behavior Modification, 18*(3), 289-306. https://doi.org/10.1177/01454455940183003

Iwata, B. A., Pace, G. M., Kalsher, M. J., Cowdery, G. E., & Cataldo, M. F. (1990). Experimental analysis and extinction of self-injurious escape behavior. *Journal of Applied Behavior Analysis, 23*(1), 11-27. https://doi.org/10.1901/jaba.1990.23-11

Jessel, J., Hanley, G. P., & Ghaemmaghami, M. (2016). Interview-informed synthesized contingency analyses: Thirty replications and reanalysis. *Journal of Applied Behavior Analysis, 49*(3), 576–595. https://doi.org/10.1002/jaba.316

Jessel, J., Ingvarsson, E. T., Metras, R., Whipple, R., Kirk, H., & Solsbery, L. (2018). Treatment of elopement following a latency-based interview-informed, synthesized contingency analysis. *Behavioral Interventions, 33*(3), 271-283. https://doi.org/10.1002/bin.1525

Jessel, J., Metras, R., Hanley, G. P., Jessel, C., & Ingvarsson, E. T. (2020). Evaluating the boundaries of analytic efficiency and control: A consecutive controlled case series of 26 functional analyses. *Journal of Applied Behavior of Analysis, 53*(1), 25-43. https://doi.org/10.1002/jaba.544

Kahng, S. W., Hausman, N. L., Fisher, A. B., Donaldson, J. M., Cox, J. R., Lugo, M., Wiskow, K. M. (2015). The safety of functional analyses of self-injurious behavior. *The Journal of Applied Behavior Analysis, 48*(1), 107-114. https://doi.org/10.1002/jaba.168

Kahng, S. W., & Iwata, B. A. (1999). Correspondence between outcomes of brief and extended functional analyses. *Journal of Applied Behavior Analysis, 32*(2), 149-159. https://doi.org/10.1901/jaba.1999.32-149

Kahng, S., Iwata, B. A., & Lewin, A. B. (2002). Behavioral treatment of self-injury, 1964-2000. *American Journal on Mental Retardation, 107*(3), 212-221. https://doi.org/10.1352/0895-8017(2002)107<0212:BTOSIT>2.0.CO;2

Kamlowsky, M. E., Wilder, D. A., Ertel, H., Hodges, A. C., Colon, N., & Domino, L. (2021). Latency-based functional analysis and treatment of elopement. *Behavioral Interventions, 36*(2), 1-13. https://doi.org/10.1002/bin.1781

Kelley, M. E., LaRue, R. H., Roane, H. S., & Gadaire, D. M. (2011). Indirect behavioral assessments: Interviews and rating scales. In W. W. Fisher, C. C. Piazza, & H. S., Roane (Eds.), *Handbook of Applied Behavior Analysis* (pp. 182-190). New York, NY: Guilford Press.

Kodak, T., Fisher, W. W., Paden, A., & Dickes, N. (2013). Evaluation of the utility of a discrete-trial functional analysis in early intervention classrooms. *Journal of Applied Behavior Analysis, 46*(1), 301-306. https://doi.org/10.1002/jaba.2

Kodak, T., Miltenberger, R. G., & Romaniuk, C. (2003). A comparison of differential reinforcement and noncontingent reinforcement for the treatment of a child's multiply controlled problem behavior. *Behavioral Interventions, 18*(4), 267-278. https://doi.org/10.1002/bin.143

Kodak, T., Northup, J., & Kelley, M. E. (2007). An evaluation of the types of attention that maintain problem behavior. *Journal of Applied Behavior Analysis, 40*(1), 167-171. https://doi.org/10.1901/jaba.2007.43-06

Lalli, J. S., Mace, F. C., Wohn, T., & Livezey, K. (1995). Identification and modification of a response-class hierarchy. *Journal of Applied Behavior Analysis, 28*(4), 551-559. https://doi.org/10.1901/jaba.1995.28-551

Lambert, J. M., Parikh, N., Stankiewicz, K. C., Juarez-Houchins, N. J., Sweeney, E. M., & Milam, M. E. (2019). Decreasing food stealing of child with Prader-Willi syndrome through function-based differential reinforcement. *Journal of Autism and Developmental Disorders, 49*, 721-728. https://doi.org/10.1007/s10803-018-3747-y

Lang, R., Harmon, T., Mclay, L., Phinney, A., Ledbetter-Cho, K., Lubarsky, A., Erhard, P., Strong, K., Detar, W., Rispoli, M. (2020). Characteristics and Assessment of Pica in

Individuals with Intellectual Disability. In: Matson J. (eds) Handbook of Dual Diagnosis. Autism and Child Psychopathology Series. Springer, Cham. https://doi.org/10.1007/978-3-030-46835-4_26

Le, D. D., & Smith, R. G. (2002). Functional analysis of self-injury with and without protective equipment. *Journal of Developmental and Physical Disabilities, 14*(3), 277-290. https://doi.org/10.1023/A:1016028522569

Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. *Journal of Applied Behavior Analysis, 24*(3), 553–562. https://doi.org/10.1901/jaba.1991.24-553

Marcus, B. A., Vollmer, T. R., Swanson, V., Roane, H. R., & Ringdahl, J. E. (2001). An experimental analysis of aggression. *Behavior Modification, 25*(2), 189-213. https://doi.org/10.1177/0145445501252002

Matson, J. L., & Vollmer, T. R. (1995). User's guide: Questions about behavioral function (QABF). Baton Rouge, LA: Scientific Publishers.

Mueller, M. M., & Nkosi, A., & Hine, J. F., (2011). Functional Analyses in Public Schools: A Summary of 90 Functional Analyses. *Journal of Applied Behavior Analysis, 44*(4), 807 818. https://doi.org/10.1901/jaba.2011.44-807

Najdowski, A. C., Wallace, M. D., Ellsworth, C. L., MacAleese, A. N., & Cleveland, J. M. (2008). Functional analyses and treatment of precursor behavior. *Journal of Applied Behavior Analysis, 41*(1), 97-105. https://doi.org/10.1901/jaba.2008.41-97

Neidert, P. L., Dozier, C. L., Iwata, B. A., & Hafen, M. (2010). Behavior analysis in intellectual disabilities. *Psychological Services, 7*(2), 103-113. https://doi.org/10.1037/a0018791

Neidert, P. L., Iwata, B. A., Dempsey, C. M., & Thomason-Sassi, J. L. (2013a). Latency of response during the functional analysis of elopement. *Journal of Applied Behavior Analysis, 46*(1), 312-316. https://doi.org/10.1002/jaba.11

Neidert, P. L., Rooker, G. W., Bayles, M. & Miller, J. (2013b). Functional analysis of problem behavior. In D. D. Reed, F. D. DiGennaro Reed, & J. K. Luiselli (Eds.), *Handbook of crisis intervention for individuals with developmental disabilities* (pp. 147-168). New York: Springer. https://10.1007/978-1-4614-6531-7_9

Neil, N., & Jones, E. A. (2015). Studying treatment intensity: Lessons from two preliminary studies. *Journal of Behavioral Education, 24*, 51-73. https://doi.org/10.1007/s10864-014-9208-6

Newcomb, E. T., Wright, A., & Camblin, J. G. (2019). Assessment and treatment of aggressive behavior maintained by access to physical attention. *Behavior Analysis: Research and Practice, 19*(3), 222-231. https://doi.org/10.1037/bar0000136

Northup, J., Wacker, D., Sasso, G., Steege, M., Cigrand, K., Cook, J., & DeRaad, A. (1991). A brief functional analysis of aggression and alternative behavior in an outclinic setting. *Journal of Applied Behavior Analysis, 24*(3), 509-522. https://doi.org/10.1901/jaba.1991.24-509

Oliver, A. C., Pratt, L. A., & Normand, M. P. (2015). A survey of functional behavior assessment methods used by behavior analysts in practice. *Journal of Applied Behavior Analysis, 48*(4), 817-829. https://doi.org/10.1002/jaba.256

Payne, S. W., & Dozier, C. L. (2013). Positive reinforcement as treatment for problem behavior maintained by negative reinforcement. *Journal of Applied Behavior Analysis, 46*(3), 699-703. https://doi.org/10.1002/jaba.54

Payne, S. W., Dozier, C. L., Neidert, P. L., Jowett, E. S., & Newquist, M. H. (2014). Using additional analyses to clarify the function of problem behavior: An analysis of two cases. *Education and Treatment of Children, 37*(2), 249-275. https://doi.org/10.1353/etc.2014.0017

Perrin, C. J., Perrin, S. H., Hill, E. A., & DiNovi, K. (2008). Brief functional analysis and treatment of elopement in preschoolers with autism. *Behavioral Interventions, 23*(2), 87-95. https://doi.org/10.1002/bin.256

Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H. L., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 33*(1), 13-27. https://doi.org/10.1901/jaba.2000.33-13

Piazza, C. C., Hanley, G. P., Bowman, L.G., Ruyter, J. M., Lindauer, S. E., & Saiontz, D. M. (1997). Functional analysis and treatment of elopement. *Journal of Applied Behavior Analysis, 30*(4), 653-672. https://doi.org/10.1901/jaba.1997.30-653

Piazza, C. C., Patel, M. R., Gulotta, C. S., Sevin, B. M., Layer, S. A. (2003). On the relative contributions of positive reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis, 36*(3), 309-324. https://doi.org0.1901/jaba.2003.36-309

Querim, A. C., Iwata, B. A., Roscoe, E. M., Schlichenmeyer, K. J., Ortega, J. V., & Hurl, K. E. (2013). Functional analysis screening for problem behavior maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 46*(1), 47-60. https://doi.org/10.1002/jaba.26

Rapp, J. T., Miltenberger, R. G., Galensky, T. L., Ellingson, S. A., & Long, E. S. (1999). A functional analysis of hair pulling. *Journal of Applied Behavior Analysis, 32*(3), 329-337. https://doi.org/10.1901/jaba.1999.32-329

Rapp, J. T., & Vollmer, T. R. (2005). Stereotypy I: A review of behavioral assessment and treatment. *Research in Developmental Disabilities, 26*(6), 527-547. https://doi.org/10.1016/j.ridd.2004.11.005

Reed, D. D., Luiselli, J. K., Miller, J. R., & Kaplan, B. A. (2013). Therapeutic restraint and protective holding. In D. D. Reed, F. D. DiGennaro Reed, & J. K. Luiselli (Eds.), *Handbook of crisis intervention for individuals with developmental disabilities* (pp. 107-120). New York: Springer.

Retzlaff, B. J., Fisher, W. W., Akers, J. S., & Greer, B. D. (2020). A translational evaluation of potential iatrogenic effects of single and combined contingencies during functional analysis. *Journal of Applied Behavior Analysis, 53*(1), 67-81. https://doi.org/10.1002/jaba.595

Reynolds, R. S. (1961). An analysis of interactions in a multiple schedule. *Journal of Applied Behavior Analysis, 4*(2), 107-117. https://doi.org/10.1901/jeab.1961.4-107

Rispoli, M. J., Davis, H. S., Goodwyn, F. D., & Camargo, S. (2013). The use of trial-based functional analysis in public school classrooms for two students with developmental disabilities. *Journal of Positive Behavior Interventions, 15*(3), 180-189. https://doi.org/10.1177/1098300712457420

Roane, H. S., Lerman, D. C., Kelley, M. E., & VanCamp, C. M. (1999). Within-session patterns of responding during functional analyses: The role of establishing operations in clarifying behavioral function. *Research in Developmental Disabilities, 20*(1), 73-89. https://doi.org/https://doi.org/10.1016/S0891-4222(98)00033-X

Rooker, G. W., Iwata, B. A., Harper, J. M., Fahmie, T. A., & Camp, E. M. (2011). False-positive tangible outcomes of functional analyses. *Journal of Applied Behavior Analysis, 44*(4), 737–745. http://doi.org10.1901/jaba.2011.44-737

Rooker, G. W., Jessel, J., Kurtz, P. F., & Hagopian, L. P. (2013). Functional communication training with and without alternative reinforcement and punishment: An analysis of 58 applications. *Journal of Applied Behavior Analysis, 46*(4), 708–722. https://doi.org/10.1002/jaba.76

Roscoe, E. M., Iwata, B. A., & Zhou, L. (2013). Assessment and treatment of chronic hand mouthing. *Journal of Applied Behavior Analysis*, *46*(1), 181-198. https://doi.org/10.1002/jaba.14

Roscoe, E. M., Phillips, K. M., Kelly, M. A., Farber, R., & Dube, W. V. (2015). A statewide survey assessing practitioners' use and perceived utility of functional assessment. *Journal of Applied Behavior Analysis, 48*(4), 830-844. https://doi.org/10.1002/jaba.259

Rose, J. C., & Beaulieu, L. (2019). Assessing the generality and durability of interview-informed functional analyses and treatment. *Journal of Applied Behavior Analysis, 52*(1), 271-285. https://doi.org/10.1002/jaba.504

Saini, V., Fisher, W. W., Retzlaff, B. J., & Keevy, M. (2020). Efficiency in functional analysis of problem behavior: A qualitative review. *Journal of Applied Behavior Analysis, 53*(1), 44-66. https://doi.org/10.1002/jaba.583

Santiago, J. L., Hanley, G. P., Moore, K., & Jin, C. S. (2016). The generality of interview-informed functional analyses: Systematic replications in school and home. *Journal of Autism and Developmental Disorders, 46*(3), 797-811. https://doi.org/10.1007/s10803-015-2617-0

Schlichenmeyer, K. J., Roscoe, E. M., Rooker, G. W., Wheeler, E. E., & Dube, W. V. (2013). Idiosyncratic variables that affect functional analysis outcomes: A review (2001-2010). *Journal of Applied Behavior Analysis, 46*(1), 339-348. https://doi.org/10.1002/jaba.12

