Schedule Thinning Following Functional Communication Training: A Comparison of Chained Schedules and Multiple Schedules

by

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Abstract

Functional communication training (FCT) is a well-supported, effective, function-based intervention used to reduce rates of problem behavior by teaching communicative responses that access functionally equivalent reinforcers. During the initial phase of FCT, the communicative response is typically placed on a dense schedule of reinforcement that is not likely to be maintained in the natural environment. Experiment 1 evaluated the effects of two schedule-thinning procedures (chained schedules and multiple schedules) on problem behavior maintained by escape from demands for four participants following the implementation of FCT. During Experiment 1, the multiple schedule thinning procedure produced lower rates of problem behavior and higher rates of compliance for one of four participants. The chained and multiple schedule procedures were effective in reducing rates of problem behavior for three participants. Compliance increased under both schedules for all participants, but the most effective schedule was idiosyncratic across participants. In Experiment 2 participants' preference for the chained or the multiple schedule procedure was evaluated with three participants. Results of the assessment identified the chained schedule as a preferred procedure for first participant and the multiple schedule procedure for the second participant. No preference was determined for the third participant.

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Individuals with developmental and intellectual disabilities are at an increased risk for deficits in communication and are more likely to engage in problem behavior to access reinforcers in their environment (Lecavalier, Leone, & Wiltz, 2006). The reduction of problem behavior and the strengthening of adaptive behavior with individuals with intellectual and developmental disabilities are of paramount importance because of the detrimental effects such problem behavior has on the quality of life experienced by these individuals. Individuals that engage in problem behavior are at increased risk for developing deficits in academic, communication, and social skills (Olson & Hoza, 1993). As a result, researchers have worked towards developing technologies that can be implemented in the natural environment to reduce the occurrence of problem behavior in an effective and efficient manner.

Function-Based Interventions

Since the advent of functional analyses, function-based interventions have been used in the reduction of problem behavior and are identified as being more effective than non-function-based interventions in decreasing problem behavior (Beare, Severtson, & Brandt, 2004; Carr & Durand, 1985; Ingram, Palmer, & Sugai, 2005; Iwata, Dorsey, Slifer, Bauman, & Richman,1982/1994). A functional behavior assessment (FBA) can include a variety of assessments (i.e., interviews, indirect assessments, direct assessments, functional analyses) aimed at identifying environmental situations that predictably evoke and maintain problem behavior (Ellingson, Miltenberger, & Long, 1999). The fundamental purpose of an FBA is to assist with the development of a comprehensive, effective, and efficient intervention by identifying the characteristics of the target behavior (i.e., operational definition of the response

class), antecedent events (i.e., potential motivating operations, discriminative stimuli), and consequence events (i.e., potential reinforcers). An FBA should provide information on when the individual is most likely to engage in the problem behavior and what environmental stimuli may maintain the behavior.

An FBA can consist of an indirect assessment, descriptive assessment, and functional analysis. Indirect assessments are typically conducted with an individual's caregiver, teacher, or family member. During indirect assessments, information is gathered on the characteristics of the target behavior and relevant environmental variables. During descriptive assessment observations, the therapist directly observes the individual and collects data on the antecedent events, target behavior, and consequence events. Although indirect and direct assessments are useful to identify and operationally define target behaviors and to develop hypotheses of potential motivating operations and reinforcers, these assessments are unreliable in determining the function of problem behavior (Pence, Roscoe, Bourret, & Ahearn, 2009; Thompson & Iwata, 2007).

A functional analysis allows clinicians to systematically manipulate the environment to identify the function of problem behavior. In their seminal study, Iwata and colleagues (1982/1994) developed technology to determine the function of a target behavior by systematically manipulating antecedent and consequence events and measuring the effects on levels of problem behavior. In their original procedure, therapists conducted four conditions: play (control), escape, alone, and attention. Subsequent researchers evaluated the use of a tangible condition to use with individuals who engage in target behavior hypothesized to be maintained by access to tangibles (Wacker et al., 1990). Through the use of a functional analysis, a therapist can determine if a target behavior is maintained by nonsocial reinforcement

(automatic) or social reinforcement (attention, escape, access to tangibles), allowing for the development of a function-based intervention.

