A Comparison of Isolated and Synthesized Contingencies in Functional Analyses

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Submitted to the graduate degree program in Applied Behavioral Science and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

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Date Defended: April 9, 2019

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Date approved: April 9, 2019

Abstract

In a series of recent studies, Hanley and colleagues have evaluated the efficacy of an FA methodology termed the Interview Informed Synthesized Contingency Analyses (IISCA; Hanley, Jin, Vanselow, & Hanratty, 2014), which involves conducting (a) an open-ended interview to determine potential antecedents, consequences, and precursors to target problem behavior; (b) a brief observation based on the interview results; and (c) test and control conditions that involve synthesized contingencies (as determined by interview and observation). However, it is unknown whether synthesis of contingencies is necessary for determining a functional relation between problem behavior and environmental events. We extended Fisher, Greer, Romani, Zangrillo, and Owen (2016) and Slaton, Hanley, and Raferty (2017) by comparing the outcomes of FAs that involved isolated versus synthesized contingencies while controlling for other differences across the FAs for problem behavior of five young children. Next, we compared the effects of function-based interventions based on isolated and synthesized functional variables for each participant. Results showed that synthesized contingencies were not necessary to show functional relations between problem behavior and environmental events, and function-based treatments based on isolated contingencies were equally effective to those based on synthesized contingencies.

Keywords: functional analysis, functional communication training, problem behavior, synthesized contingencies

Acknowledgements

To my advisor, Dr. Claudia Dozier, thank you for your constant guidance and support throughout this study and my graduate career thus far. To my lab mates and colleagues, thank you for conducting sessions with me, providing valuable input, and keeping me in check during this process. Finally, to my family and friends, thank you for your never-ending understanding and encouragement. I am grateful for your presence in my life during this journey.

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Functional analyses (FAs) allow clinicians and researchers to determine the function of problem behavior and derive effective interventions (Hagopian, Dozier, Rooker, & Jones, 2013). Functional analyses involve measurement of the occurrence of problem behavior under at least one test condition and one control condition that involve manipulation of environmental events (i.e., antecedents and consequences; Iwata & Dozier, 2008). Higher levels of problem behavior in a test condition as compared to the control condition suggest the variable(s) maintaining problem behavior. Determination of these functional variables allows clinicians and researchers to develop effective, function-based interventions to decrease the occurrence of problem behavior (Hagopian et al., 2013).

Since Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) developed the first comprehensive FA methodology, researchers have suggested various procedural and methodological modifications of FA methodology (e.g., Beavers, Iwata, & Lerman, 2013; Hanley, Iwata, & McCord, 2003). Researchers have suggested modifications to address various potential challenges of FA methodology including practicality issues (e.g., time needed to conduct the FA) and ethical issues (e.g., potential harm to the individual associated with FA), as well as modifications for clarifying FA outcomes. For example, studies have involved evaluation of the effects of (a) FA duration (e.g., Bloom, Iwata, Fritz, Roscoe, & Carreau, 2011; Derby et al., 1992; Thomason-Sassi, Iwata, Neidert, & Roscoe, 2011; Wallace & Iwata, 1999), (b) various establishing operations (e.g., Call, Wacker, Ringdahl, & Boelter, 2005; Harper, Iwata, & Camp, 2013; McComas, Hoch, Paone, & El-Roy, 2000) and consequences (e.g., Kodak, Northup, & Kelley, 2007; Roscoe, Kindle, & Pence, 2010) (see Schlichenmeyer, Roscoe, Rooker, Wheeler, & Dube, 2013 for a review), and (c) experimental designs (e.g., Iwata,

Duncan, Zarcone, Lerman, & Shore, 1994; Vollmer, Marcus, Ringdahl, & Roane, 1995) for increasing the efficacy and efficiency of FAs.

In a series of recent studies, Hanley and colleagues have proposed and evaluated the efficacy of a modified FA methodology termed the Interview Informed Functional Analysis (also known as the Interview Informed Synthesized Contingency Analyses [IISCA]); Hanley, Jin, Vanselow, & Hanratty, 2014; Jessel, Hanley, & Ghaemmaghami, 2016; Jessel, Ingvarsson, Metras, Kirk, & Whipple, 2018; Santiago, Hanley, Moore, & Jin, 2016). The process for the IISCA involves first conducting an open-ended interview with caregivers to determine the possible antecedent and consequent events associated with problem behavior, as well as potential precursors to problem behavior. Clinicians then use the interview results to design a brief structured observation in which hypothesized maintaining contingences are presented and removed. The results from both the interview and direct observation are then used to inform the test condition(s) in the FA. To date, most studies on the IISCA have included one or two test conditions that are synthesized. That is, they include a combination of establishing operations, discriminative stimuli, and consequences in a single test condition. For example, if the interview and structured observation suggests possible maintenance by escape from instructional demands and access to preferred items and activities, then the test condition would involve (a) a combined establishing operation in which instructions are presented and preferred items and activities are removed, (b) discriminative stimuli that denote the presence of demands and the removal of preferred items, and (c) the delivery of escape and access to preferred items and activities contingent upon the occurrence of problem behavior. Finally, the control condition(s) in the IISCA is specific to the test condition(s) in the FA and involves continuous delivery of the putative reinforcers. For example, if both escape and tangible contingencies are manipulated in

the test condition, as in the example above, then both escape (no instructional demands) and access to preferred items and activities are provided throughout control sessions.

In their initial study on the IISCA, Hanley et al. (2014) evaluated whether differentiation in problem behavior occurred across synthesized test conditions as compared to condition-specific control conditions with three children with autism and evaluated the effects of treatment based on the outcomes of the IISCA. Results showed that all participants' problem behavior occurred at higher levels in the test condition as compared to the control condition. Furthermore, interventions derived from synthesized functions of problem behavior that included functional communication training (FCT) and tolerance training of delays and denials were effective for decreasing problem behavior and increasing appropriate behavior. Similar results have been replicated in additional evaluations of the IISCA by Hanley and colleagues (e.g., Jessel et al., 2016; Jessel et al., 2018; Santiago et al., 2016).

Although researchers have shown (a) the IISCA has resulted in differentiated responding in FAs and (b) interventions based on IISCA outcomes have been effective, there are some limitations to this methodology. First, IISCA FA conditions are based on the outcomes of indirect assessment and direct observation, which have been shown to have poor validity with respect to determining the function of problem behavior (Kelley, LaRue, Roane, & Gadaire, 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 for functional

control. Second, because the IISCA involves synthesized contingencies, the extent to which contingencies presented in isolation influence the occurrence of problem behavior is unknown. Thus, 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 rehabilitation 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, Greer, Romani, Zangrillo, & Owen, 2016).

In a recent study, Fisher et al. (2016) compared the outcomes of "traditional FA methodology" as described by Iwata et al. (1982/1994) and IISCA FA methodology as described by Hanley et al. (2014) for problem behavior displayed by five individuals. This was the first systematic study to evaluate the extent to which problem behavior is sensitive to isolated contingencies (as evaluated in traditional FA methodology), combined contingencies (as evaluated in IISCA methodology), or both. Overall, results showed that differentiated responding occurred in both traditional and IISCA FAs for four out of five participants. For one participant, no problem behavior occurred during either FA. For three of the four participants whose FAs were differentiated, the traditional FA in which contingencies were isolated resulted in maintenance by only one variable manipulated in the IISCA FA; for all three participants, that variable was access to tangibles. For the other participant whose FAs were differentiated, the traditional FA resulted in maintenance by two variables (access to tangibles and escape) manipulated in the IISCA FA. These data suggest that combined contingencies in the IISCA FA were unnecessary for differentiated responding in the FAs. Furthermore, based on the outcomes of the traditional FAs, the IISCA FAs included one or more irrelevant contingencies for all four

participants. However, a major limitation of this study is that function-based treatments 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 IISCA FAs with respect to function of problem behavior, it is possible that interventions based on IISCA FAs may be more effective than those based on isolated contingencies (Slaton & Hanley, 2018).

In a more recent study, Slaton, Hanley, and Raftery (2017) replicated and extended Fisher et al. (2016) by comparing the outcomes of traditional FAs and IISCAs and the outcomes of treatments based on the outcomes of both FAs. Overall, results of the FA comparison showed that all nine participants showed differentiated responding in the IISCA FA. However, only four of the nine participants showed differentiated responding in the initial traditional FA, with two more of the remaining five participants showing differentiated responding once contingencies were placed on precursors. After completing the FAs, the experimenters compared the effects of functional communication training with extinction (FCT+EXT; Tiger, Hanley, & Bruzek, 2008) developed from each FA for the four participants for whom both FA results were differentiated but resulted in different outcomes. Overall, results of the treatment comparison showed that FCT+EXT based on the IISCA was more effective than FCT+EXT based on the traditional FA for two participants and similarly effective for the other two participants. However, a limitation of the treatment evaluation was the use of a multielement design to compare the effects of the treatments. 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 treatments that did not involve access to those additional reinforcers. Thus, a different experimental design may be more appropriate in comparing these interventions.

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

In summary, few studies have compared the effects of isolated and synthesized contingencies in FAs, and the few studies that have compared the effects of isolated and synthesized contingencies have produced different results (Fisher et al., 2016; Slaton et al., 2017). Given that these studies did not control for other differences across FA methodologies, it is possible that one or more of these variables influenced results. Furthermore, only one study

(Slaton et al., 2017) compared treatment outcomes based on isolated and synthesized contingencies, and the design used to compare the effects may have influenced outcomes. Therefore, the purpose of the current study was to compare the outcomes of FAs that involve isolated versus synthesized contingencies while controlling for other differences across FAs (e.g., design, type of control condition, inclusion of precursor behavior) (Study 1) and to compare effects of function-based interventions based on the outcomes of differentiated isolated and synthesized FAs while using an experimental design (multiple baseline across functions design) that may address the limitation of comparing treatments using a multielement design (Study 2).