Scott, T. M., Liaupsin, C., Nelson, M., & McIntyre, J. (2005). Team-based functional behavior assessment as a proactive public school process: A descriptive analysis of current barriers. *Journal of Behavioral Education, 14*(1), 57-71. https://doi.org/10.1007/s10864-005-0961-4

Scotti, J. R., Schulman, D. E., & Hojnacki, R. M. (1994). Functional analysis and unsuccessful treatment of Tourette's syndrome in a man with profound mental retardation. *Behavior Therapy, 25*(4), 721-738. https://doi.org/10.1016/S0005-7894(05)80206-0

Shabani, D. B., Carr, J. E., & Petursdottir, A. I. (2009). A laboratory model for studying response-class hierarchies. *Journal of Applied Behavior Analysis, 42*(1), 105-121. https://doi.org/10.1901/jaba.2009.42-105

Shirley, M. J., Iwata, B. A., & Kahng, S. (1999). False positive maintenance of self-injurious behavior by access to tangible reinforcers. *Journal of Applied Behavior Analysis, 32*(2), 201–204. https://doi.org/10.1901/jaba.1999.32-201

Sigafoos, J., & Saggers, E. (1995). A discrete-trial approach to the functional analysis of aggressive behavior in two boys with autism. *Australia & New Zealand Journal of Developmental Disabilities, 20*(4), 287-297. https://doi.org/10.1080/07263869500035621

Slaton, J. D., & Hanley, G. P. (2018). Nature and scope of synthesis in functional analysis and treatment of problem behavior. *Journal of Applied Behavior Analysis, 51*(4), 943-973. https://doi.org/10.1002/jaba.498

Slaton, J. D., Hanley, G. P., & Raftery, K. J. (2017). Interview-informed functional analyses: A comparison of synthesized and isolated components. *Journal of Applied Behavior Analysis, 50*(2), 252–277. https://doi.org/10.1002/jaba.384

Smith, R. G., & Churchill, R. M. (2002). Identification of environmental determinants of behavior disorders through functional analysis of precursor behaviors. *Journal of Applied Behavior Analysis, 35*(2), 125-136. https://doi.org/10.1901/jaba.2002.35-125

Stokes, J. V., & Luiselli, J. K. (2009). Applied behavior analysis assessment and invention for health: Threateining self-injury (rectal picking) in an adult with Prader-Willi syndrome. *Clinical Case Studies, 8*(1), 38-47. H ttps://doi.org/10.1177/1534650108327011

Strohmeier, C., Mulé, C., & Luiselli, J. K. (2014). Social validity assessment of training methods to improve treatment integrity of special education service providers. *Behavior Analysis in Practice, 7*(1), 15–20. https://doi.org/10.1007/s40617-014-0004-5

Thomason-Sassi, J. L., Iwata, B. A., & Fritz, J. N. (2013). Therapist and setting influences on functional analysis outcomes. *Journal of Applied Behavior Analysis, 46*(1), 79–87. https://doi.org/10.1002/jaba.28

Thomason-Sassi, J. L., Iwata, B. A., Neidert, P. L., & Roscoe, E. M. (2011). Response latency as an index of response strength during functional analyses of problem behavior. *Journal of Applied Behavior Analysis, 44*(1), 51-67. https://doi.org/10.1901/jaba.2011.44-51

Thompson, R. H., & Iwata, B. A. (2005). A review of reinforcement control procedures. *Journal of Applied Behavior Analysis, 38*(2), 257-278. https://doi.org/10.1901/jaba2005.176-03

Thompson, R. H., & Iwata, B. A. (2007). A comparison of outcomes from descriptive and functional analyses of problem behavior. *Journal of Applied Behavior Analysis, 40*(2), 333-338. https://doi.org/10.1901/jaba.2007.56-06

Tiger, J. H., & Effertz, H. M. (2020). On the validity of data produced by isolated and synthesized contingencies during the functional analysis of problem behavior. *Journal of Applied Behavior Analysis.* https://doi.org/10.1002/jaba.792

Tsami, L. K., & Lerman, D. C. (2019). Transfer of treatment effects from combined to isolated conditions during functional communication training for multiply controlled problem behavior. *Journal of Applied Behavior Analysis, 53*(2), 649-664. https://doi.org/10.1002/jaba.629

Vollmer, T. R., Marcus, B. A., & LeBlanc, L. A. (1994). Treatment of self-injury and hand mouthing following inconclusive functional analyses. *Journal of Applied Behavior Analysis, 27*(2), 331-344. https://doi.org/10.1901/jaba.1994.27-331

Vollmer, T. R., Marcus, B. A., Ringdahl, J. E., & Roane, H. S. (1995). Progressing from brief assessments to extended experimental analyses in the evaluation of aberrant behavior. *Journal of Applied Behavior Analysis, 28*(4), 561-576. https://doi.org/10.1901/jaba.1995.28-561

Wacker, D., Lee, P., Padilla Dalmau, J., Kopelman, F., Lindgren, Y., Kuhle, C., Pelzel, T., Dyson, G., Schieltz, S., & Waldron, D. (2013). Conducting functional communication training via telehealth to reduce the problem behavior of young children with autism. *Journal of Developmental and Physical Disabilities, 25*(1), 35–48. https://doi.org/10.1007/s10882-012-9314-0

Wallace, M. D., & Iwata, B. A. (1999). Effects of session duration on functional analysis outcomes. *Journal of Applied Behavior Analysis, 32*(2), 175-183. https://doi.org/10.1901/jaba.1999.32-175

Ward, S. N., Hanley, G. P., Warner, C. A. and Gage, E. E. (2021). Does teaching an omnibus mand preclude the development of specifying mands? *Journal of Applied Behavior Analysis, 54*(1), 248-269. https://doi.org/10.1002/jaba.784

Warner, C. A., Hanley, G. P., Landa, R. K., Ruppel, K. W., Rajaraman, A., Ghaemmaghami, M., Slaton, J. D. and Gover, H. C. (2020). Toward accurate inferences of response class membership. *Journal of Applied Behavior Analysis, 53*(1), 331-354. https://doi.org/10.1002/jaba.598

Weber, K. P., Killu, K., Derby, K. M., & Barretto, A. (2005). The status of functional behavioral assessment (FBA): Adherence to standard practice in FBA methodology. *Psychology in the Schools, 42*(7), 737-744. https://doi.org/10.1002/pits.20108

Weeden, M., Mahoney, A., Poling, A. (2010) Self-injurious behavior and functional analysis: Where are the descriptions of participant protections? *Research in Developmental Disabilities, 31*(2), 299-303. https://doi.org/10.1016/j.ridd.2009.09.016

Wilder, D. A., Masuda, A., O'Conner, C., & Baham, M. (2001). Brief functional analysis and treatment if bizarre vocalizations in an adult with schizophrenia. *Journal of Applied Behavior Analysis, 34*(1), 65-68. https://doi.org/10.1901/jaba.2001.34-65

Wiskirchen, R. R., Deochand, N., & Peterson, S. M. (2017). Functional Analysis: A Need for clinical decision support tools to weigh risks and benefits. *Behavior Analysis: Research and Practice, 17*(4), 325–333. https://doi.org/10.1037/bar0000088

Table 1

Participant Characteristics

Participant	Age (yrs)	Sex	Race	Diag-nosis	Expressive Language	Target Problem Behavior	Precursor Behavior
Riley	2	F	Caucasian	None	Sentences containing five or more words	Tantrum	NA
Madeline	5	F	Biracial (African American/ Caucasian)	ASD	Three- to four-word phrases	Physical Aggression	Foot stomping, Screeching, Negative Vocalizations
Emmett	5	M	Caucasian	None	Four- to five-word phrases	Elopement	NA
Owen	5	M	Caucasian	ASD	Four- to five-word phrases	Elopement	NA

Table 2

Participant-Specific Behavior

Participant	Precursor Behavior	Precursor Behavior Definition	Target Problem Behavior	Target Problem Behavior Definition	Other Problem Behavior	Other Problem Behavior Definition
Riley	None	NA	Tantrum	Any occurrence of the following behavior (a) Flopping: any instance or attempt to drop from a standing position or bucking back from a sitting position, (b) Screaming: any instance of a vocalization above normal convo level for any period of time, (c) Foot stomp:	Property Destruction	Any attempt or occurrence of ripping or crumbling paper/stimuli or throwing items on the floor
					Self-Injury	Any attempt or instance of forceful contact between participant and themselves or surface that could result in injury

				same definition as above		
Madeline	Foot stomp	Any instance of bringing one or both feet down forcibly making contact with the ground	Aggression	Any instance of forcibly making contact between any part of the participants body and the body of another person, including actions with objects towards other people that could result in injury	Self-Injury	Same definition as above
	Screech	Any instance of a discrete high-pitched vocalization (e.g., shriek)				
	Negative Vocs	Any occurrence of a minimum of 3 s of crying, screaming, whining, or sounds				

		of distress (stop scoring when occurrence ceases)				
Emmett	None	NA	Elopement	Any instance or attempt of the participant's body passing through the threshold of the middle session room door (excludes main door used to enter room)	Self-Injury Aggression	Same definition as above Same definition as above
Owen	None	NA	Elopement	Same definition as above	Property Destruction Flopping Aggression	Same definition as above Any attempt or occurrence of changing from a standing or sitting position to the floor

Same
definition
as above

Table 3

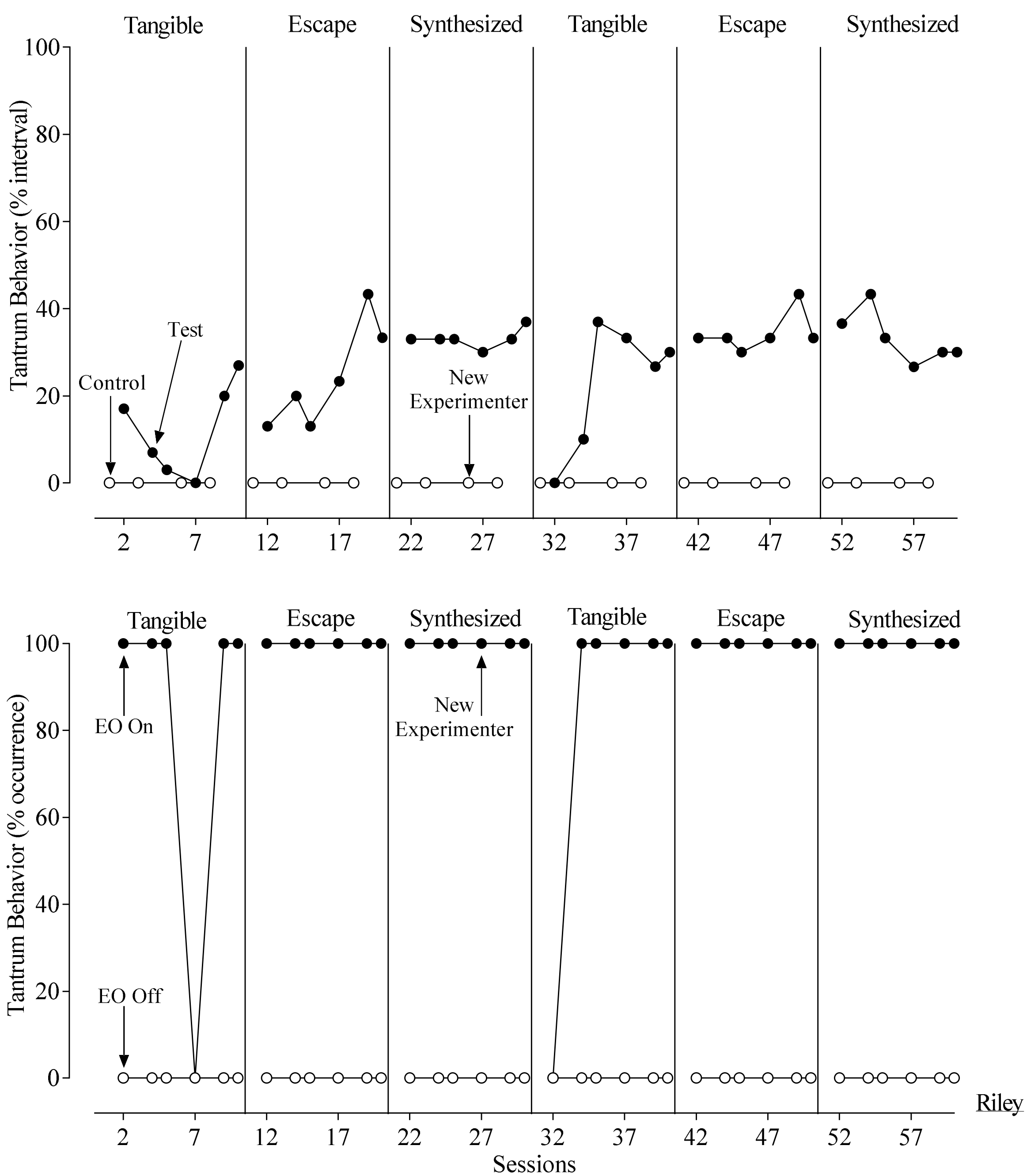
Participant-Specific Functional Analyses (FA)

Participant	Isolated FA 1	Isolated FA 2	Isolated FA 3	Synthesized FA
Riley	**Tangible**	**Escape**	NA	**Tangible & Escape**
Madeline	**Tangible**	**Diverted Attention**	NA	**Tangible & Diverted Attention**
Emmett	**Tangible**	**Escape**	**Attention**	**Escape & Tangible & Attention**
Owen	**Escape**	**Attention**	NA	**Escape & Attention**

Note. Bolded FAs indicate the variables(s) maintains target behavior.