Beavers, Iwata, and Lerman (2013) conducted a review of the literature on functional analyses or. Functional analyses were used to identify a variety of functions maintaining problem behavior, including social-positive reinforcement (attention, access to tangible items), social-negative reinforcement (escape from demands), and automatic reinforcement (persistence of responding in the absence of social contingencies). The most commonly investigated topographies included self-injurious behavior (SIB), aggression, disruption, vocalizations, property destruction, elopement, stereotypy, tantrums, and pica. Less commonly targeted behavior included mouthing, ruminating, vomiting, gagging, food refusal, engaging in inappropriate sexual behavior, and nail biting. The versatility of functional analyses can also be seen in their use across a wide array of populations and settings. Currently, functional analyses have been used with individuals with and without intellectual disabilities, children, adults, and geriatric populations. Functional analyses have been applied in hospital inpatient units, outpatient clinics, homes, schools, and community settings.

Functional Communication Training

Functional analysis outcomes are used to inform treatment for typically developing individuals with behavioral disorders (Broussard & Northup, 1995; Restori, Gresham, Chang, Lee, & Laija-Rodriquez, 2007) and individuals with developmental disabilities who engage in problem behavior (Carr & Durand, 1985; Umbreit, Lane, & Dejud, 2004). Interventions developed based on the function of problem behavior, are more effective and efficient than non-function-based interventions at decreasing rates of problem behavior (Beare, Severtson, &

Brandt, 2004; Carr & Durand, 1985). Function-based interventions often consist of arranging the environment so that the individual can earn the functional reinforcer for an appropriate response.

Differential reinforcement involves providing reinforcement for one set of target responses (e.g., compliance, functional communication, task engagement), while withholding reinforcement for another set of responses (e.g., aggression, property destruction, vocalizations; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). A differential reinforcement of alternative behavior (DRA) procedure involves reinforcing an appropriate alternative behavior and withholding reinforcement following the target behavior. For example, a caregiver delivers attention following appropriate requests (e.g., "Help please"), but refrains from delivering attention following target behavior (e.g., aggression). DRA procedures have been used with a wide array of populations, including individuals diagnosed with autism spectrum disorder (ASD) and developmental disabilities (Piazza, Moes, & Fisher, 1996; Petscher, Rey, & Bailey, 2009; Vollmer & Iwata, 1992;) and typically developing individuals (LeGray, Dufrene, Mercur, Olmi, & Sterling, 2013; Wright-Gallo, Higbee, Reagon, & Davey, 2006) and with a range of problem behavior, including stereotypy (DiGennaro Reed, Hirst, Hyman, 2012), aggression (DeLeon et al., 2000), SIB (Lindauer et al., 2002), and property destruction (Fisher et al., 2000).

Functional communication training (FCT) is an DRA intervention that focuses on increasing an appropriate communicative response and decreasing problem behavior (Day, Horner, & O'Neill, 1994; Hagopian et al., 1998; Hagopian et al., 2011; Hagopian, Kuhn, Long, & Rush, 2005; Wacker et al., 1990). FCT involves the delivery of the functional reinforcer contingent on an appropriate behavior (i.e., functional communication response (FCR); Iwata et al., 1994; Vollmer & Iwata, 1992). During FCT, the therapist teaches the individual to emit an appropriate FCR to gain access to the stimulus maintaining his or her problem behavior (Carr &

Durand, 1985). For example, if an individual's aggression is reinforced by attention from adults, the FCR should also result in the delivery of attention from adults (e.g., saying "play with me" or "let's talk").