Study 1 Method: Isolated versus Synthesized FAs

Participants

Participants were five children, two who attended a university-based early intensive behavioral intervention (EIBI) program and three who attended a university-based preschool, referred for the assessment and treatment of problem behavior that occurred multiple times per day. Tim, a 3-year-old boy diagnosed with autism spectrum disorder (ASD), was referred for tantrum behavior (i.e., crying, whining, screaming, and flopping). He communicated using single-word utterances and gestures (pointing). Adam, a 4-year-old boy with no known diagnoses, was referred for tantrum behavior (i.e., crying, whining, screaming, and flopping) and physical aggression (i.e., hitting, kicking, and pushing others). He communicated using three- to five-word sentences. Sage, a 4-year-old girl with no known diagnoses was referred for inappropriate verbal behavior (IVB; i.e., screaming, crying, and verbal threats) and physical aggression (i.e., hitting, kicking, pushing, and spitting on others). She communicated using complete and complex sentences. Christopher, a 3-year-old boy with no known diagnoses was

referred for physical aggression (i.e., hitting, kicking, and pushing others). He communicated using three-word sentences. Valerie, a 6-year-old girl diagnosed with Down syndrome and ASD, was referred for physical aggression (i.e., hitting, grabbing, and biting others). She communicated using three- to five-word sentences.

Setting and Materials

Trained graduate students conducted FA sessions in a session room (Tim) or the participant's classroom (Valerie, Adam, Christopher, Sage). Session rooms were barren (i.e., no table or chairs) and contained a padded floor and walls to ensure Tim's safety due to his tantrums which included forcefully flopping to the ground. Adam, Christopher, and Sage's sessions were conducted during free play or outside time within the context of the typical preschool classroom schedule. These classrooms were staffed with three teachers and a graduate student supervisor. During the free play period, various areas were set up in which the participants could play, which included dramatic play, blocks, 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, hula hoops). Valerie's early intervention program included five child-specific work stations (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 early intensive behavioral intervention (EIBI) program. Materials used during sessions were participant specific (i.e., those necessary to conduct test and control sessions) as determined by an open-ended interview and informal observations conducted by the experimenters.

Response Measurement and Interobserver Agreement

Trained observers collected data using software on iPods. Dependent variables were occurrences of precursor behavior (i.e., IVB and screaming) and problem behavior (i.e., physical aggression, tantrums, and IVB). Table 1 lists the precursor and problem behavior and their definitions for each participant. Note that precursor behavior was not reported or observed for three participants (Adam, Tim, and Sage), so it was not included as a dependent variable. Data collectors measured precursor and problem behavior using a percent-interval measure in which sessions were divided into 10-s intervals and the behavior was scored if it occurred during any portion of the interval. Percent interval of target behavior (both precursor and problem behavior) was graphed as target behavior for data analysis; this was calculated by dividing the number of intervals in which either precursor or problem behavior occurred by the total number of 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 also 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 instructions 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 observed to occur following problem 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 and observed to evoke problem behavior during informal observations for each participant. Escape was defined as the removal of demands and materials that were reported to evoke problem behavior in the indirect assessment and in informal observations 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 if necessary.

A second observer simultaneously but independently collected data during at least 30% 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 and problem behavior) or duration measures (i.e., delivery of stimulus events). That is, 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). 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%. Mean IOA for Tim, Adam, Sage, Christopher, and Valerie was 97.6% (range, 70%-100%), 97.9% (range, 80%-100%), 98.3% (range, 56.7%-100%), 99.3% (range, 70%-100%), and 97.5% (range, 53%-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 Valerie's sessions was 53% because one data collector scored each demand delivered during a three-step prompting procedure instead of only the initial vocal-verbal instruction. After this session, data collectors were provided with retraining to score only the initial vocal-verbal instruction as a demand.

Pre-Assessment Procedures

Prior to conducting FAs, Masters and Ph.D. level Board Certified Behavior Analysts (BCBAs) interviewed supervisors for each participant using 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 A). Experimenters conducted IAs in a conference room or office containing a table and chairs. For each participant, an experimenter conducted the IA with two or three classroom supervisors who were doctoral students in a behavior analysis program, had taken a doctoral-level course in functional behavioral assessment and function-based intervention, had supervised training in the assessment and treatment of problem behavior, and had worked for at least three months in the classroom in which the participant attended. Questions focused on identification of target behavior, antecedents likely to evoke target behavior, consequences that followed target 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 experimenters conducted the IA for a participant, they conducted an informal observation in the participant's classroom to gain additional information regarding the problem

behavior, precursor behavior, and environmental events. Upon completing the observation, both the IA and observation information were reviewed to determine definitions of problem behavior and precursor behavior (if applicable) and the conditions to be conducted in subsequent isolated and synthesized FAs. Once specific conditions were determined, information from the IA and observation were used to tailor the different conditions for each participant (i.e., high-preferred items to be used in tangible conditions, attention or interactions to manipulate in attention conditions, and demands or tasks to use in escape conditions).

Functional Analyses

Based on the IA and informal observations for each participant, experimenters conducted two isolated contingency FAs and one synthesized contingency FA (see Table 2 for conditions conducted for each participant). All sessions were 5 min. During test conditions in all FAs, experimenters placed contingencies on both precursor (when applicable) and problem behavior. We used a pairwise design (Tim, Adam, and Sage) or a pairwise with a reversal design (Christopher and Valerie) to demonstrate experimental control. 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 and 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. In addition, experimenters wore different color t-shirts across conditions to aid in discrimination.

Tim. Results of Tim's IA and informal observation suggested that his problem behavior was tantrum behavior and that he did not display a precursor to this problem behavior.

Furthermore, these assessments suggested that Tim's target behavior was evoked when difficult demands (e.g., matching identical items, one-step instructions, gross motor imitation, articulation) were presented and access to preferred tangibles (e.g., coloring materials, balls, playdoh, moon sand) was removed or denied, and that terminating demands and regaining access to preferred tangibles were maintaining his target behavior. Therefore, we conducted an isolated escape FA, an isolated tangible FA, and a synthesized escape and tangible FA with Tim.

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 by stating, "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 matching!"). However, contingent on target behavior, 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. After 30 s elapsed, the experimenter again presented the demands, signaled by "It's time to work." The condition-specific control condition consisted of no demands and no access to tangibles (i.e., tangibles were not present in the session room).

During the isolated tangible FA, a tangible test condition and a condition-specific control condition were rapidly alternated. Prior to the test condition, the experimenter presented Tim with a bin of his high-preferred tangibles for 1 min. Next, the experimenter began the session by stating, "It's my turn" and removing the tangibles. Contingent on target behavior the experimenter said, "You can have it" and provided access to the tangibles for 30 s. After 30 s elapsed, the experimenter again removed the tangibles, signaled by "It's my turn." The condition-specific control condition consisted of access to the same high-preferred tangibles used in tangible test condition and no demands.

During the synthesized escape and tangible FA, a combined escape and tangible test condition and a condition-specific control condition were rapidly alternated. Prior to the test condition, the experimenter presented Tim with a bin of the same high-preferred tangibles that were presented in the tangible test condition for 1 min. Next, the experimenter began the session by stating, "It's my turn, it's time to work," removing the tangibles, and immediately delivering the same demands as in the escape test condition. Contingent on compliance with a demand, the experimenter delivered praise (e.g., "Nice matching!"). However, contingent on target behavior, the experimenter said, "Ok you don't have to, you can have it," provided escape (i.e., no longer delivered demands and removed task materials), and provided access to the tangibles for 30 s. After 30 s elapsed, the experimenter again removed the tangibles and presented demands, signaled by "It's my turn, it's time to work." The condition-specific control condition consisted of access to same high-preferred tangibles used in the test conditions and no demands.

Adam. Results of Adam's IA and informal observation suggested that his problem behavior included physical aggression and tantrum behavior and that he did not display a precursor to this problem behavior. Furthermore, these assessments suggested that his target behavior was evoked when transition demands (e.g., "Walk to the bathroom," "Line up," "Get your nametag") were presented and access to preferred tangibles (e.g., bubbles, balloons, bumble ball) were removed or denied, and that terminating demands and regaining access to preferred tangibles were maintaining his target behavior. Therefore, we conducted an isolated escape FA, an isolated tangible FA, and a synthesized escape and tangible FA with Adam.

Adam's FAs were identical to Tim's with a few exceptions. First, during conditions in which demands were delivered, demands for Adam included transition demands. Second, during conditions in which tangibles were manipulated, Adam's preferred tangibles were used. Third,

given that his sessions were conducted in the classroom, access to items (e.g., painting, house and figures, dinosaurs, blocks) and interactions (e.g., praise for appropriate behavior) typically available during the ongoing classroom activity were available during all conditions. Fourth, in conditions in which tangibles were manipulated, high-preferred tangibles were manipulated in addition to other tangibles available in the classroom with which Adam was playing at certain times. For example, when removing tangibles, the experimenter removed not only the high-preferred tangibles, but also any other tangible with which Adam was engaged with at the time.