Figure 1

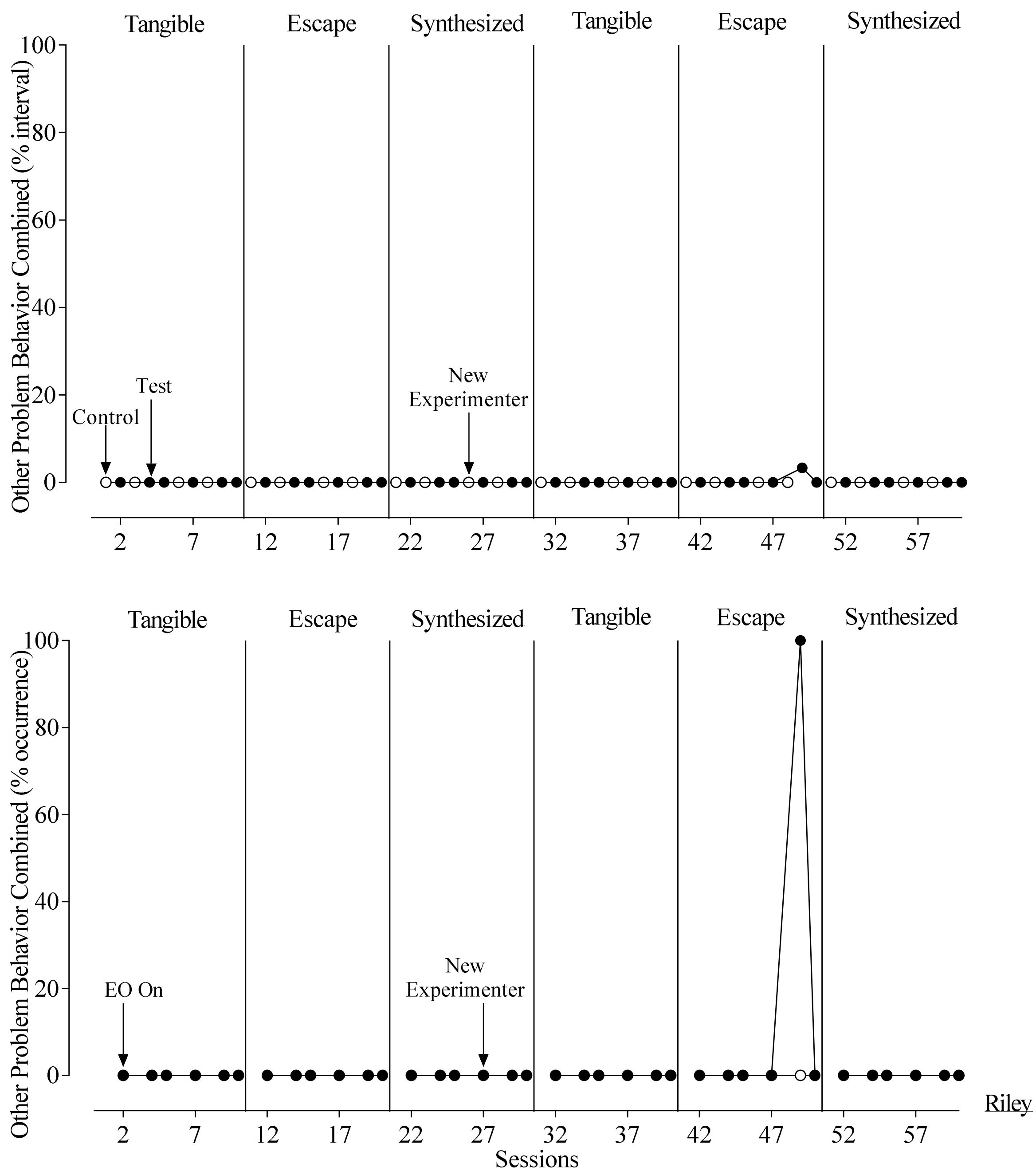
Percentage of intervals with tantrum behavior during test and control conditions (top panel) and percentage of occurrence of tantrum behavior during EO-on and EO-off periods (bottom panel)



Note. Isolated tangible, isolated escape, and synthesized tangible and escape FAs for Riley.

Figure 2

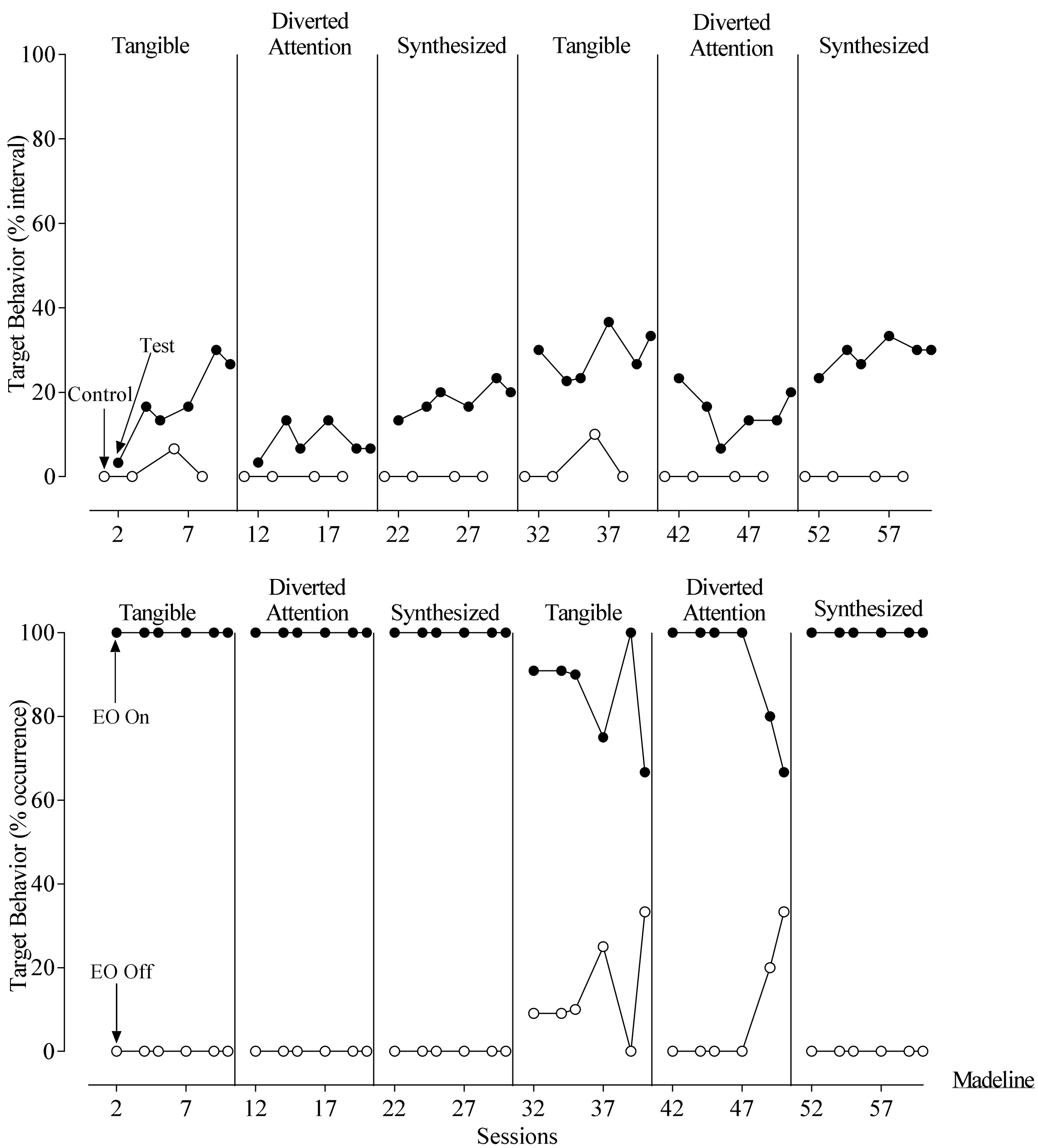
Percentage of intervals with combined other problem behavior during test and control conditions (top panel) and percentage of occurrence of combined other problem behavior during EO-on and EO-off periods (bottom panel)



Note. Isolated tangible, isolated escape, and synthesized tangible and escape FAs for Riley.

Figure 3

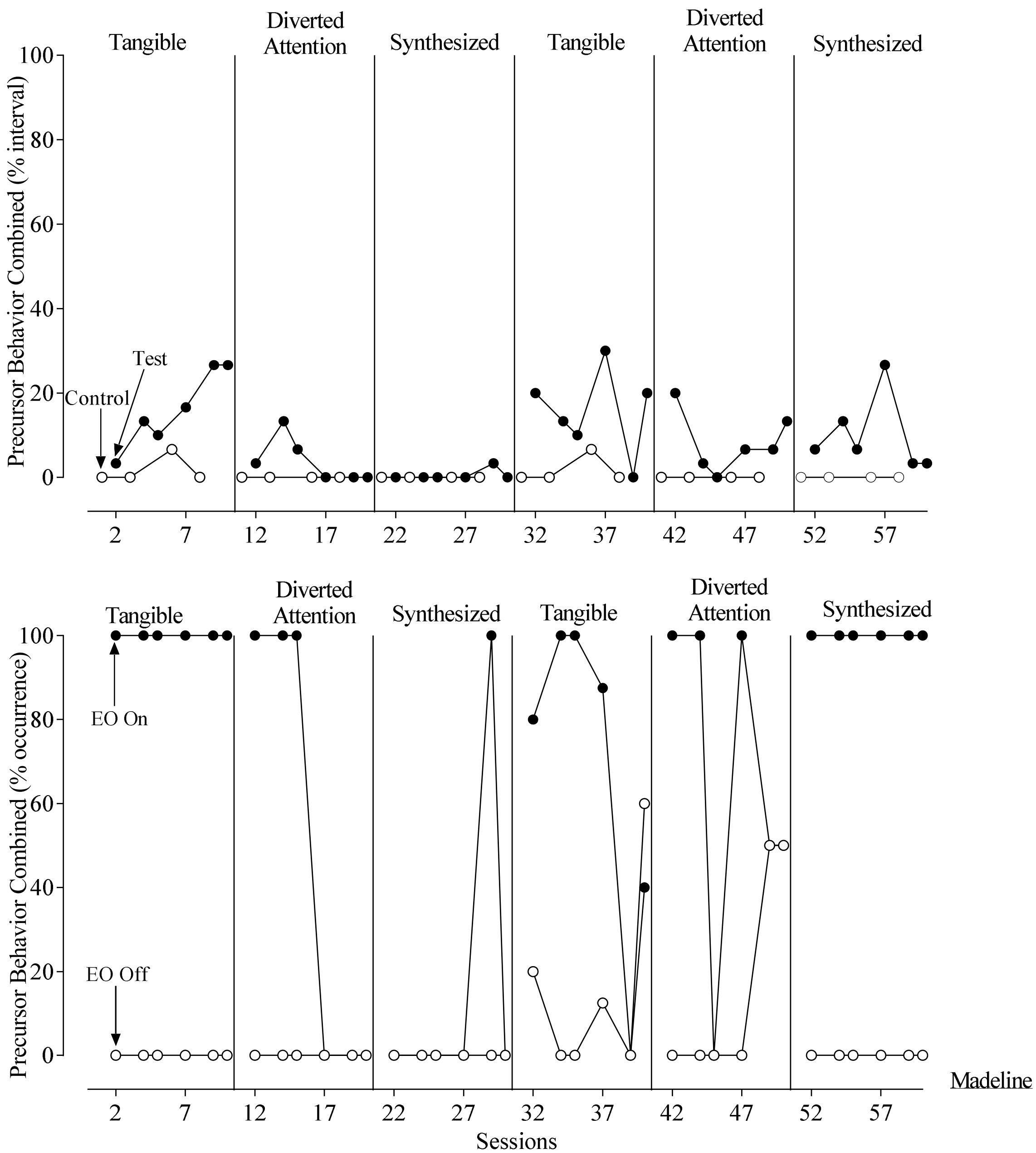
Percentage of intervals with target behavior during test and control conditions (top panel) and percentage of occurrence of target behavior during EO-on and EO-off periods (bottom panel)



Note. Isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention FAs for Madeline.