Carr and Durand (1985) highlighted the importance of teaching a functional response matched to the function of problem behavior with participants who engaged in problem behavior maintained by access to attention or escape from demands. All participants were taught the responses, "I don't understand," and "Am I doing good work." Participants' problem behavior only decreased when the reinforced FCR resulted in access to the reinforcer maintaining their problem behavior. For example, saying "Am I doing good work," did not decrease problem behavior for participants with escape-maintained behavior, whereas saying "I don't understand" was an effective communicative response to replace problem behavior because this response resulted in assistance to complete the aversive task.

Since Carr and Durand (1985), FCT has been used by researchers and practitioners to help reduce problem behavior, mostly in individuals with developmental disabilities, including aggression (Hagopian et al., 1998), SIB (Fisher et al., 1993), bizarre vocalizations (Mace & Lalli, 1991), and inappropriate sexual behavior (Fyffe, Kahng, Fittro, & Russell, 2004). In a review of the FCT literature, Tiger, Hanley, and Bruzek (2008) noted aggression, SIB, and motor and vocal disruptions were the most commonly targeted problem behavior. Additionally, the authors summarized the percentage of participants within studies that used FCT as the primary intervention across social functions of behavior. They found that 43% of the participants' problem behavior were maintained by escape from demands, 32% maintained by attention, and 29% maintained by access to materials, suggesting that FCT is used to address problem behavior maintained by social-positive and social-negative reinforcement.

Treatment components. Although multiple procedural variations exist, FCT is typically associated with four main components to teach the FCR and contribute to an effective intervention. The main treatment components to consider before implementing FCT include (1) creating an establishing operation, (2) selecting the response topography, (3) selecting a prompting procedure to train the response, and (4) programming consequences for problem behavior. Each treatment component can be designed to increase the effectiveness of FCT (Tiger et al., 2008).

Creating the establishing operation. Establishing operations (EO) momentarily alter the reinforcing potency of specific consequences and affect the frequency of behavior previously associated with that consequence (Michael, 1993). For example, the continuous presentation of an aversive stimulus (e.g., difficult demand) is an establishing operation that increases the reinforcing properties of accessing escape and increases the likelihood of problem behavior maintained by negative reinforcement (escape). During FCT, it is imperative to include the relevant EO in which the problem behavior will occur and under which the FCR (e.g., "Break," "Play with me") can be taught to replace the problem behavior. For example, an individual with problem behavior maintained by attention should be exposed to low-attention periods (e.g., the therapist is orientated away from the individual) when being taught to request attention. An individual with escape-maintained behavior should be taught to request for breaks in the presence of aversive tasks (e.g., difficult math problems). Individuals with behavior maintained by access to tangible items should be taught to emit the communicative response (e.g., "toy") only when a preferred item is taken away or access is restricted (e.g., peer is playing with the toy).

Brown and colleagues (2000) compared the effectiveness of FCT under two conditions: EO-present and EO-absent. In EO-present condition, the EO related to the function of problem behavior was present. The EO-absent condition was arranged like the functional analysis condition associated with zero or low rates of target behavior. Researchers taught a series of relevant (i.e., functionally equivalent) and irrelevant (i.e., not functionally equivalent) responses to each participant. For three of four participants, the relevant communicative response was used more frequently than the irrelevant response and occurred exclusively in the EO-present condition. During the EO-absent condition, near-zero levels of relevant and irrelevant responses were observed. Findings highlight the importance of conducting FCT under the functional (relevant) EO for the FCR to effectively replace target behavior.

Selecting the response topography. Studies have trained various response topographies during FCT, including motor responses (e.g., gestures, signing, touching a card) and vocal responses (Fisher et al., 1993; Hanley, Iwata, & Thompson, 2001; Horner & Day, 1991). There are several important factors to consider before selecting a communicative response, including the response effort required to emit the new response, the social recognition of the response, and the student's prior history in acquiring new skills (Tiger et al., 2008). When selecting a new response to train, it is vital that the new response requires less effort than the previously reinforced problem behavior (Hagopain et al., 1998; Horner & Day, 1991). FCRs that require more effort are less likely to occur at higher rates than problem behavior; however, responses that require less effort are more likely to be emitted at higher rates than problem behavior. For example, Horner and Day (1991) found that when the communicative response required more effort (e.g., signing "I want to go, please"), the response did not successfully replace problem behavior. However, when the communicative response required less effort (e.g., signing

"break"), problem behavior decreased.