Sage. Results of Sage's IA and informal observation suggested that her problem behavior was inappropriate verbal behavior (IVB) and physical aggression and that she did not display any precursor to problem behavior. Furthermore, these assessments suggested that Sage's target behavior was evoked when preferred attention (e.g., conversation, eye contact, being picked up and swung around, tickles) was diverted from her and delivered to her peers and access to preferred tangibles (e.g., playdoh, babies, Barbie's, stuffed animals) was removed or denied, and that delivery of attention (i.e., reprimands and rationales) and regaining access to preferred tangibles were maintaining her target behavior. Therefore, we conducted an isolated diverted-attention FA, an isolated tangible FA, and a synthesized diverted-attention and tangible FA with Sage.

During the isolated diverted-attention FA, a diverted-attention test condition and a condition-specific control condition were rapidly alternated. Since sessions were conducted in the classroom, Sage had access to items that were available during the ongoing classroom activity during all sessions. Prior to test sessions, however, the experimenter told classroom teachers not to interact with Sage during the session, and the experimenter provided Sage 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 the things in this area” and provided Sage’s preferred attention to peers in her area. Contingent on target behavior, the experimenter delivered a brief (approximately 3-5 s) reprimand or rationale. For IVB, the experimenter might say, “Don’t do that, it’s too loud for our friends.” For aggression, the experimenter might say, “Stop hitting me, it isn’t nice.” Then, the experimenter again removed their attention from Sage and provided Sage’s preferred attention to peers in her immediate area. Prior to the condition-specific control condition, experimenters reminded classroom teachers to provide attention to peers in Sage’s area to decrease the likelihood of them soliciting attention from the experimenter. During the control condition, the experimenter provided continuous preferred attention to Sage while she had access to items typically available during the ongoing classroom activity.

Sage’s isolated tangible FA was similar to the one conducted with Adam except that Sage’s high-preferred items were used in this FA.

During the synthesized diverted-attention and tangible FA, a combined diverted-attention and tangible test condition and a condition-specific control condition were rapidly alternated. Because sessions were conducted in the classroom, Sage had access to items that were available during the classroom free play or outside period during all sessions. However, prior to the test sessions, the experimenter told classroom teachers not to interact with Sage during the session, and the experimenter provided Sage with her preferred attention for 1 min. At the beginning of the session, the experimenter began the session by stating, “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” and provided Sage’s preferred attention to peers in her area. Contingent on target behavior, the experimenter delivered a brief (approximately 3-5 s) reprimand or rationale (same reprimands and rationales

provided in isolated diverted-attention test conditions) and access to high-preferred tangibles. Given that her sessions were conducted in the classroom, access to items and interactions typically available during the ongoing classroom activity were available during all conditions. Additionally, high-preferred tangibles were manipulated in addition to any tangibles available in the classroom in which Sage was engaged (i.e., when removing tangibles, the experimenter removed not only the high-preferred tangibles, but also any other tangible with which Sage was engaged at the time). After 30 s elapsed, the experimenter again removed the tangibles, signaled by "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." Prior to the condition-specific control condition, experimenters reminded classroom teachers to provide attention to peers in Sage's area to decrease the likelihood of them soliciting attention from the experimenter. During the control condition, the experimenter provided continuous preferred attention to Sage while she had access to high-preferred tangibles and items typically available during the ongoing classroom activity.

Christopher. Results of Christopher's IA and informal observation suggested that his problem behavior was physical aggression and that his precursor behavior was screaming. Furthermore, his assessments suggested that his target behavior was evoked when attention (e.g., conversation, eye contact) was diverted to a peer or another teacher and access to preferred tangibles (e.g., moon sand, water beads, bumble ball) was removed or denied, and that delivery of attention in the form of reprimands and rationales and regaining access to preferred tangibles were maintaining his target behavior. Therefore, we conducted an isolated diverted-attention FA, an isolated tangible FA, and a synthesized diverted-attention and tangible FA with Christopher.

Christopher's FAs were similar to Sage's with two exceptions. First, during conditions in which attention was diverted to peers, attention delivered to peers included Christopher's preferred attention mentioned above. Second, during conditions in which tangibles were manipulated, Christopher's preferred tangibles were used.

Valerie. Results of Valerie's IA and informal observation suggested that her problem behavior was physical aggression and that her precursor behavior was IVB. Furthermore, these assessments suggested that her target behavior was evoked when difficult demands (e.g., sorting, articulation) were presented and access to preferred tangibles (e.g., mirror, music toys, sensory bin) was removed or denied, and that terminating demands and regaining access to preferred tangibles were maintaining her target behavior. Therefore, we conducted an isolated escape FA, an isolated tangible FA, and a synthesized escape and tangible FA with Valerie.

Valerie's FAs were similar to Tim's with a few exceptions. First, all conditions were conducted in Valerie's classroom. Second, during all conditions, contingencies were placed on both her problem and precursor behavior. Third, during conditions in which demands were delivered, demands for Valerie included her difficult demands mentioned above. Fourth, during conditions in which tangibles were manipulated, Valerie's preferred tangibles were used. Fifth, given that her sessions were conducted in the classroom, during all conditions, tangibles were present (during the isolated escape condition access to these tangibles was blocked) and access to interactions typically available during the ongoing classroom activity were available.

Study 1 Results

Figure 1 shows the data for Tim (top panel) and Adam's (bottom panel) FAs of target behavior. Target behavior for Tim included only his problem behavior (tantrum behavior); target behavior for Adam included only his problem behavior (physical aggression and tantrum

behavior). For both participants, experimenters conducted an isolated escape FA, an isolated tangible FA, and a synthesized escape and tangible FA. Results for both participants showed that target behavior occurred at higher levels during the test conditions as compared to the control conditions in all three FAs. For Tim, somewhat higher levels of target behavior occurred in isolated tangible test conditions and synthesized tangible and escape test conditions as compared to isolated escape test conditions. For Adam, somewhat higher levels of target behavior occurred in the synthesized tangible and escape test conditions as compared to the isolated escape and isolated tangible test conditions.

Figure 2 shows the data for Sage (top panel) and Christopher's (bottom panel) FAs of target behavior. Target behavior for Sage included only her problem behavior (IVB and physical aggression); target behavior for Christopher included both his problem behavior (physical aggression) and his precursor behavior (screaming). For both participants, experimenters conducted an isolated diverted-attention FA, an isolated tangible FA, and a synthesized diverted-attention and tangible FA. Results for Sage showed higher levels of target behavior in the test condition as compared to the control condition in the isolated tangible FA and the synthesized diverted-attention and tangible FA. No target behavior occurred in the isolated diverted-attention FA. Results for Christopher showed higher levels of target behavior in the test condition as compared to the control condition only in the isolated tangible FA. Infrequent target behavior occurred in the isolated diverted-attention FA and the synthesized FA. Also, we replicated the results of the isolated diverted-attention and isolated tangible FAs, which provided additional support for those outcomes. It is important to note that Christopher engaged in more precursor behavior than problem behavior across all FAs.

Figure 3 shows the data for Valerie's FA of target behavior. Target behavior for Valerie included both her problem behavior (physical aggression) and her precursor behavior (IVB). Experimenters conducted an isolated escape FA, an isolated tangible FA, and a synthesized escape and tangible FA. Results for Valerie showed that target behavior occurred at higher levels during the test conditions as compared to the control conditions in the isolated escape FA and the synthesized escape and tangible FA. Infrequent target behavior occurred in the isolated tangible FA. Also, we replicated the results of these FAs, which provided additional support for these outcomes. It is important to note that Valerie engaged in more problem behavior than precursor behavior across all FAs.

Study 2 Method: Functional Communication Training + Extinction

Participants, Setting, and Materials

Participants were the same five children who participated in Study 1. The setting and materials were the same as those in Study 1 except discriminative stimuli were not used during treatment sessions. Additionally, a laminated piece of red construction paper was used for one of Tim's communication responses during one treatment condition.

Response Measurement and Interobserver Agreement

Trained observers collected data on the same variables in Study 1 including problem behavior, precursor behavior (if applicable), compliance (in sessions in which demands were presented), and experimenter behavior (i.e., delivery of vocal-only instruction, duration of reinforcer delivery). In addition, observers collected data on the frequency of prompted and independent functional communication responses (FCRs), which were individually defined for each participant. Prompted FCRs were defined as those that occurred within 5 s of an experimenter prompt. Independent FCRs were defined as those that occurred outside of an

experimenter prompt. Data for prompted and independent FCRs were converted to a rate measure for the purpose of data analysis; however, only independent FCRs are presented in the figures.

A second observer simultaneously, but independently, collected data during at least 30% of sessions across phases with all participants. As in Study 1, IOA was calculated using the interval method for behaviors scored using percent-interval measures (i.e., precursor and problem behavior) or duration measures (i.e., delivery of stimulus events). IOA was calculated using the proportional agreement method for behaviors scored using frequency measures (i.e., demands, compliance, independent FCRs). Mean IOA for Tim, Adam, Sage, Christopher, and Valerie was 98.9% (range, 83%-100%), 98.5% (range, 87%-100%), 98.7% (range, 90%-100%), 98.6% (range, 93%-100%), and 98.7% (range, 70%-100%), respectively. For the one session in which IOA was below 80%, observers were retrained on correct body positioning while collecting data to minimize the possibilities of responses being missed. For example, IOA for one of Valerie's sessions was 70% because one data collector was standing too far away to hear occurrences of independent FCRs. After this session, data collectors were provided feedback and were trained to stand close enough to Valerie to hear vocal responses emitted.