Figure 4

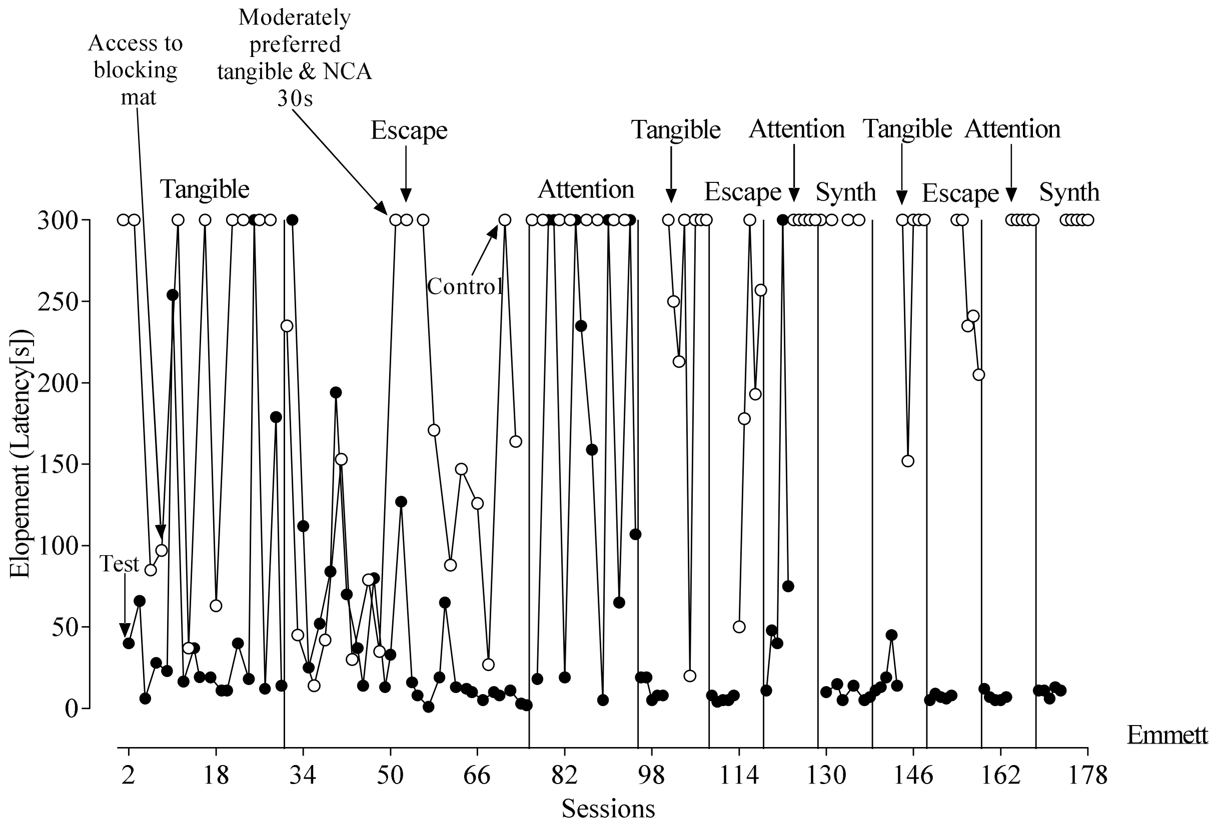
Percentage of intervals with combined precursor behavior during test and control conditions (top panel) and percentage of occurrence of combined precursor behavior during EO-on and EO-off periods (bottom panel)



Note. Isolated tangible, isolated diverted-attention, and synthesized tangible and diverted-attention FAs for Madeline.

Figure 5

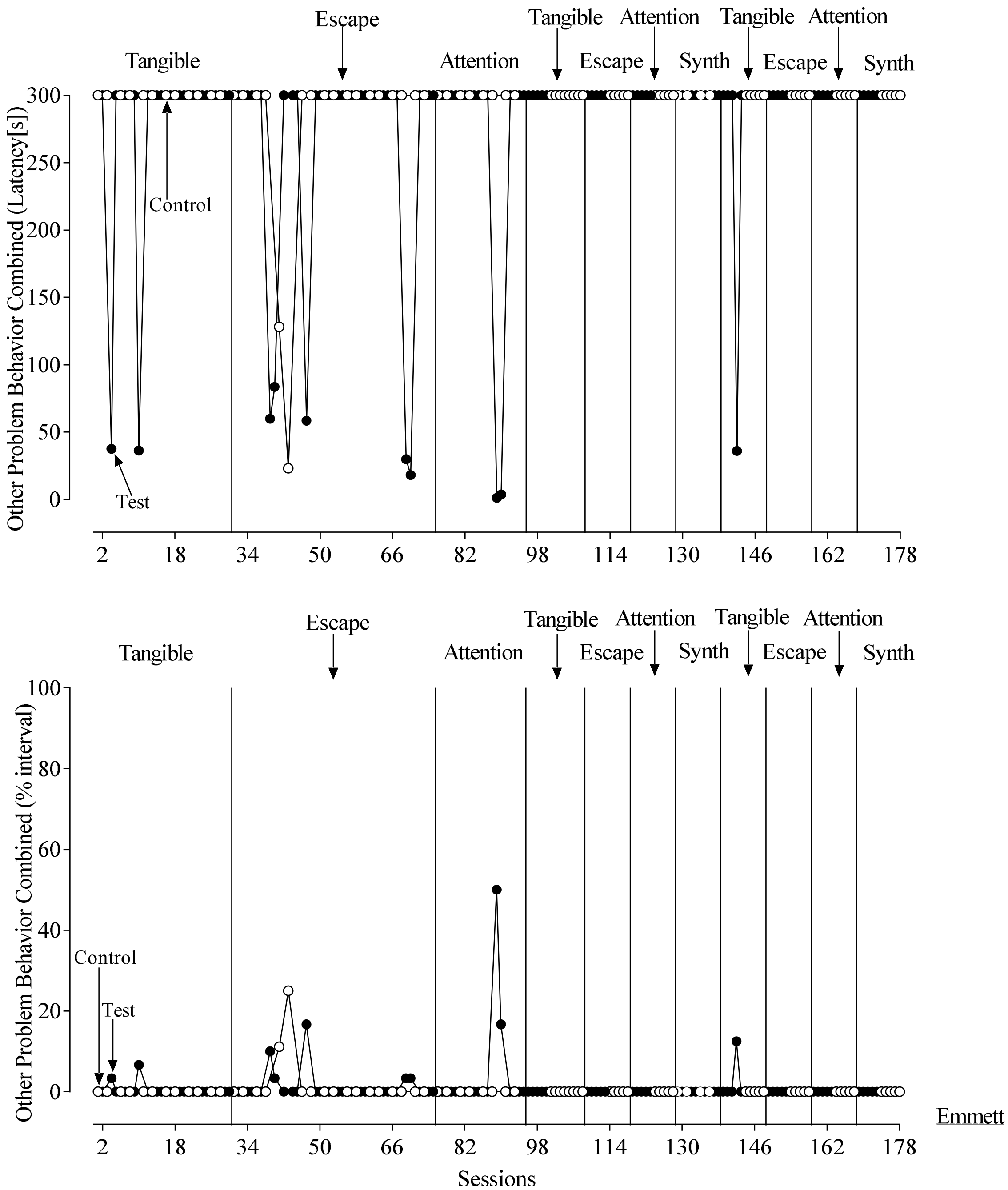
Latency to elopement during test and control conditions



Note. Isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention FAs for Emmett.

Figure 6

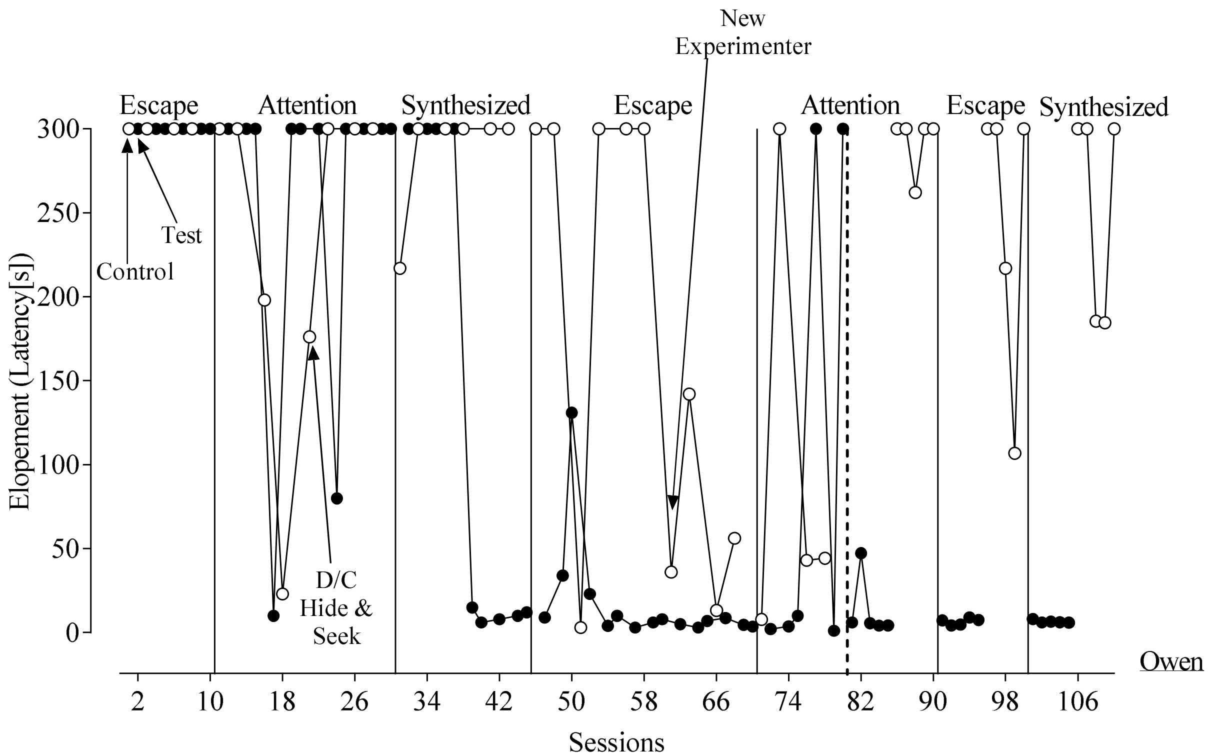
Latency to combined other problem behavior during test and control conditions (top panel) and percentage of intervals with combined other problem behavior during test and control conditions (bottom panel)



Note. Isolated tangible, isolated escape, isolated attention, and synthesized tangible, escape, and attention FAs for Emmett.

Figure 7

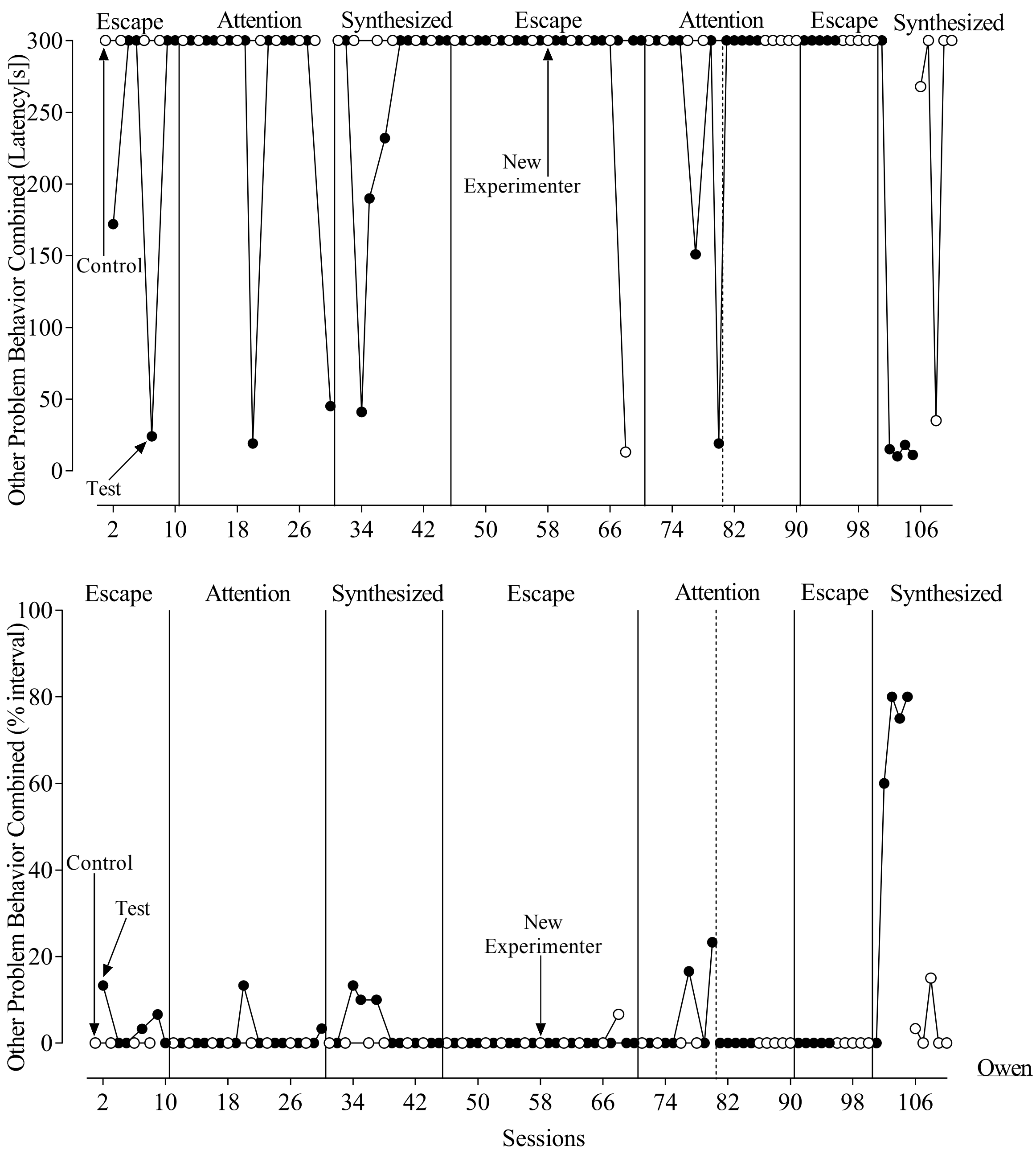
Latency to elopement during test and control conditions



Note. Isolated escape, isolated attention, and synthesized escape and attention FAs for Owen.