Another important consideration is the social recognizability of the communicative response. Socially recognizable response topographies are those in which a person with no prior history with the trained response would recognize and therefore reinforce the response (Durand, 1999; Durand & Carr, 1992). Although, response topographies such as signs have more social recognition than arbitrary gestures, signs are more limited than other potential response topographies (e.g., vocal requests). In some situations, the therapist should consider using an icon (e.g., break card) or voice-output device to increase the likelihood the social community will respond appropriately to the request. For example, Durand (1999), found that novel adults were able to recognize and respond appropriately to the trained communicative response when the participants requested through a voice-output device. Ambiguous response topographies such as specialized gestures or signs are less likely to be reinforced by novel individuals that are not familiar with the response topography. As a result, response topographies that do not consistently produce the functional reinforcer outside the contrived treatment setting are less likely to persist. Thus, it is important that practitioners consider the social community when selecting a response topography.

The speed of response acquisition should also be considered before selecting a communicative response to train (Tiger et al., 2008). Although vocal responses are the optimal choice when selecting the communicative response, a vocal response is not always appropriate for each client (e.g., clients with little or no vocal or verbal skills). Motor responses, such as touching a break card or signing for attention, may be better suited for individuals who would require extensive training to emit vocal communicative responses. Furthermore, motor responses may be preferred as a communicative response even when an individual's vocal verbal skills are

intact because the therapist can physically prompt motor responses. Additionally, some motor responses (e.g., touching a card) may require less response effort than a vocal response and should be used to facilitate faster acquisition of the FCR.

Prompting the Response. When training the communicative response, practitioners commonly use either most-to-least or least-to-most prompting procedures (Fisher, Kuhn, & Thompson, 1998; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997). During least-to-most prompting sequences, the therapist provides an opportunity for the response to occur independently and then gradually increases the intrusiveness of the prompt until the correct response occurs. One benefit to the least-to-most procedure is that it allows target problem behavior to come into contact with extinction early during training (Libby et al., 2008; Tiger et al., 2008). Once the establishing operation is arranged, the therapist allows a specific duration of time (e.g., 5 s) for the individual to emit the communicative response before providing response prompts. Depending on the topography of the communicative response, if the response is not emitted, a vocal, model, or physical prompt may be provided (Libby, Weiss, Bancroft, & Ahearn, 2008). Following the correct FCR, the therapist delivers the corresponding reinforcer. For example, Shirley and colleagues (1997) used a least-to-most prompting procedure (independent, verbal prompt, physical prompt) to teach participants to either clap or raise their hand as a communicative response.

During a most-to-least prompting procedure, the therapist prompts the FCR at the most intrusive level (e.g., physical prompting), immediately following the arrangement of the establishing operation (Carr & Durand, 1985; Fisher et al., 1993). The therapist gradually fades the intrusiveness of the prompt contingent on correct FCRs. For example, the therapist may initially provide manual guidance to prompt the FCR and fade the prompts by providing physical

guidance at the forearm, then upper arm, and then modeling the correct response. The reinforcer is delivered once the individual emits the FCR. Unlike least-to-most prompting, problem behavior is less likely to come into contact with extinction during training, increasing the likelihood that problem behavior may persist following communication training (Tiger et al., 2008). A benefit to the most-to-least prompting is that it produces less errors resulting in fewer opportunities for the FCR and the problem behavior to form a response chain (Fisher et al., 1993; Fentress & Lerman, 2012).