Procedure

The effects of functional communication training with extinction (FCT+EXT; Tiger et al., 2008) was evaluated for variables in which FAs produced differentiated responding (i.e., higher levels of target behavior in the test condition compared to the control condition) in Study 1. See Table 2 for the FAs for participants that showed differentiated responding (bolded conditions). We used a nonconcurrent multiple baseline across functions design (e.g., Neidert, Iwata, & Dozier, 2005; Smith, Iwata, Vollmer, & Zarcone, 1993) to evaluate the effects of

FCT+EXT interventions across isolated and synthesized continencies based on FA outcomes for four participants (Tim, Valerie, Adam, and Sage). We used a reversal design to evaluate the effects of FCT+EXT in the isolated tangible condition for Christopher given that was his only FA that showed differentiated responding.

For all participants, baseline conditions were the same as the test conditions in the FAs that showed differentiated responding. In fact, sessions in the initial baselines for all participants were the test sessions from the FA. However, for most participants additional sessions were conducted. For all participants, FCT+EXT sessions involved delivery of the putative reinforcer(s) programmed for target behavior in baseline for the occurrence of both prompted and independent FCRs. In addition, all target behavior (problem and precursor behavior) was placed on extinction (i.e., the putative reinforcer was no longer delivered contingent on target behavior). Participants were taught to emit specific FCRs using various procedures. During initial FCT+EXT sessions, we conducted pre-session training for all participants. That is, we conducted multiple trials in which we implemented the antecedent condition, prompted participants to engage in the target FCR, and provided the programmed reinforcer contingent on the target FCR. Once a participant was consistently and independently emitting the target FCR, the experimenter no longer conducted pre-session training. Additional procedures were used to increase the occurrence of the target FCR. For some participants (Adam, Sage, Christopher), we provided a rule immediately prior to the session in which the participant was reminded to engage in the target FCR to access the programmed reinforcer(s) (e.g., "If you want a break, all you have to do is ask for it by saying, 'May I have a break please' or 'Can I have a break please'"). For other participants, we used a prompt-delay procedure in which experimenters systematically

increased the delay from the onset of the antecedent to the prompt to engage in the target FCR from 0 s to 10 s.

Tim. Based on the outcome of Tim's FAs, we evaluated the effects of FCT+EXT for isolated escape, isolated tangible, and synthesized escape and tangible contingencies. During isolated tangible treatment sessions, procedures were similar to tangible baseline sessions except Tim was taught to emit the FCR "toy" to gain access to high-preferred tangibles. Specifically, every time Tim said, "toy" the experimenter said, "Ok, you can have it" and provided him access to a bin of his preferred items for 30 s. In addition, instances of target behavior no longer resulted in access to preferred tangibles. During isolated escape treatment sessions, procedures were similar to the isolated escape baseline sessions except Tim was taught to emit the FCR "no" to escape demands. Specifically, every time Tim said, "no" 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. In addition, instances of target behavior no longer resulted in escape from demands. During synthesized escape and tangible treatment sessions, procedures were similar to synthesized escape and tangible baseline sessions except Tim was taught to emit the FCR of touching a red laminated card to escape demands and gain access to high-preferred tangibles. Specifically, every time Tim touched the card the experimenter said, "Ok you don't have to, you can have it" and provided escape from demands (i.e., no longer delivered demands and removed task materials) and access to the bin of preferred tangibles for 30 s. In addition, instances of target behavior no longer resulted in escape from demands and access to tangibles.

Adam. Based on the outcome of Adam's FAs, we evaluated the effects of FCT+EXT for isolated escape, isolated tangible, and synthesized escape and tangible contingencies. During isolated escape treatment sessions, procedures were similar to the isolated escape baseline

sessions except Adam was taught to emit the FCR "May I have a break, please" to escape demands; however, any full sentence that Adam engaged in suggesting that he wanted a break (e.g., Can I have a break, please"), was also reinforced. Specifically, every time Adam said, "May I have a break, please" (or a similar sentence) the experimenter said, "Ok, you don't have to" and provided escape (i.e., no longer delivered demands) for 30 s. In addition, instances of target behavior no longer resulted in escape from demands. During isolated tangible treatment sessions, procedures were similar to isolated tangible baseline sessions except Adam was taught to emit the FCR "May I have that toy, please" to gain access to high-preferred tangibles; however, any full sentence that Adam engaged in suggesting that he wanted access to his preferred tangibles (e.g., "May I have that back"), was also reinforced. Specifically, every time Adam said, "May I have that toy, please" (or a functionally similar full sentence) the experimenter said, "Ok, you can have it" and provided him access to his bin of preferred items for 30 s. In addition, instances of target behavior no longer resulted in access to preferred tangibles. During synthesized escape and tangible treatment sessions, procedures were similar to synthesized escape and tangible baseline sessions except Adam was taught to emit the FCR "I want my way, please" to escape demands and gain access to high-preferred tangibles; however, any full sentence in which Adam appropriately asked for a break and tangibles (e.g., "Can I have a break with my toys, please), was reinforced. Specifically, every time Adam said, "I want my way, please" (or a functionally similar sentence) the experimenter said, "Ok you don't have to, you can have it" and provided escape from demands (i.e., no longer delivered demands) and access to his bin of preferred tangibles for 30 s. In addition, target behavior no longer resulted in escape from demands and access to preferred tangibles.

Sage. Based on the outcome of Sage's FAs, we evaluated the effects of FCT+EXT for isolated tangible and synthesized diverted-attention and tangible contingencies. During isolated tangible treatment sessions, procedures were similar to isolated tangible baseline sessions except Sage was taught to emit the FCR "May I have that toy, please" to gain access to high-preferred tangibles; however, any full sentence that Sage engaged in suggesting that she wanted access to her preferred tangibles (e.g., "May I have that back"), was also reinforced. Specifically, every time Sage said, "May I have that toy, please" (or a functionally similar full sentence) the experimenter said, "Ok, you can have it" and provided her access to her bin of preferred items for 30 s. In addition, instances of target behavior no longer resulted in access to tangibles. During synthesized diverted-attention and tangible treatment sessions, procedures were similar to the synthesized diverted-attention and tangible baseline sessions except Sage was taught to emit the FCR "I want my way, please" to access high-preferred attention and tangibles; however, any full sentence in which Sage appropriately asked for attention and tangibles (e.g., "Can we play together with my toys"), was reinforced. Specifically, every time Sage said, "I want my way, please" (or a functionally similar full sentence) the experimenter said, "Ok, you can have it" and provided attention and access to her bin of preferred tangibles for 30 s. In addition, instances of target behavior no longer resulted in access to preferred attention and tangibles.

Christopher. Based on the outcome of Christopher's FAs, we evaluated the effects of FCT+EXT for isolated tangible. During isolated tangible treatment sessions, procedures were similar to isolated tangible baseline sessions except Christopher was taught to emit the FCR "May I have that toy, please" to gain access to high-preferred tangibles; however, any full sentence that Christopher engaged in suggesting that he wanted access to his preferred tangibles (e.g., "May I have that back"), was also reinforced. Specifically, every time Christopher said,

"May I have that toy, please" (or a functionally similar full sentence) the experimenter said, "Ok, you can have it" and provided him access to his bin of preferred items for 30 s. In addition, instances of target behavior no longer resulted in access to tangibles.

Valerie. Based on the outcome of Valerie's FAs, we evaluated the effects of FCT+EXT for isolated escape and synthesized escape and tangible. During isolated escape treatment sessions, procedures were similar to the isolated escape baseline sessions except Valerie was taught to emit the FCR "break please" to escape demands. Specifically, every time Valerie said, "break please" 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. In addition, instances of target behavior no longer resulted in escape from demands. Based on Valerie's responding in the isolated escape treatment evaluation we conducted some additional analyses. That is, because we saw variable levels of target behavior during some of the treatment sessions we went back and conducted within-session analyses to determine why this might be. Results of this additional analysis suggested that during escape periods of the treatment, Valerie sometimes engaged in behaviors in an attempt to access tangible items available in the classroom (e.g., approaching, reaching and grabbing for) in conjunction with target behavior. Therefore, we conducted the same treatment in a barren session room where no tangibles were present. During synthesized escape and tangible treatment sessions, procedures were similar to synthesized escape and tangible baseline sessions except Valerie was taught to emit the FCR "my way, please" to escape demands and gain access to high-preferred tangibles. Specifically, every time Valerie said, "my way, please" the experimenter said, "Ok you don't have to, you can have it" and provided escape from demands (i.e., no longer delivered demands and removed task materials) and access to her bin of preferred tangibles for 30 s. In addition, instances of target behavior no longer resulted in

escape from demands and access to tangibles. We also conducted additional analyses in this condition in an attempt to further evaluate the isolated effects of escape. The first manipulation involved providing continuous access to high-preferred tangibles throughout the session (NCT) such that the FCR resulted in only a break; however, she continued to have access to the tangibles. In the second manipulation, we wanted to further determine the importance of the escape variable by providing high-preferred tangibles throughout the session but no longer providing escape for the FCR (NCT +EXT [FCR]). We conducted this analysis to determine whether no longer providing escape for FCRs would evoke target behavior.

Study 2 Results

Treatment evaluation results for Tim (left panel) and Adam (right panel) are depicted in Figure 4. For both participants, we evaluated effects of FCT+EXT under isolated escape, isolated tangible, and synthesized escape and tangible conditions. Results for both participants showed moderate levels of target behavior in baseline across all functions and decreases in target behavior with the implementation of FCT+EXT across all functions. In addition, during FCT+EXT, high levels of independent FCRs occurred across all functions. These data suggest FCT+EXT was similarly effective across all functions for both participants. It is important to note that during session 16 and 17 of synthesized treatment sessions for Adam, he began emitting high rates of FCRs. Within-session analyses suggested he would emit FCRs multiple times in a row during the EO-on period and sometimes he would emit FCRs during the EO-off period. To decrease these repetitive FCRs, the experimenter provided a rule to Adam prior to each session reminding him that he only needed to ask one time. Following the addition of the rule, rate of FCRs decreased to acceptable levels (i.e., one to two responses per minute).