Figure 8

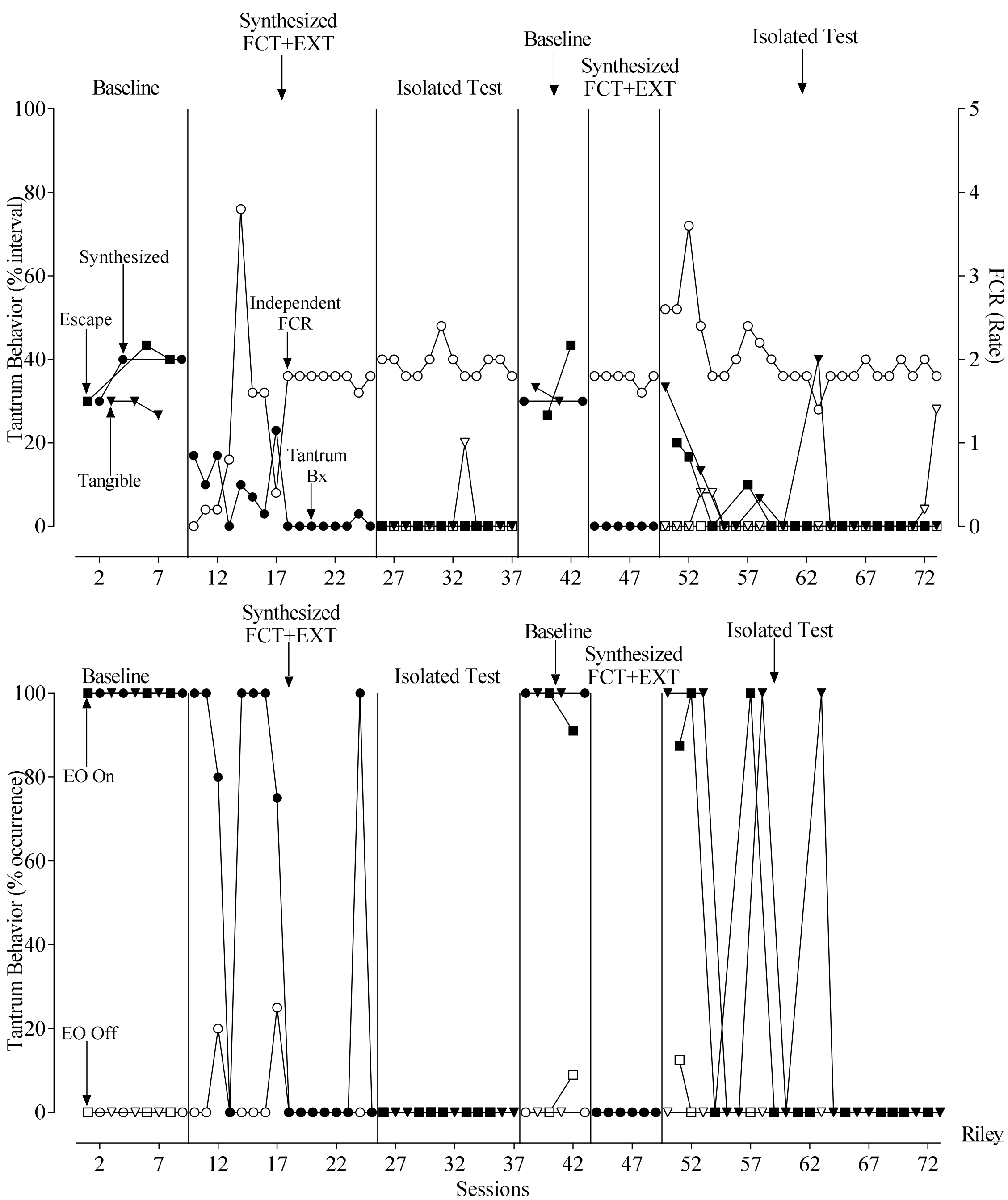
Latency to combined other problem behavior during test and control conditions (top panel) and percentage of intervals with combined other problem behavior during test and control conditions (bottom panel)



Note. Isolated escape, isolated attention, and synthesized escape and attention FAs for Owen.

Figure 9

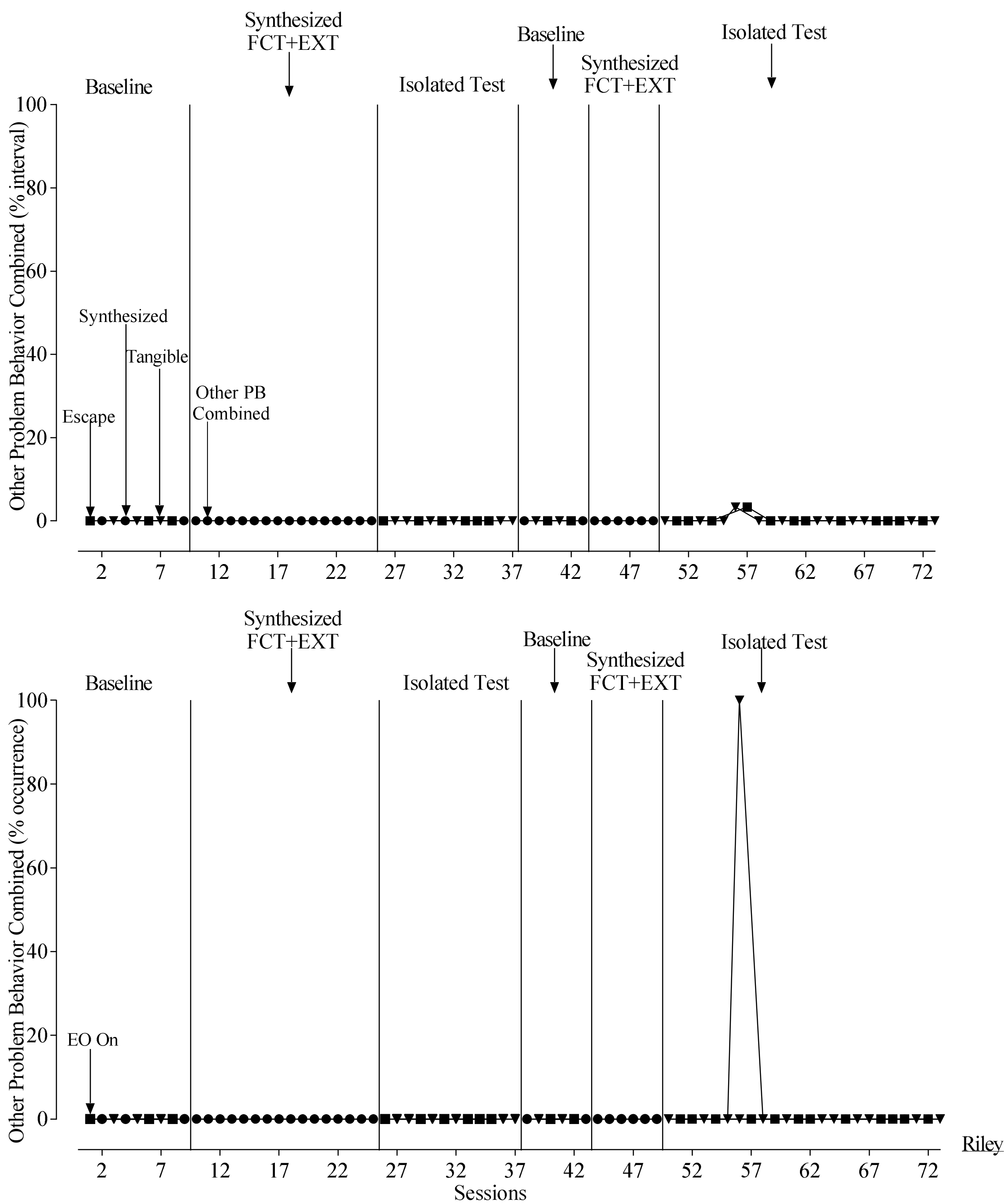
Percentage of intervals with tantrum behavior and responses per minute of functional communication responses during intervention conditions (top panel) and percentage of occurrence of tantrum behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible and escape FCT+EXT and isolated tangible and isolated escape test FCT+EXT conditions for Riley.

Figure 10

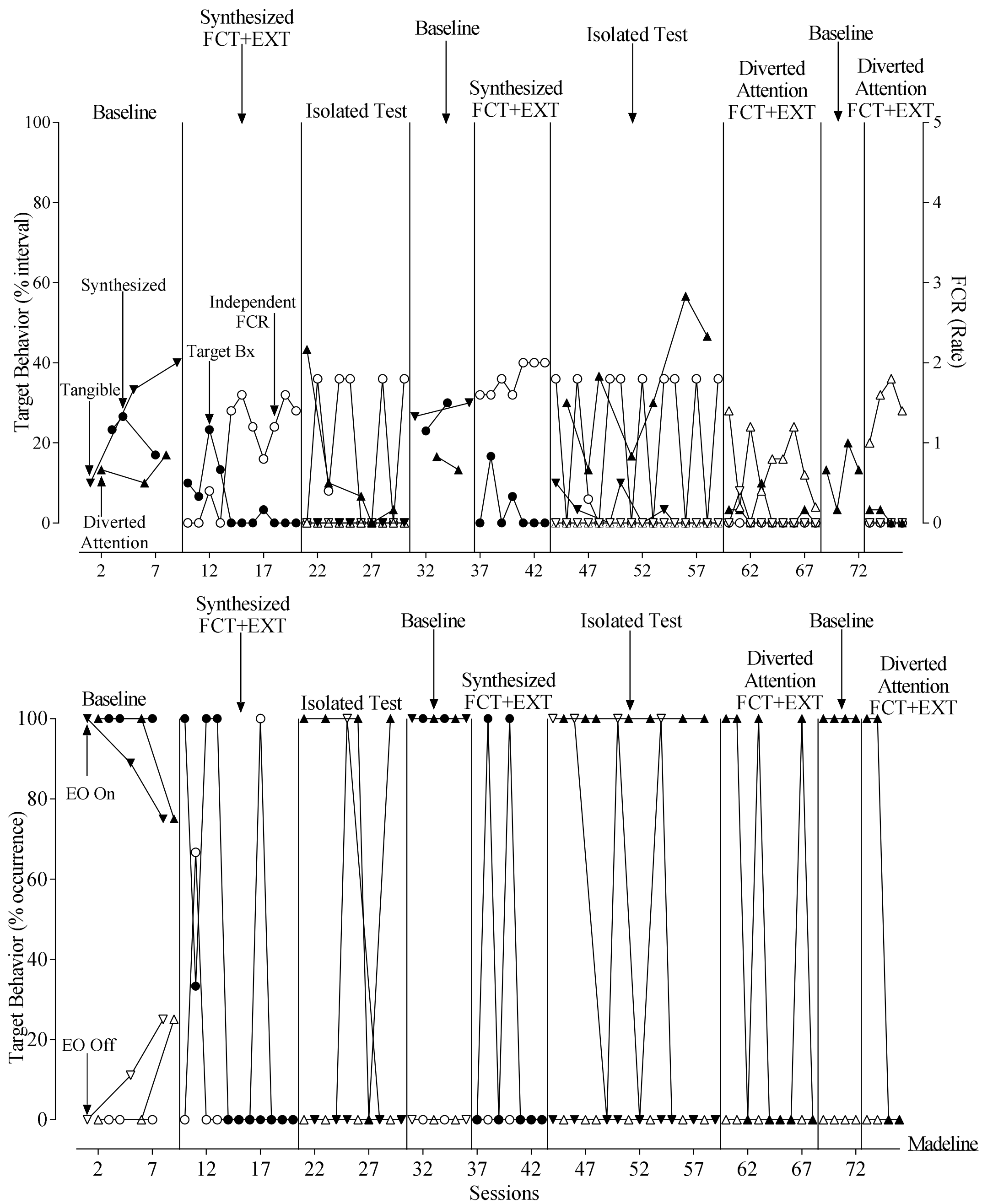
Percentage of intervals with combined other problem behavior during intervention conditions (top panel) and percentage of occurrence of combined other problem behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible and escape FCT+EXT, and isolated tangible and isolated escape test FCT+EXT conditions for Riley.

Figure 11

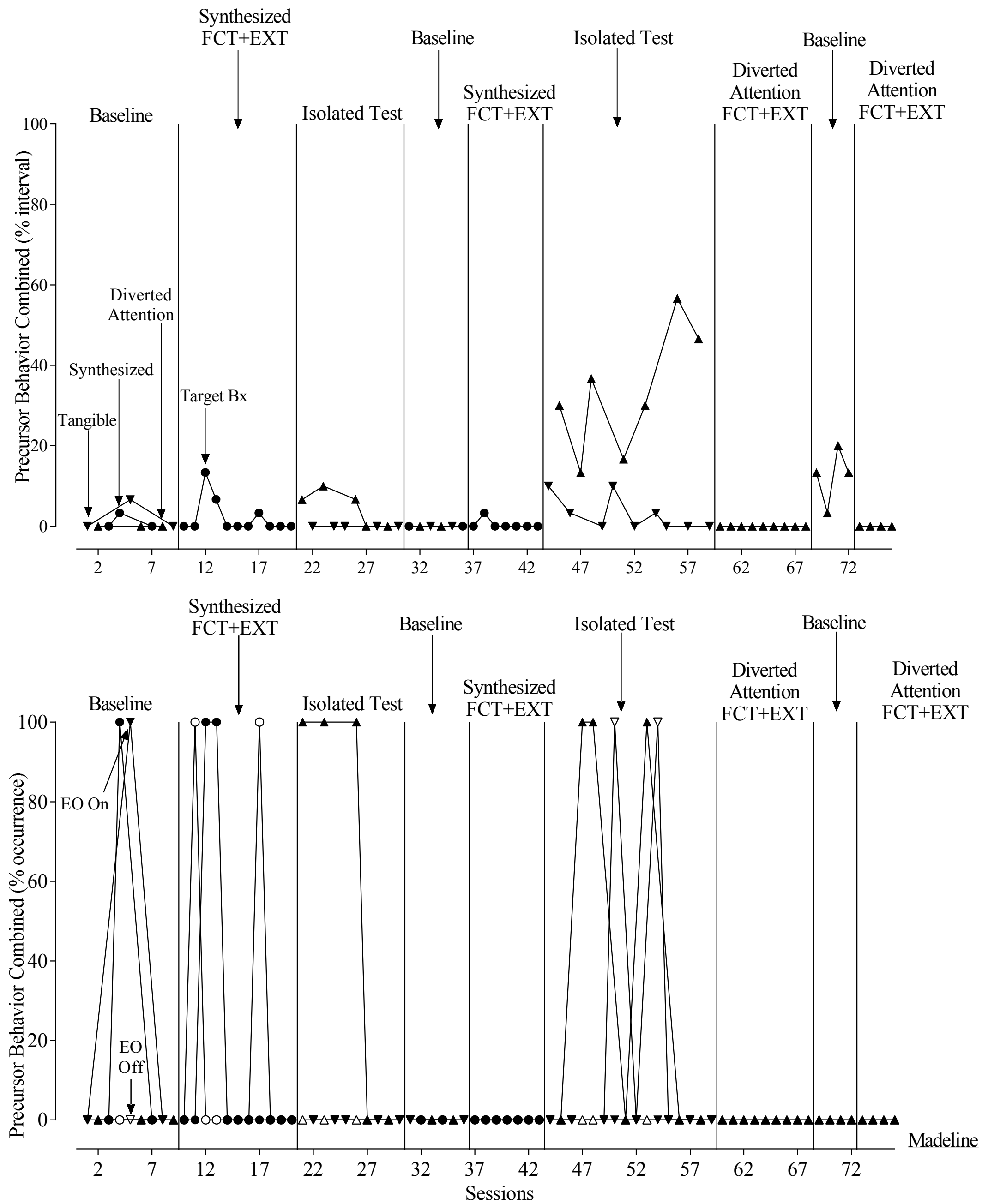
Percentage of intervals with target behavior and responses per minute of functional communication responses during intervention conditions (top panel) and percentage of occurrence of target behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible and diverted-attention FCT+EXT, isolated tangible and isolated diverted-attention test, and isolated diverted-attention FCT+EXT conditions for Madeline.

Figure 12

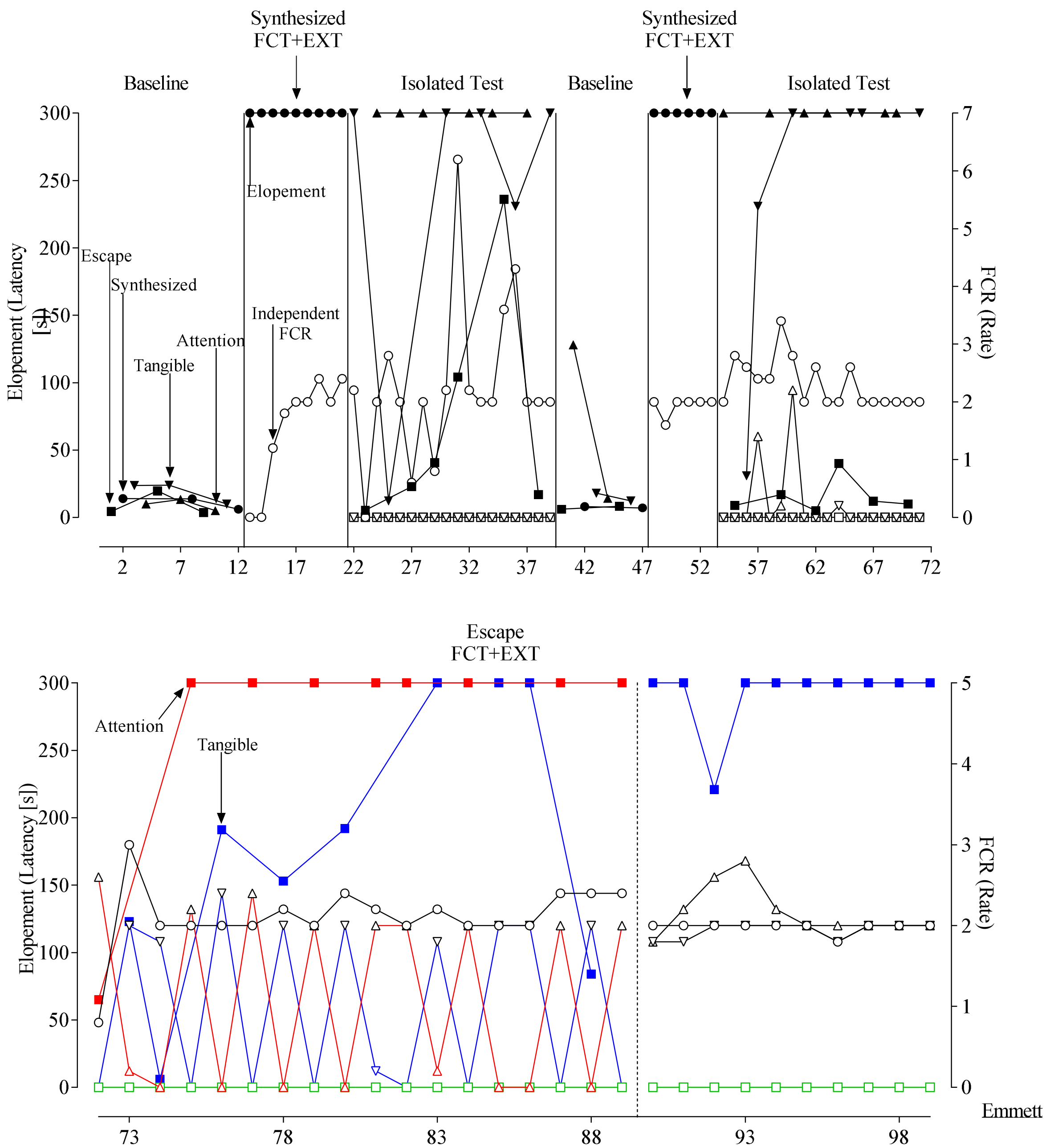
Percentage of intervals with combined precursor behavior during intervention conditions (top panel) and percentage of occurrence of combined precursor behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible and diverted-attention FCT+EXT, isolated tangible and isolated diverted-attention test, and isolated diverted-attention FCT+EXT conditions for Madeline.

Figure 13

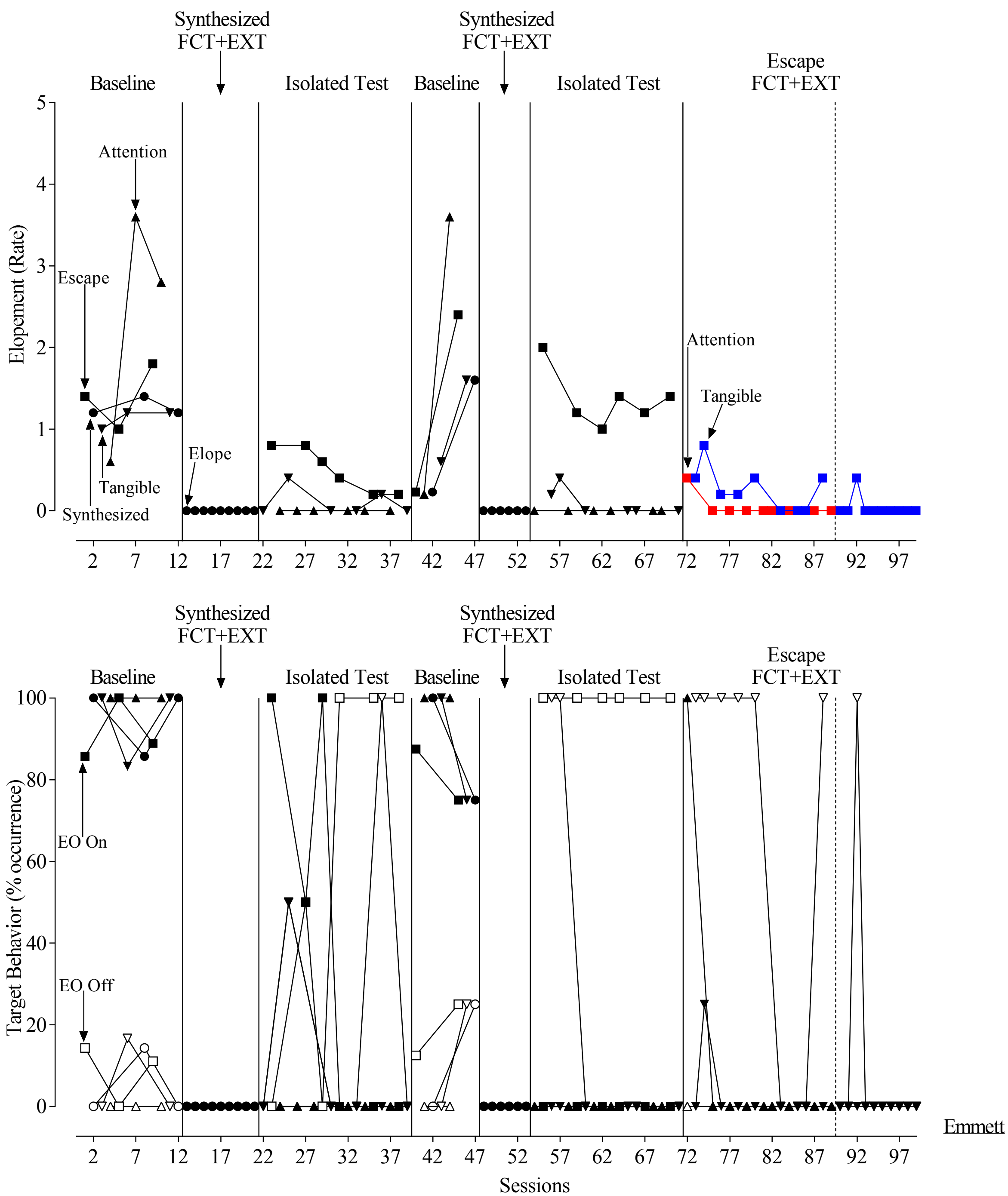
Latency to elopement and responses per minute of functional communication responses during intervention conditions



Note: Baseline, synthesized tangible, escape, and attention FCT+EXT, isolated tangible, isolated escape, and attention test conditions, and isolated escape FCT+EXT conditions for Emmett. All FCR data points with a black border were reinforced.

Figure 14

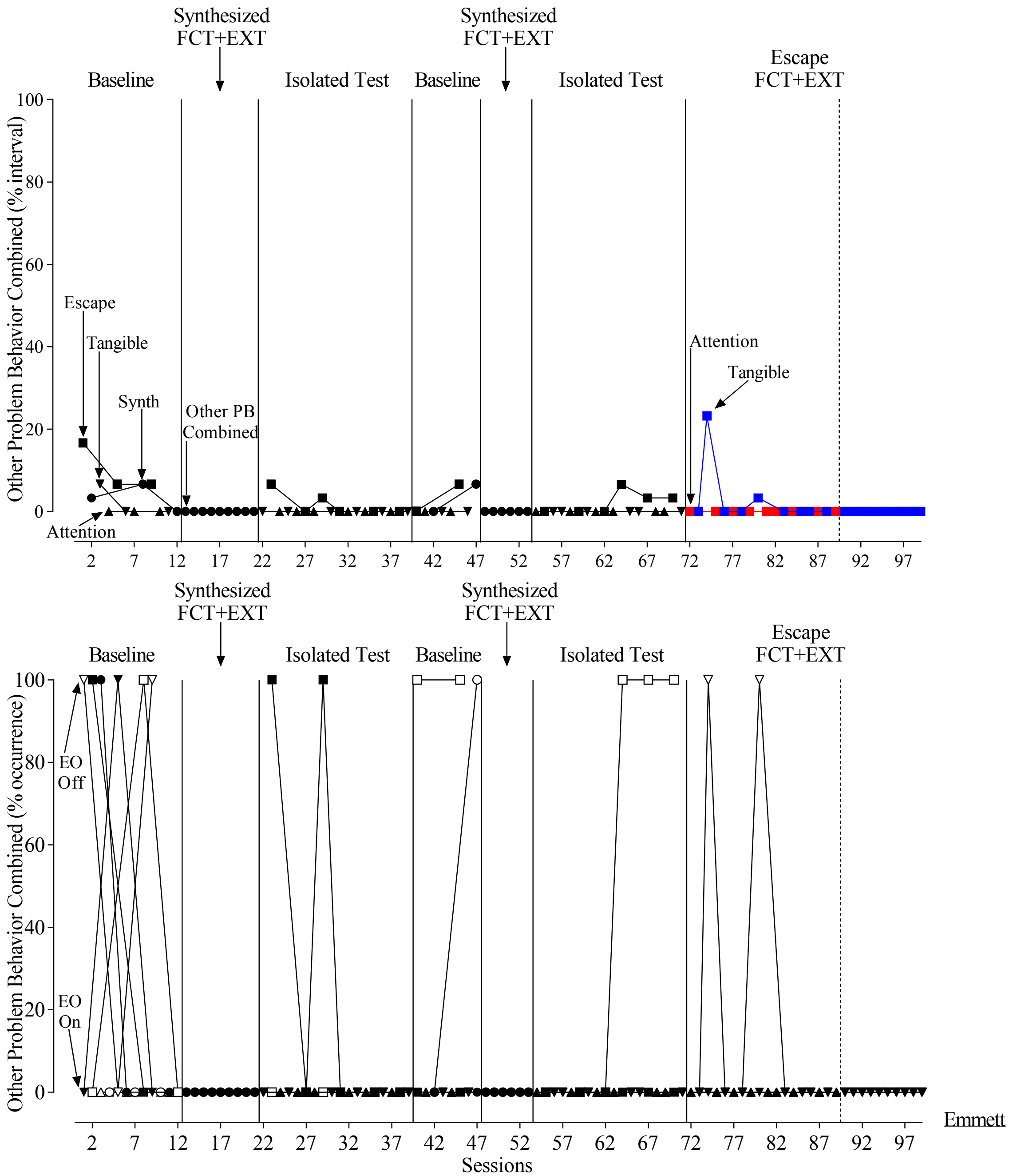
Responses per minute of elopement during intervention conditions (top panel) and percentage of occurrence of elopement during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible, escape, and attention FCT+EXT, isolated tangible, isolated escape, and attention test conditions, and isolated escape FCT+EXT conditions for Emmett.