Treatment evaluation results for Sage (top panel) and Christopher (bottom panel) are depicted in Figure 5. For Sage, we evaluated effects of FCT+EXT under isolated tangible and synthesized diverted-attention and tangible conditions. Results showed moderate levels of target behavior in both baseline conditions and decreases in target behavior with the implementation FCT+EXT across both functions. In addition, FCT+EXT resulted in high levels of independent FCRs across functions. For Christopher, we evaluated effects of FCT+EXT under the isolated tangible condition. Results showed moderate levels of target behavior in baseline conditions and decreases in target behavior and increases in FCRs with the implementation of FCT+EXT conditions. These data suggest that FCR+EXT was similarly effective for all relevant functions for both participants.

Treatment evaluation results for Valerie are depicted in Figure 6. For Valerie, we evaluated the effects of FCT+EXT under isolated escape and synthesized escape and tangible conditions. Results for Valerie showed moderate levels of target behavior in baseline across all functions. With the implementation of FCT+EXT in the isolated escape treatment sessions conducted in her classroom, we saw variable levels of target behavior and high levels of independent FCRs. With the implementation of FCT+EXT in the isolated escape treatment sessions conducted in a session room, we saw low levels of target behavior and maintained high levels of independent FCRs. These data support the isolated FA results suggesting target behavior occurred to access escape alone; however, it also suggests that when tangibles are present in the environment, problem behavior may occur in an attempt to access those tangibles. With the implementation of FCT+EXT in the synthesized escape and tangible treatment sessions, we observed decreases in target behavior and high levels of independent FCRs suggesting Valerie's target behavior is maintained by both escape from demands and access to high-

preferred tangibles. With the implementation of NCT, we observed maintenance of low levels of target behavior and high levels of independent FCRs again suggesting that escape was valuable; however, it is also possible that Valerie was engaging in FCRs to access uninterrupted interaction with her preferred items. Furthermore, with the implementation of NCT+EXT (FCR), we observed decreases in independent FCRs and maintained low levels of target behavior. These data may suggest the importance of the tangible variable as the functional variable; however, they may also suggest that continuous access to tangibles decreased the establishing operation for escape.

Discussion

We extended previous research (Hanley et al., 2014; Fisher et al., 2016) by comparing the outcomes of isolated and synthesized FAs while controlling for variables across FAs. In addition, we evaluated the effects of FCT+EXT for decreasing target behavior (problem behavior and precursor behavior) and increasing functional communication responses to access putative reinforcer(s) to determine the validity of FA outcomes. We extended previous research (Slaton et al., 2017) by using a multiple baseline across functions design to decrease the likelihood of interaction effects seen in multielement designs. Out of five participants, FA results suggested that all five participants' FAs were differentiated in at least one of their two isolated FAs. That is, for Tim and Adam, both isolated escape and isolated tangible FAs showed differentiated responding. For Sage and Christopher, the isolated tangible FA showed differentiated responding. For Valerie, the isolated escape condition showed differentiated responding. Synthesized FAs were differentiated for four out of five participants (all participants except Christopher). Furthermore, FCT+EXT was similarly effective for increasing FCRs and decreasing target behavior for all participants for all functions (isolated and synthesized).

Results of comparison of isolated and synthesized FAs were similar to results of Fisher et al. in that at least one isolated FA showed differentiated responding. Thus, although we showed differentiated responding in the synthesized FA for four out of five of these participants, the results suggest that synthesized contingencies were not necessary to produce differentiated responding in FAs. For example, for Tim and Adam, it is possible that their target behavior is maintained by multiple control (i.e., tangibles and escape) but synthesizing those contingencies is not necessary. For Sage and Valerie, it is possible that their 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. However, our data for Valerie, particularly with additional analyses may suggest the importance of both variables for maintaining problem behavior. Although we conducted additional analyses in an attempt to tease this out, it is still unclear whether one variable (escape) was discriminative for the availability of tangibles or a synthesized contingency was important in the maintenance of the behavior. Finally, for Christopher, we only observed differentiated responding in the isolated tangible FA but not in the synthesized diverted-attention and tangible FA even though it included the tangible contingency. This may be because the inclusion of the diverted-attention contingency interfered with target behavior maintained by access to tangibles. For example, in this situation, rationales and reprimands may have functioned as punishers for tangibly maintained target behavior.

Results of our comparison of isolated and synthesized FAs differed from Slaton et al. (2017) in that isolated FAs were differentiated for all five of our participants. Furthermore, for one participant, we did not show differentiated responding in the synthesized FA. Thus, it is possible that some of the variables that we controlled for in our study that varied across isolated and synthesized FAs in Slaton et al. may have influenced their outcomes. For example, it is

possible that the use of a pairwise design in which only two conditions are rapidly alternated as compared to a multielement design in which multiple test and one control condition may have influenced the outcomes in Slaton et al. It is also possible that participant characteristics (e.g., age, functioning level), contexts in which problem behavior was observed to occur (e.g., home vs. school), the skill sets and backgrounds of caregivers who were interviewed in the IA, and how the IAs were conducted may have influenced the difference in FA outcomes between our study and Slaton et al. For example, given that our caregiver informants were mostly doctoral students, many of whom had master's degrees and experience in functional assessment and function-based intervention, it is possible that they were better at predicting the isolated contingencies (including specific types of stimuli such as attention, tangibles, and demands) that maintained behavior, as compared to informants in Slaton et al.

Slaton and Hanley (2018) reported that only a small percentage of synthesized FA articles report reinforcing both precursor and problem behavior in isolated and synthesized FAs. The current study involved reinforcement of both precursor and problem behavior in both isolated and synthesized contingency FAs; however, only two of our participants' IAs (Christopher and Valerie) identified precursor behavior. Furthermore, our results suggested that Christopher engaged in more precursor behavior than problem behavior across all FAs, whereas Valerie engaged in more problem behavior than precursor behavior across all FAs. Future research might determine the prevalence of precursor behavior found via IAs, as well as the degree to which precursors occur during FAs. Furthermore, 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.

Results of our FCT+EXT evaluation also support the notion that synthesis was not necessary for the four participants for which differentiated responding was observed in the synthesized contingency. That is, FCT+EXT was similarly effective across isolated and synthesized functions. These results are different from Slaton et al. (2017) who showed that treatment based on the synthesized contingency was more effective than those based on isolated contingencies, even though differentiated responding occurred. As mentioned before, a possible reason for this difference is Slaton et al. used a multielement design to compare the effects of the treatment. Thus, the rapid alternation of combined contingencies compared to isolated contingencies may have influenced the efficacy of treatments that did not involve access to those additional reinforcers. Thus, our study used a nonconcurrent multiple baseline across functions design. That is, treatment for one functional variable was conducted at a time in order to control for the design limitations in Slaton et al.

Our results, as well as the results of various other studies evaluating the IISCA, suggest that escape and tangible are common variables manipulated in IISCA FAs. For example, for three of our participants, IAs suggested synthesized escape and tangible. Furthermore, many participants in IISCA studies have suggested these variables are common. It is possible escape and tangible are common variables manipulated in IISCA FAs because these two variables typically occur together in educational or learning settings (e.g., schools, EIBI classrooms). That is, typically tangibles are removed prior to demands being delivered, and when demands are terminated, tangibles are often available. Interestingly, two of our participants IA and observations suggested diverted-attention may evoke target behavior and rationales and reprimands may maintain target behavior; however, for both participants only isolated tangible and synthesized diverted-attention and tangible FAs were differentiated. Given what we know

about the prevalence of attention-maintained problem behavior, it is unclear why few IISCA FAs suggest maintenance by attention (Slaton & Hanley, 2018). Future research should be conducted to determine whether certain populations, behaviors, and contexts are likely to suggest certain synthesized variables are more prevalent than others.

Although the results of our study are clear, there are several limitations worth mentioning. One limitation is that IAs were conducted with two or more supervisors at the same time to allow for discussion and clarification of questions. By interviewing supervisors together there is potential that other people's opinion influenced responding. That is, one supervisor may have agreed with other supervisor's statements and omitted antecedents and consequences they themselves observed. Future research should compare conducting individual versus group IAs and outcomes.

There are several limitations associated with the methodology used to compare FAs. First, Adam and Tim engaged in higher levels of target behavior in the synthesized escape and tangible FA conditions compared to the isolated escape and isolated tangible FA conditions, which may suggest the synthesized contingency is more robust. However, it is possible that because the synthesized FA condition was conducted last (i.e., after both isolated conditions), a history of reinforcement influenced the level of responding in that last phase. Second, several participant's initial isolated FAs show little responding across control and test conditions (e.g., Tim and Sage); however, subsequent isolated and synthesized FAs did show responding. Thus, it is unclear whether these results are due to the variables manipulated or the order in which these conditions were implemented. Therefore, future research might involve counterbalancing the order of FAs in comparisons of isolated and synthesized FAs. Another option is to replicate FA phases to increase the confidence in those outcomes.

Another limitation of the study was that Tim quickly acquired FCRs in order to gain access to tangibles and escape demands; however, for the synthesized escape and tangible contingency, experimenters unsuccessfully attempted to train four vocal FCRs (i.e., "my way," "please," "break," "all done") before moving to the non-vocal response of a card touch. Furthermore, when trying to train those four vocal FCRs during the synthesized treatment sessions, Tim independently and frequently emitted the FCR taught and acquired in the escape condition (i.e., "no"). This could indicate that for Tim, the more potent reinforcer was escape. One thing we could have done was accept "no" for escape, then train him to emit the vocal FCR for access to tangibles during the break to access tangibles. Future research might involve evaluating the best ways to train FCRs when problem behavior is multiply controlled or synthesized. That is, is it better to train one omnibus mand for the synthesized contingency or separate FCRs for each of the different contingencies?

Multiple studies have shown the utility of combining EOs, consequences, or both in FAs (see Slaton & Hanley, 2018 for a review); however, most of this research has been conducted after FAs with isolated contingencies are undifferentiated. Few studies have shown the utility of synthesized contingencies from the start of the assessment process. Of the studies that have evaluated synthesized contingencies, it is unclear at this point the necessity of synthesizing contingencies to determine functional variables or for determining an effective treatment. Therefore, additional research should be conducted with various populations, target behaviors, contexts, settings, and contingencies in comparing isolated and combined contingencies.

The outcomes of this study do not necessarily negate the utility of synthesized FAs; however, future research is needed to determine the conditions under which they may be equally useful or more useful as compared to isolated contingencies. For example, it is possible that

synthesized treatments may be 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 more difficult to implement interventions or interventions that impede rehabilitation and education goals of the individual. Thus, future research is needed to determine whether this is the case. First, research could be conducted to determine the integrity with which treatments based on synthesized versus isolated contingencies are implemented. Second, 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. Third, social validity of treatments based on synthesized versus isolated contingencies should be conducted. That is, determining the degree to which caregivers and individuals prefer isolated versus synthesized treatments is important.

Given that synthesized treatments often involve two or three common contingencies (e.g., attention, tangible, escape), it would be interesting to compare the effects of an intervention based on antecedent and consequent manipulations based on all three common contingencies to a synthesized treatment based on an IISCA. If the former is effective, it may be one way to treat target behavior without conducting an FA; however, research on this type of procedure would need to be conducted to determine the validity, integrity with which it could be implemented, long term effects, and social validity of this type of intervention.

In summary, results of the current study suggest that although responding was differentiated in synthesized FAs for four out of the five participants, synthesized contingencies are not necessary to show functional relations between problem behavior and environmental

events. Furthermore, function-based treatments based on isolated contingencies were equally effective to those based on synthesized contingencies. Specifically, FCT+EXT was similarly effective across isolated and synthesized functions. Thus, future research is needed to determine the conditions under which synthesized FAs and treatments may be most useful.

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Figures

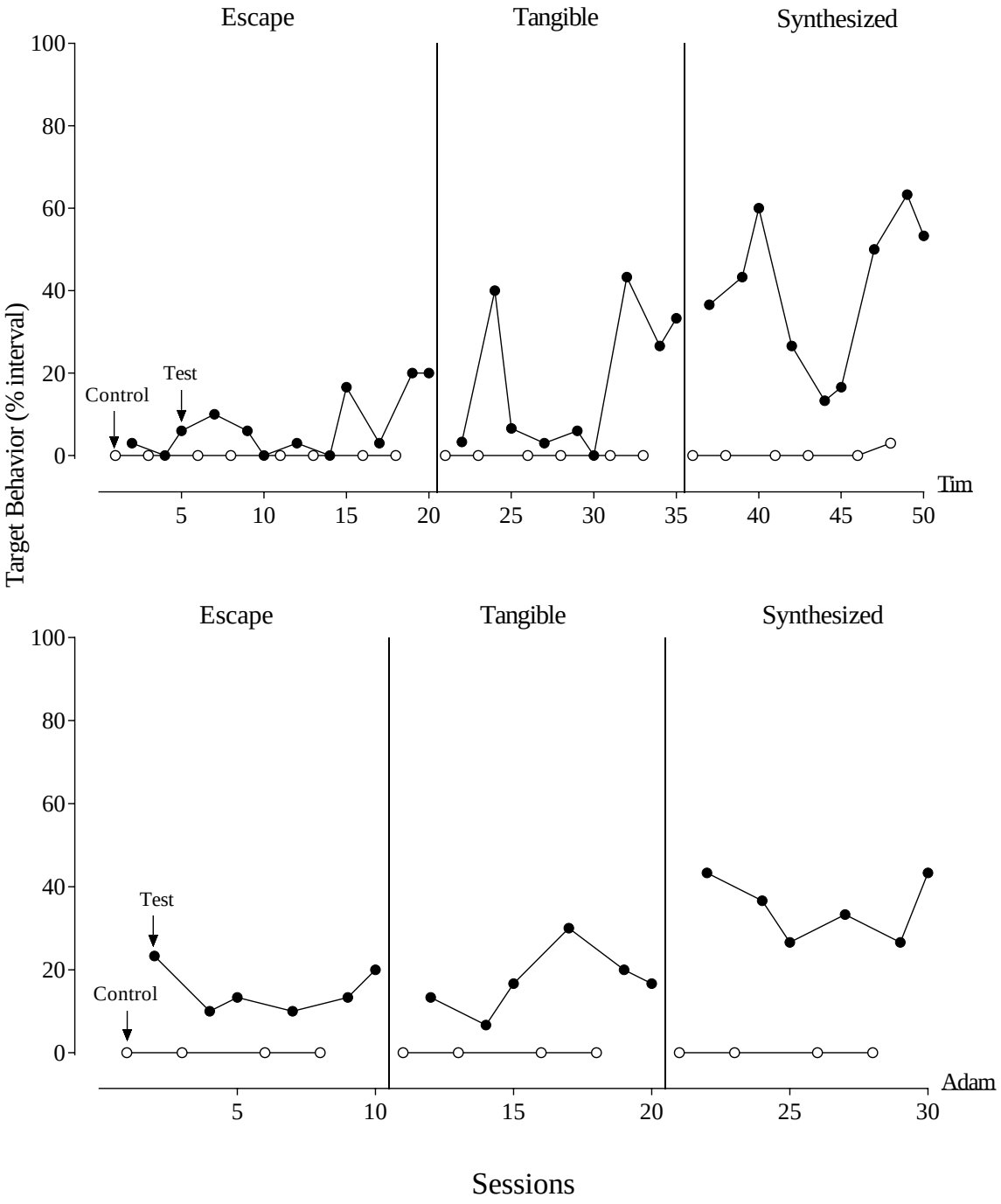

Figure 1. This figure depicts the percentage of target behavior during control and test conditions across the isolated escape, isolated tangible, and synthesized escape and tangible FAs for Tim (top panel) and Adam (bottom panel). Target behavior for Tim was his problem behavior (tantrum behavior); target behavior for Adam was his problem behavior (physical aggression and tantrum behavior).