Figure 15

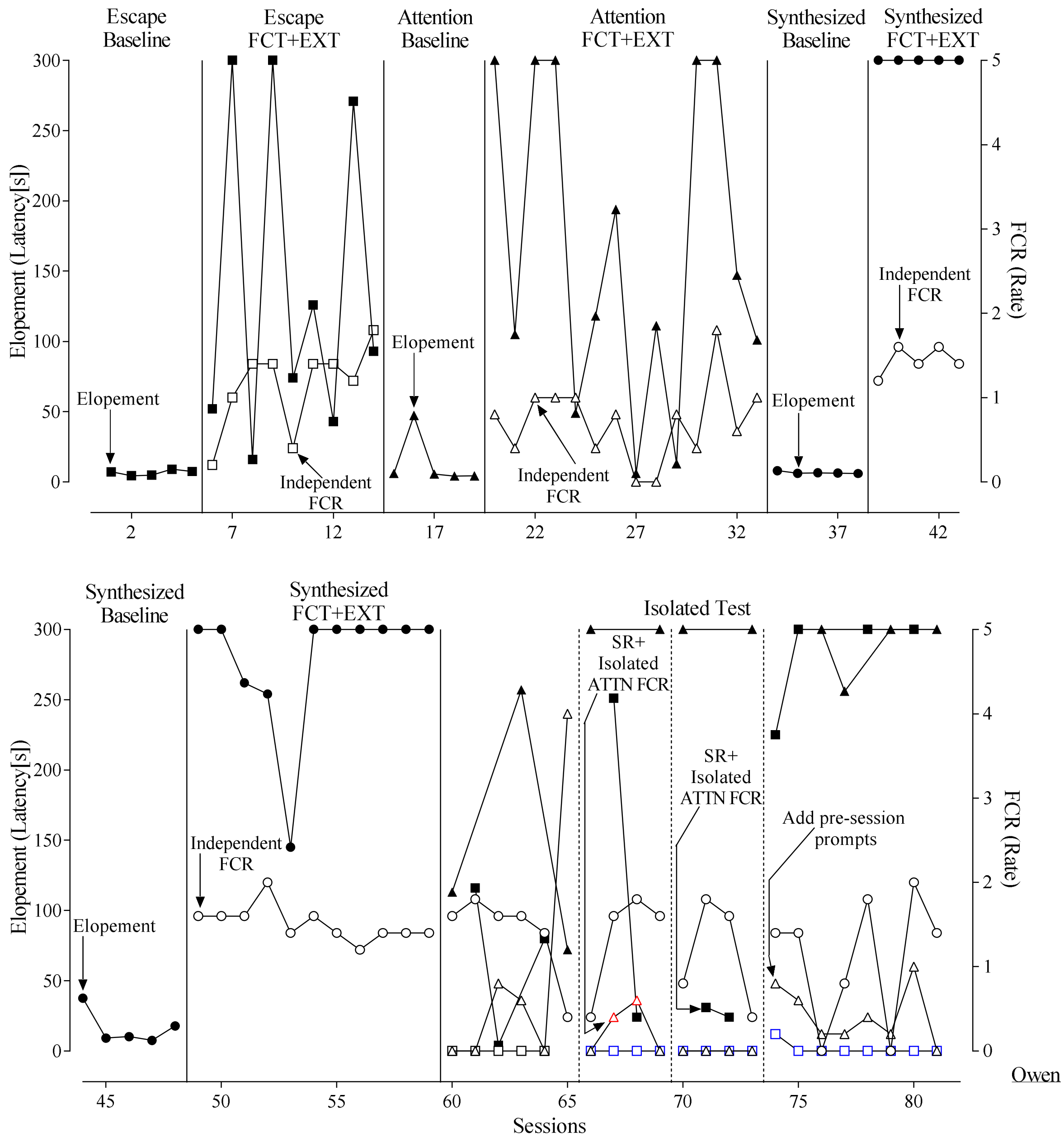
Percentage of intervals with combined other problem behavior during intervention conditions (top panel) and percentage of occurrence of combined other problem behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, synthesized tangible, escape, and attention FCT+EXT, isolated tangible, isolated escape, and attention test conditions, and isolated escape FCT+EXT conditions for Emmett.

Figure 16

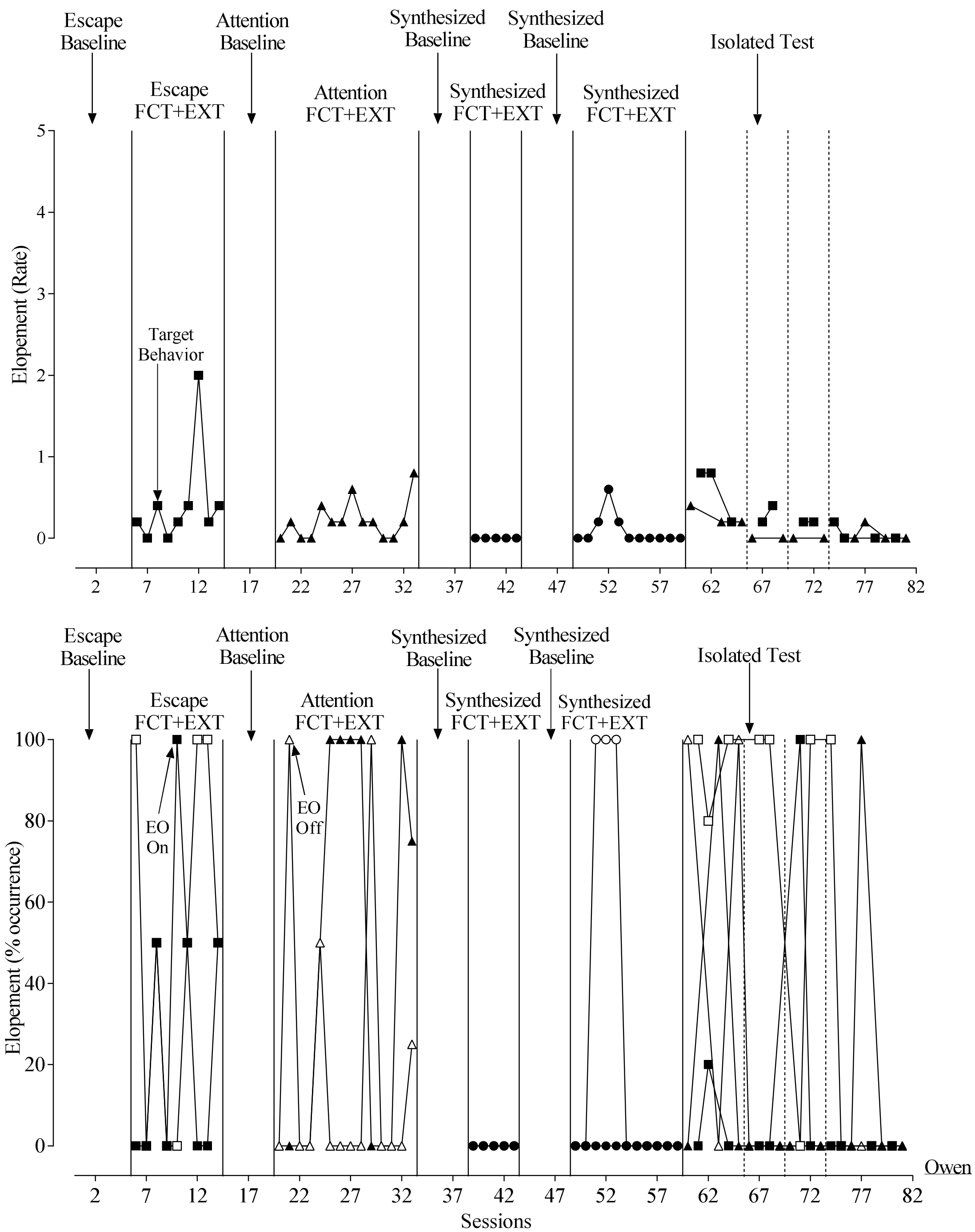
Latency to elopement and responses per minute of functional communication responses during intervention conditions



Note: Baseline, isolated escape FCT+EXT, isolated attention FCT+EXT, synthesized escape and attention FCT+EXT, and isolated escape and isolated attention test conditions for Owen. All FCR data points with a black border were reinforced.

Figure 17

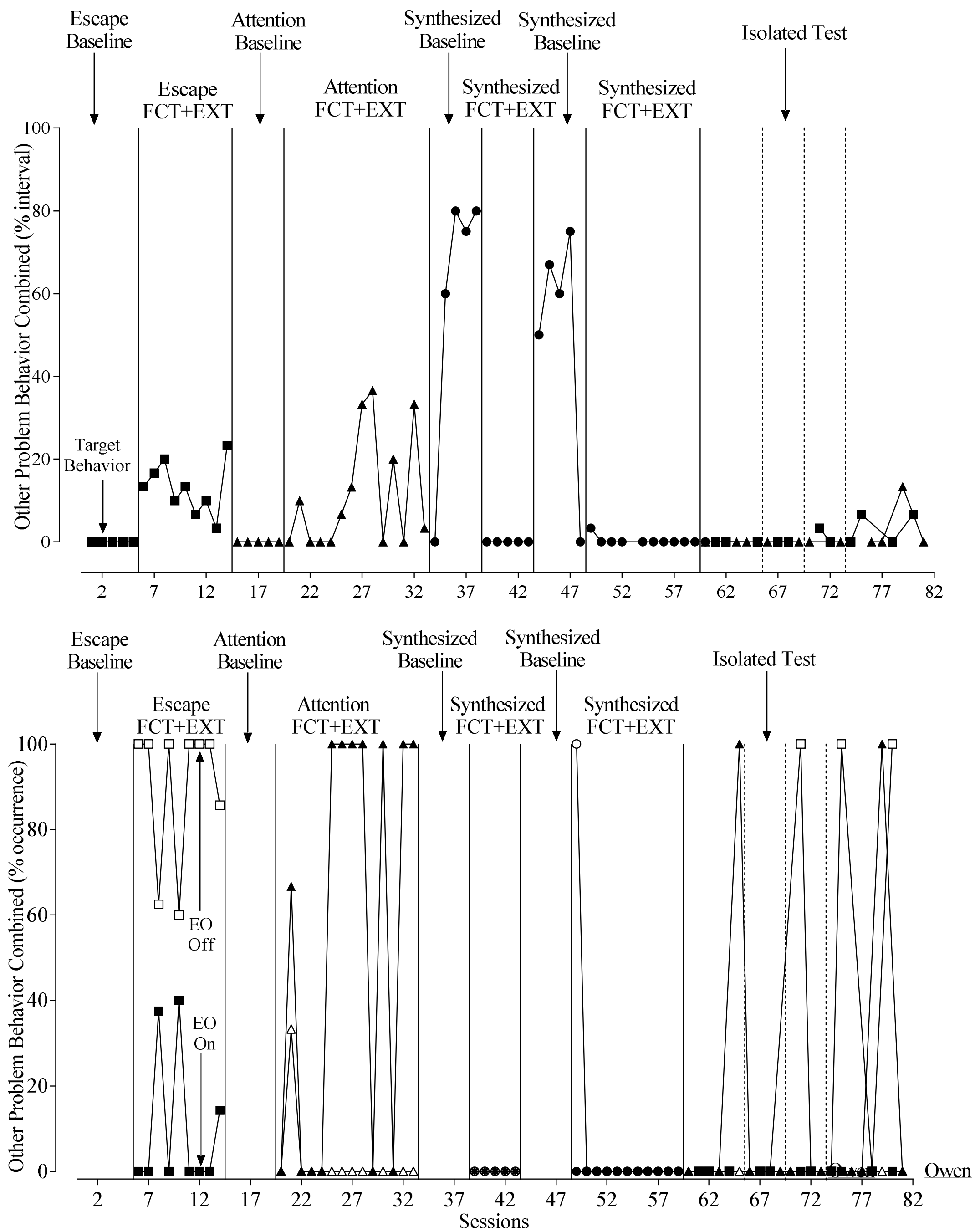
Responses per minute of elopement during intervention conditions (top panel) and percentage of occurrence of elopement during EO-on and EO-off periods (bottom panel)



Note: Baseline, isolated escape FCT+EXT, isolated attention FCT+EXT, synthesized escape and attention FCT+EXT, and isolated escape and isolated attention test conditions for Owen.

Figure 18

Percentage of intervals with combined other problem behavior during intervention conditions (top panel) and percentage of occurrence of combined other problem behavior during EO-on and EO-off periods (bottom panel)



Note: Baseline, isolated escape FCT+EXT, isolated attention FCT+EXT, synthesized escape and attention FCT+EXT, and isolated escape and isolated attention test conditions for Owen.