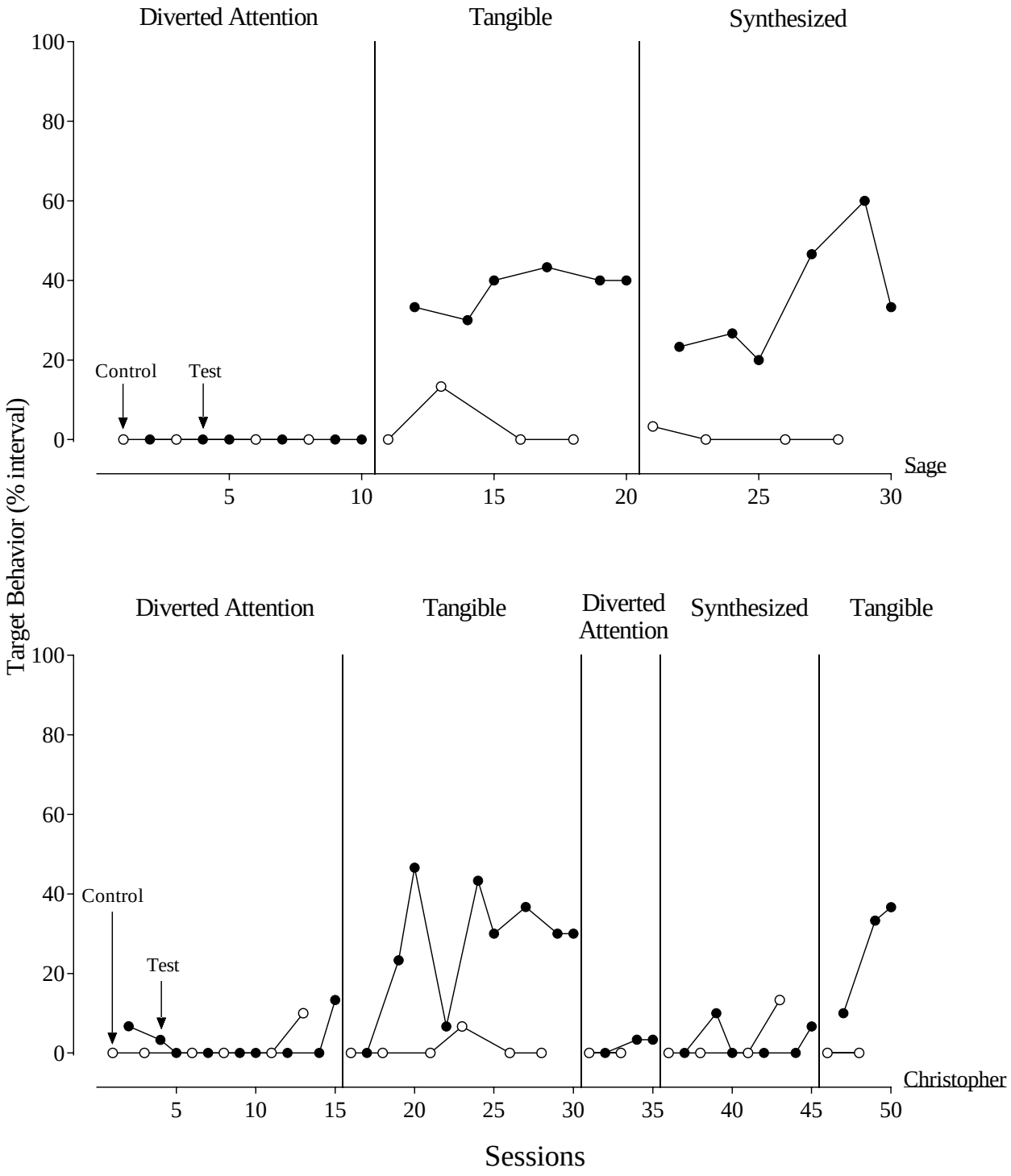

Figure 2. This figure depicts the percentage of target behavior during control and test conditions across the isolated diverted-attention, isolated tangible, and synthesized diverted-attention and tangible FAs for Sage (top panel) and Christopher (bottom panel). Target behavior for Sage was her problem behavior (IVB and physical aggression); target behavior for Christopher was his precursor behavior (screaming behavior) and problem behavior (physical aggression).

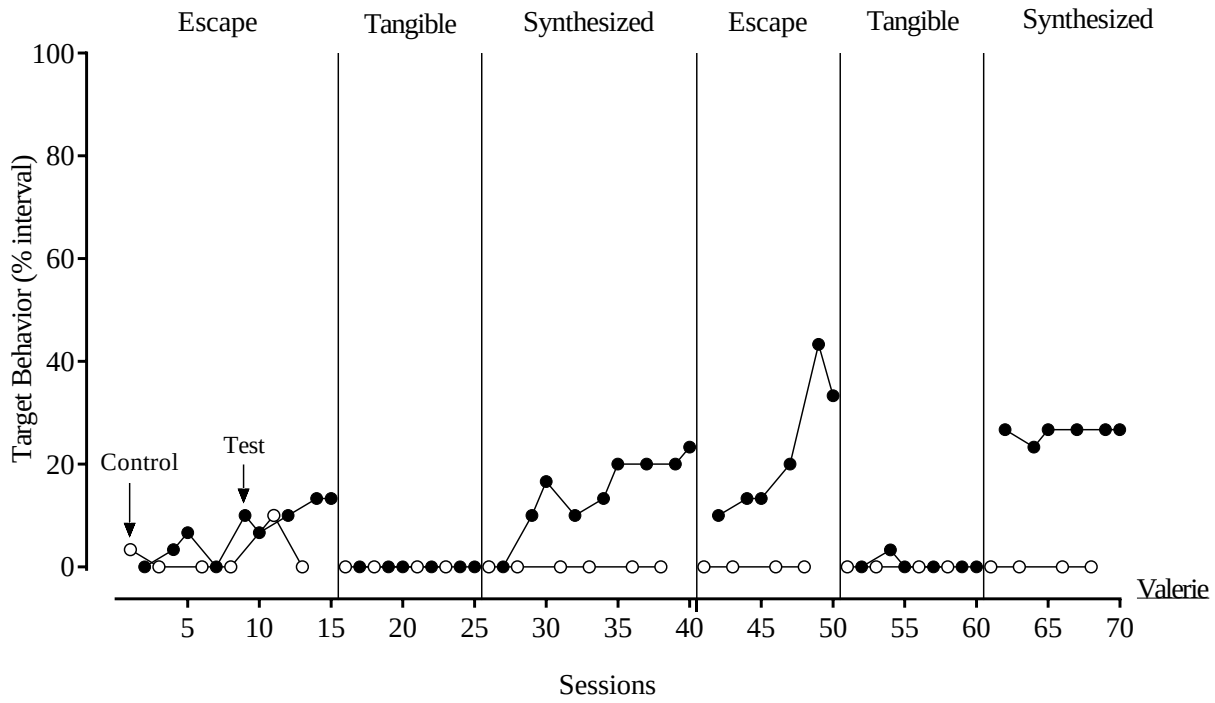

Figure 3. This figure depicts the percentage of target behavior during control and test conditions across the isolated escape, isolated tangible, and synthesized escape and tangible FAs for Valerie. Target behavior for Valerie was her precursor behavior (IVB) and problem behavior (physical aggression).

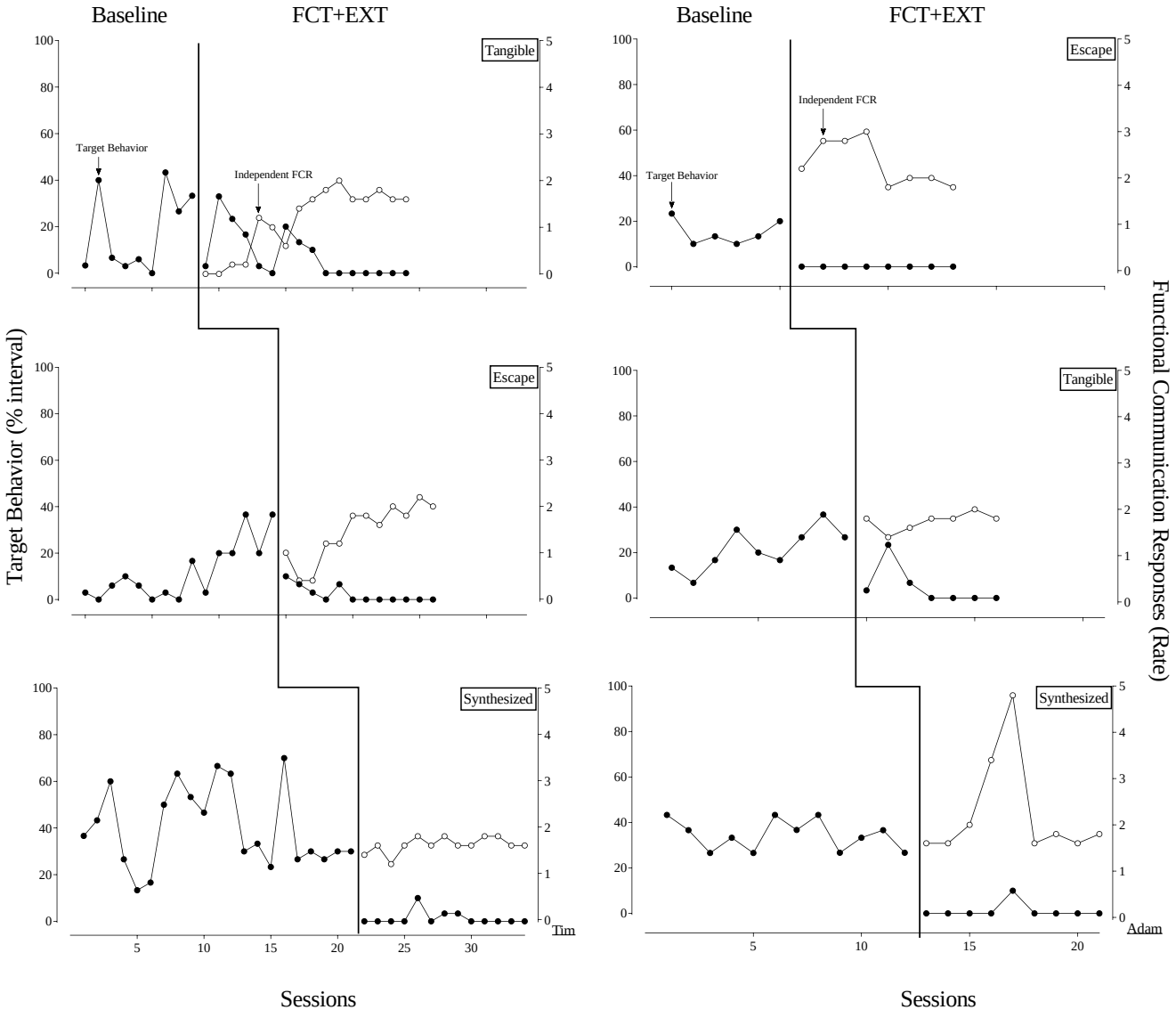

Figure 4. This figure depicts the percentage of target behavior and rate of independent FCRs during baseline and FCT+EXT conditions across isolated escape, isolated tangible, and synthesized escape and tangible treatment for Tim (left panel) and Adam (right panel). Target behavior for Tim included his problem behavior (tantrum behavior); target behavior for Adam included his problem behavior (physical aggression and tantrum behavior).

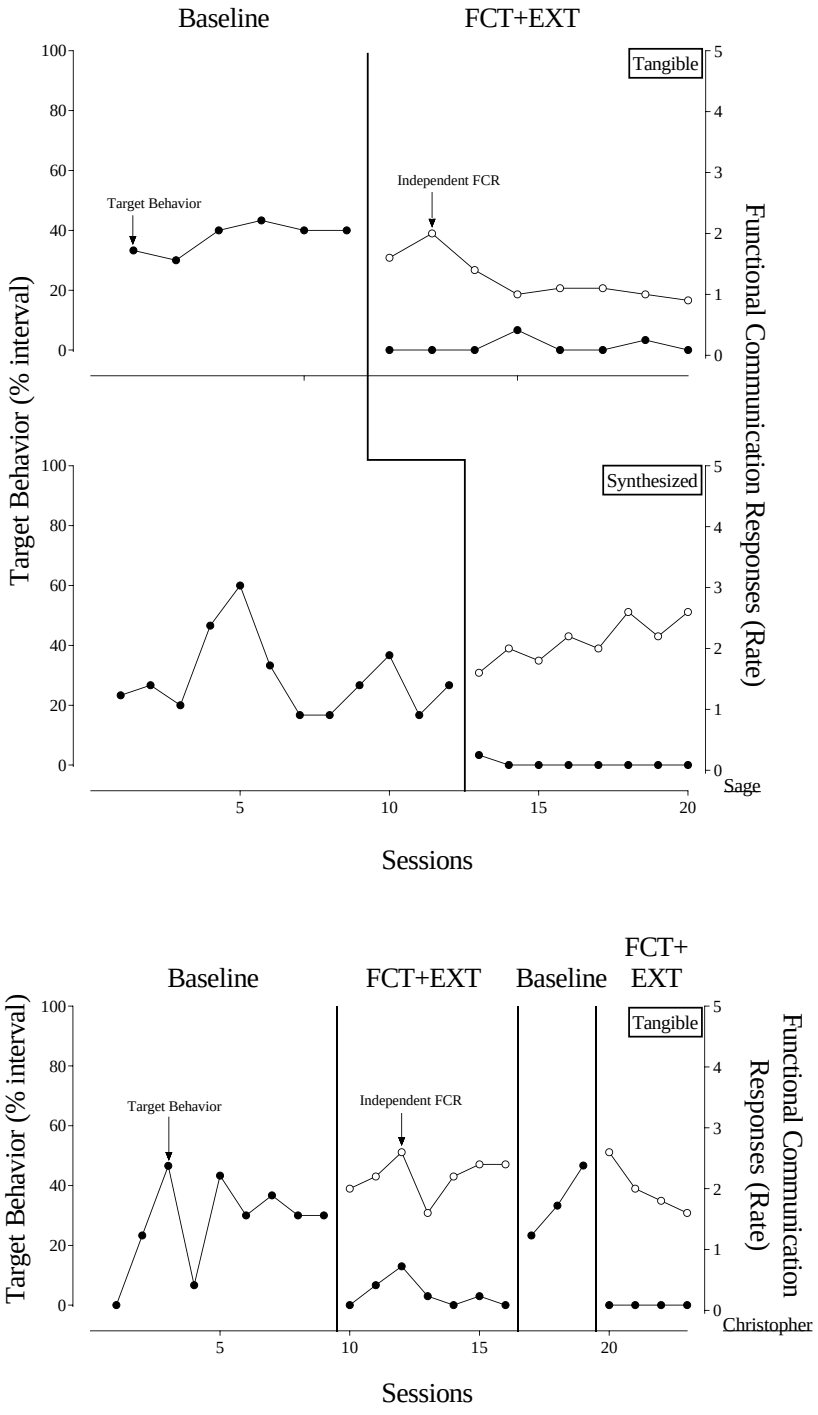

Figure 5. This figure depicts the percentage of target behavior and rate of independent FCRs during baseline and FCT+EXT conditions across isolated tangible conditions and synthesized diverted-attention and tangible treatment for Sage (top panel) and isolated tangible treatment for Christopher (bottom panel). Target behavior for Sage included her problem behavior (IVB and physical aggression); target behavior for Christopher included his precursor behavior (screaming behavior) and problem behavior (physical aggression).

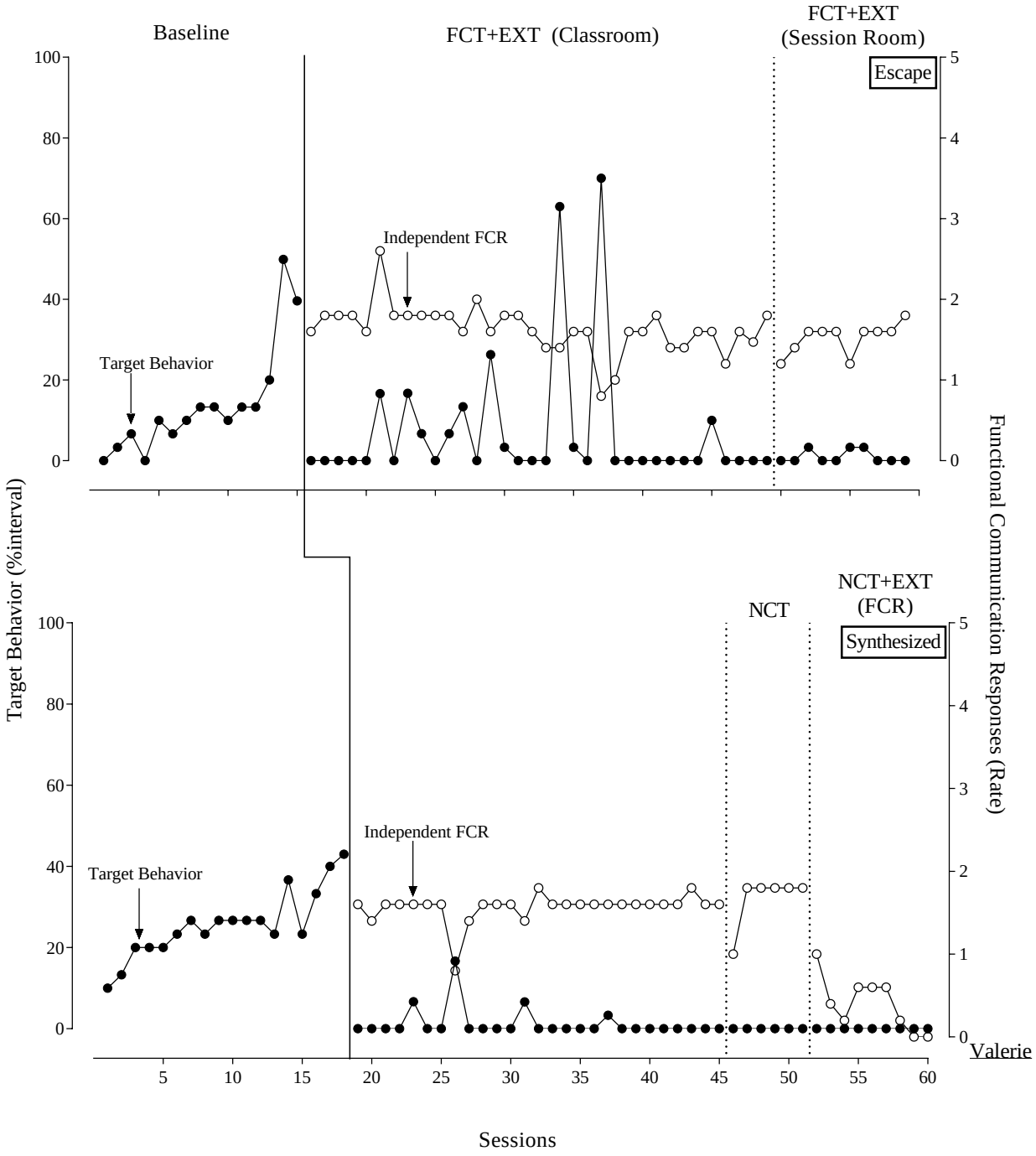

Figure 6. This figure depicts the percentage of target behavior and rate of independent FCRs during baseline and FCT+EXT conditions across and isolated escape and synthesized escape and tangible treatment for Valerie. Also depicted are the additional manipulations including noncontingent access to high-preferred tangibles (NCT) and noncontingent access to high-preferred tangibles where FCRs did not result in escape (NCT+EXT [FCR]). Target behavior for Valerie included her precursor behavior (IVB) and problem behavior (physical aggression).

Table 1.

Participant Target Behavior

Participant	Precursor Behavior	Precursor Behavior Definition	Problem Behavior	Problem Behavior Definition
Tim	None	NA	Tantrum	(a) Crying or whining: any vocalizations (sounds or words) accompanied by facial contortions with and without tears, (b) screaming: vocalizations above normal conversation level, or (c) flopping: any instance or attempt to drop from a standing position or bucking back from a sitting position
Adam	None	NA	Aggression	Any completed or attempted response that could injure another person
			Tantrum	Same definition as above
Sage	None	NA	IVB	Any vocal behavior above conversational level, vocalizations (sounds or words) accompanied by facial contraction with or without tears (i.e., crying), or verbalizations that involve threatening aggression or narrating aggressive behavior
			Aggression	Same definition as above
Christopher	Screaming	Vocalizations above normal conversational level	Aggression	Same definition as above
Valerie	IVB	Any vocal behavior above conversational level, vocalizations (sounds or words) accompanied by facial contraction with or without tears (i.e., crying)	Aggression	Same definition as above

Table 2.

Participant-Specific Functional Analyses (FA)

Participant	Isolated FA 1	Isolated FA 2	Synthesized FA
Tim	**Escape**	**Tangible**	**Escape & Tangible**
Adam	**Escape**	**Tangible**	**Escape & Tangible**
Sage	Diverted Attention	**Tangible**	**Diverted Attention & Tangible**
Christopher	Diverted Attention	**Tangible**	Diverted Attention & Tangible
Valerie	**Escape**	Tangible	**Escape & Tangible**

Appendix A

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?

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