Appendix A

Informed Consent and HIPAA Authorization Form

Parent/Guardian Permission to Participate in:
Functional Analysis and Treatment of Behavior Disorders in Young Children

INFORMED CONSENT AND HIPAA AUTHORIZATION FORM

The Department of Applied Behavioral Sciences at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish your child to participate in the present study. You may refuse to sign this form and not allow your child to participate in this study. You should be aware that even if you agree to allow your child to participate, you are free to withdraw at any time. If you do withdraw your child from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

Key information

- Your child's participation in this research project is completely voluntary.
- Your child's participation will take approximately 5-25 hours broken up across days, with no more than 2 hours per day. The duration is dependent on how long the assessment and treatment evaluation are needed to provide conclusions.
- Your child will be involved in two assessments (functional analysis and preference assessment) and a treatment evaluation for determining why they display problem behavior and what treatment may be effective for decreasing problem behavior. More detailed information on the procedures can be found below.
- There are no risks greater than what is typically present within the context of your child's typical day. However, if your child has a history of severe problem behavior, best practice methods will be used to ensure their safety and the safety of others around them in the assessment and treatment process (e.g., padded surfaces).
- Successful outcomes from the functional analysis will provide a basis for determining what features of the social environment should be changed during treatment. Successful outcomes from the preference assessment will result in identification of reinforcers that may be used either in treatment programs designed to reduce the frequency of behavior problems or in instructional programs that are a part of your child's behavior plan. Successful treatment of behavior problems may result in reduced risk from your child's problem behavior and increases in adaptive behavior.
- Your alternative to participating is this study is not to participate.
- Your child's identifiable information will not be used or distributed for future research studies even if identifiable information is removed.

Purpose

The goal of this study is to (a) evaluate and refine assessment procedures for determining why (i.e., the situations in which) typically developing children and children with intellectual and developmental disabilities engage in problem behavior such as self-injury, aggression, property destruction, and stereotypy and (b) determine the effects of particular components and variations of behavioral treatments for behavior problems.

Procedures

Two assessments will be conducted with your child. Prior to both assessments, an interview will be conducted with your child's teachers or therapists to determine the situations in which problem behavior is more and less likely to occur, what the problem behavior looks like, and to determine possible preferred items and activities to be used during treatment. After the interviews, the first assessment (functional analysis) will be to figure out the situations in which your child engages in problem behavior. This assessment will involve observing your child under several conditions that may influence the occurrence of problem behavior: (1) low levels of attention and the delivery of attention for problem behavior, (2) giving instructions to complete tasks (e.g., academic tasks, self-help tasks) and the delivery of a break from task instructions for problem behavior, (3) removal of leisure items and the delivery of leisure items following occurrences of problem behavior, (4) providing access to leisure activities, and (5) no interaction—your child will be observed in the absence of any activity. This assessment approach is well-established in the literature and is considered best practice in the field. Some variations of this procedure that may be conducted with your child may include (1) extending or shortening the length of session time or changing the typical order of conditions, (2) changing features of the conditions (e.g., how much or the type of attention provided, difficulty or type task instructions), and (3) changes in the location of the assessment (e.g., in the classroom, in an observation room). Functional analysis sessions will be from 5 minutes to 30 minutes in length and will be conducted 1-3 times per day. The total number of hours for completion of this assessment may range from 1 hour to 12 hours over a period of time.

The second assessment (preference assessment) will be to figure out rewards (preferred items and activities) that may be used to improve performance during treatment programs. This assessment will consist of (a) presenting a variety of activities (play objects) and snacks and determining which activities/items are preferred most by your child and (b) determining whether these activities/items can be used as rewards for your child completing tasks. Variations of these assessments will include (a) how activities or items are presented to your child, (b) how we measure your child's preference for these items and activities, and (c) how items and activities are arranged during the assessment. The total amount of time required for completion of the preference assessment is approximately 10 minutes to 1 hour.

Following assessments, we will evaluate the effects of a treatment that is based on the results of the above assessments. Treatment will involve delivery of preferred items/activities (a) for the absence of problem behavior, (b) for the occurrence of an appropriate, replacement behavior, or (c) independent of behavior. Variations of these procedures might include (a) how often the preferred item or activity is delivered, (b) whether reinforcement for problem behavior continues during treatment, (c) how the particular treatment procedure is made more practical or efficient, and (d) whether the reinforcer delivered is the same or different from the one found to maintain problem behavior. Treatment sessions will be 5 to10 min in length and will be conducted 1-4 times per day. The total number of hours for completion of treatment is approximately 3-12 hours.

COVID-19 PROCEDURES

The University of Kansas recognizes that the COVID-19 pandemic has changed the level of risk regarding your child's participation in this research. The university is following Centers for Disease Control & Prevention (CDC), state, and institutional guidelines and best practices and is requiring additional precautions and procedures for this project in light of this.

Please be advised that although the researchers will take precautions to maintain your child's health and safety, the nature of COVID-19 prevents the researchers from guaranteeing protection from the virus. The researchers would like to remind you to follow the CDC's recommended guidelines for protecting your child and others from exposure to the virus. If your child is at risk for contracting COVID-19, or if you do not feel comfortable participating due to the risk of COVID-19, you are encouraged not to participate.

COVID-19 SYMPTOMS

As is currently in place, upon arrival at the Child Development Center, your child will be asked to take a self-assessment of symptoms and to withdraw from participating in study sessions for at least 14 days if they have symptoms, if your child has recently traveled to a high-risk area, or if your child has come into contact with someone experiencing symptoms or who has tested positive for the virus. If your child develop symptoms, tests positive or discovers they have been in contact with someone who has tested positive after a research session, we ask that you notify us immediately so we can inform others who might have been exposed.

COVID-19 SAFETY PLAN

Specific steps have been taken to minimize the risk of contracting or spreading COVID-19. Specifically, screening will occur for researchers (i.e., completion of CVKey app symptom checker) and participants (i.e., temperature check and COVID-19 specific questions) prior to being allowed to enter the building. If any researcher or participants report or exhibit symptoms of COVID-19, they will be instructed to go/stay home and follow instructions provided on the by Lawrence-Douglas County Health Department, Douglas County COVID Hotline, or Watkins Health Center. While in the building/research area, research team members will socially distance from each other (e.g., 6 ft apart, data collectors in observation booth, use of plexiglass dividers) and will not share materials (e.g., pens, clipboards, iPods, computers). Additionally, participants will be socially distanced from other participants and research team members not essential to conduct sessions (e.g., data collectors in booth, only 1 researcher in the room with participant at a time). Participants session materials will be individualized (e.g., toys, work materials) and will not be shared across other participants or research team members. While in the research area all researchers will wear cloth or surgical face masks and plastic face shields for the duration of all sessions. Participants will also be encouraged to wear masks (either brought from home or provided by the Child Development Center) when transitioning to the research area and while in the research area. Prior to all sessions, researchers and participants will wash their hands and researchers will use an Environmental Protection Agency (EPA) approved odorless sanitizer (Member's Mark sanitizing solution) to disinfect all surfaces of items or fixtures that participants may come into contact with, including toys and work materials. Following all sessions, researchers and participants will wash their hands and researchers will disinfect all surfaces of items or fixtures that participants touched.

Alternatives to Participation
I can choose not to allow my child to participate in this study.

Risks
There are no risks greater than what is typically present within the context of your child's typical day. However, if your child has a history of severe problem behavior, best practice methods will be used to ensure their safety and the safety of others around them in the assessment and treatment process (e.g., padded surfaces).

Benefits
Successful outcomes from the functional analysis will provide information for determining what features of the social environment should be changed during treatment. Successful outcomes from the reinforcer assessment will result in identification of reinforcers that may be used either in treatment programs designed to reduce the frequency of behavior problems or in instructional programs that are a part of your child's behavior support plan. Successful treatment of behavior problems may result in reduced risk from your child's problem behavior and increases in adaptive behavior.

Payment to participants
No payment will be made to children or their guardians for participation in this study.

Information to be collected
To perform this study, researchers will collect information about your child. This information will be obtained from medical, psychological, and other records on file at the Edna A. Hill Child Development Center. Also, information will be collected from the study activities that are listed in the Procedures section of this consent form. All research related records and information from this study will be kept confidential. Research results will only be presented to others using participant number or alias. Be assured that your child's name will not be associated with the research findings in any way. Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form, you give permission for the use and disclosure of your child's information, excluding your child's name, for purposes of this study at any time in the future. The information collected about your child will be used by Dr. Dozier, members of the research team, and KU's Center for Research and officials of KU that oversee research, including committees and offices that review and

monitor research activities. The researchers will not share information about your child with anyone not specified above unless (a) it is required by law or university policy or (b) you give written permission. Video observations of sessions conducted with your child will be kept on a locked computer that can only be accessible via password by the research team. Video recordings will be destroyed within 5 years of the study completion. Any other videos (e.g., for educational or conference purposes) will not occur without signed permission from you.

Consent refusal and withdrawal of consent
You may withdraw your consent to allow participation of your child in this study at any time. You also have the right to cancel your permission to use and disclose information collected about your child, in writing, at any time, by sending your written request to: Claudia L. Dozier (see address below). If you cancel permission to use your child's information, the researchers will stop collecting additional information about your child. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above

Questions about participation
I have read the information in this form. I know if I have any more questions after signing this from, I should contact Claudia Dozier at (785) 864-0526. If I have any questions about my son's/daughter's rights as a research participant, I may call (785) 864-7429 or write the Human Research Protection Program, University of Kansas, Youngberg Hall, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email irb@ku.edu.

Participant certification
The investigator gave me information about what will be done in this research study. They also told me how it will be done, what I will have to do, and how long the research will take. The investigators told me about any inconvenience, discomfort, or risks my son/daughter might experience due to this research. I agree to allow my child to take part in this study. I am aware that my child may quit or refuse any part of the research study at any time. I know that if I have any more questions after signing this form, I may contact the investigator directly or the Human Subjects Committee listed above.

By my signature, I agree to follow the COVID-19 safety procedures required for participation in this study.

Claudia L. Dozier, Ph.D.
Principal Investigator
Associate Professor
Applied Behavioral Sciences
University of Kansas
4043 Dole Building
Lawrence, KS 66045
(785) 864-0526

____
Print Participants Guardian's Name

______________________________ ______________
Participant Guardian's Signature Date

"With my signature I acknowledge that I am over the age of eighteen, and I have received a copy of this consent form to keep."

____________________________________ ________________

Investigator's Signature Date

Appendix B

COVID-Specific Procedures

Safety Procedure	Date	Person Completing the Form	Implementation Status 2 = fully implemented 1 = partially implemented 0 = not in place	Comments
PRIOR TO SESSION				
Sanitize surfaces				
Sanitize tangibles/toys				
Sanitize work materials				
Experimenter PPE				
Participant PPE				
Experimenter health screen				
Participant health screen				
Participant wash hands				
Experimenter wash hands				
DURING SESSION				
Social distancing in place				
FOLLOWING SESSION				
Sanitize surfaces				
Sanitize tangibles/toys				
Sanitize work materials				
Participant wash hands				
Experimenter wash hands				
			%	

*If below 80%,
safety procedures
will be re-
addressed

Appendix C

Updated COVID-Specific Procedures

Safety Procedure	Date	Person Completing the Form	Implementation Status 2 = fully implemented 1 = partially implemented 0 = not in place	Comments
PRIOR TO SESSION				
Sanitize surfaces				
Sanitize tangibles/toys				
Sanitize work materials				
Experimenter PPE (i.e., face mask)				
Participant health screen				
Participant wash hands				
Experimenter wash hands				
FOLLOWING SESSION				
Sanitize surfaces				
Sanitize tangibles/toys				
Sanitize work materials				
Participant wash hands				
Experimenter wash hands				
			%	

*If below 80%, safety procedures will be re-addressed

Appendix D

Open-Ended Functional Assessment Interview

Open-Ended Functional Assessment Interview

Developed by Gregory P. Hanley, Ph.D., BCBA-D (Developed August, 2002; Revised: August, 2009)

Date of Interview: ______ Child/Client: ______ Interviewer: ______

Respondent: ______ Respondent's relation to child/client: ______

RELEVANT BACKGROUND INFORMATION

1. His/her date of birth: ______ Age: ______ yrs ______ mo Check one: Male ☐ Female ☐
2. Describe his/her language abilities:
3. Describe his/her play skills and preferred toys or leisure activities:
4. What else does he/she prefer?

QUESTIONS TO INFORM THE DESIGN OF A FUNCTIONAL ANALYSIS

⇨ *To develop objective definitions of observable problem behaviors:*

5. What are the problem behaviors? What do they look like?

⇨ *To determine which problem behavior(s) will be targeted in the functional analysis:*

6. What is the single-most concerning problem behavior?
7. What are the top 3 most concerning problem behaviors? Are there other behaviors of concern?

⇨*To determine the precautions required when conducting the functional analysis:*

8. Describe the range of intensities of the problem behaviors and the extent to which he/she or others may be hurt or injured from the problem behavior.

⇨*To assist in identifying precursors to dangerous problem behaviors that may be targeted in the functional analysis instead of more dangerous problem behaviors:*

9. Do the different types of problem behavior tend to occur in bursts or clusters and/or does any type of problem behavior typically precede another type of problem behavior (e.g., yells preceding hits)?

⇨*To determine the antecedent conditions that may be incorporated into the functional analysis test conditions:*

10. Under what conditions or situations are the problem behaviors most likely to occur?

11. Do the problem behaviors reliably occur during any particular activities?

12. What seems to trigger the problem behavior?

13. Does problem behavior occur when you break routines or interrupt activities? If so, describe.

14. Does the problem behavior occur when it appears that he/she won't get his/her way? If so, describe the

⇨*To determine the test condition(s) that should be conducted and the specific type(s) of consequences that may be incorporated into the test condition(s):*

15. How do you and others react or respond to the problem behavior?

16. What do you and others do to calm him/her down once he/she engaged in the problem behavior?

17. What do you and others do to distract him/her from engaging in the problem behavior?

⇨*In addition to the above information, to assist in developing a hunch as to why problem behavior is occurring and to assist in determining the test condition(s) to be conducted:*

18. What do you think he/she is trying to communicate with his/her problem behavior, if anything?

19. Do you think this problem behavior is a form of self stimulation? If so, what gives you that impression?

20. Why do you think he/she is engaging in the problem behavior?

Submit by E-mail