Consequences for problem behavior. As with any differential reinforcement procedure, there are three types of consequences that could follow problem behavior during FCT: reinforcement, extinction, and punishment. The target behavior may continue to be reinforced in cases where it is not feasible to withhold the reinforcer (Horner & Day, 19991; Wordsdell, Iwata, Hanely, Thompson, and Kahng, 2000). Examples include situations where the practitioner has little control over the delivery of the reinforcer (e.g., attention in a group setting) or times when withholding the reinforcer may be dangerous (e.g., refraining from delivering attention with a client with a history of severe aggression).

Extinction procedures, in which the problem behavior no longer results in reinforcement, are commonly implemented with FCT. The use of extinction may result in a temporary increased rate of problem behavior (i.e., extinction burst; Hagopian et al., 1998; Lerman & Iwata, 1996) or the emergence of new behaviors (i.e., behavioral variability; Lerman & Iwata, 1996). Nevertheless, studies have shown the most effective interventions include extinction procedures; those without an extinction component may be ineffective in reducing problem behavior (Iwata et al., 1994; Kelley, Lerman, & Van Camp, 2002). For example, Kelley and colleagues (2002) evaluated the efficacy of FCT with and without extinction with three participants that engaged in

aggression and property destruction maintained by either access to tangible items, escape from demands, or both. Initially, FCT without extinction was implemented where problem behavior was reinforced on a variable-ratio schedule. Problem behavior decreased for one of three participants. FCT with extinction was implemented for the remaining two participants and decreased problem behavior.

Hagopian and colleagues (1998) also investigated the efficacy of FCT without extinction. Functional analyses were conducted for 21 participants. After the functional reinforcer was identified, FCT without extinction, FCT with extinction, or FCT with punishment was implemented. During FCT without extinction, the functional reinforcer was provided contingent on the FCR and problem behavior. For example, if aggression was maintained by escape from demands, then an instance of aggression or the FCR (e.g., vocally stating "break") would result in escape from demands. During the FCT with extinction, problem behavior did not result in access to the functional reinforcer. Instead, only the occurrence of the FCR resulted in access to the maintaining reinforcer. During FCT with punishment, every occurrence of problem behavior resulted in the implementation of a punishment procedure (e.g., facial screen, basket hold, hands down, or contingent demand). The punishment procedure was only used after the unsuccessful implementation of FCT or FCT with extinction. FCT without extinction was the least effective of the three procedures. FCT without extinction did not result in a 90% reduction in problem behavior for any participants. However, FCT with extinction resulted in a 90% reduction in problem behavior for 44% (11 of 25) of participants. FCT with punishment was also effective and resulted in a 90% reduction in problem behavior for 90.1% (10 of 11) of participants. Findings of Hagopian et al. (1998) and Kelley et al. (2002) emphasize the importance of extinction during the initial acquisition stages of FCT.

Schedule Thinning during FCT

Typically for FCT procedures to be effective, the intervention needs to initially include a dense schedule of reinforcement (Tiger et al., 2008). For example, at the start of training, the FCR is often reinforced on a fixed-ratio 1 (FR 1) schedule where every instance of the response results in access to the reinforcer (e.g., Fisher, Kuhn, & Thompson, 1998; Jarmolowicz, DeLeon, & Kuhn, 2009). However, it is unlikely that this schedule will be maintained in the natural environment if the FCR occurs at high rates or in situations when it cannot be reinforced (Hagopian et al., 2005). As a result, levels of problem behavior may increase as the association between the FCR and reinforcer is weakened or extinguished over time. For example, an individual taught to request attention using the phrase "play with me" might begin engaging in problem behavior if his request does not result in attention from adults. Similarly, it is impractical for individuals with escape-maintained behavior to continuously be allowed to avoid schoolwork by requesting a break.

Schedule-thinning procedures work by attenuating the reinforcement schedule for the FCR or placing the FCR under stimulus control. Schedule thinning procedures are systematically introduced in an effort to maintain low levels of problem behavior, while decreasing the frequency of FCRs to a socially acceptable level. Various schedule thinning procedures, including multiple schedules and chain schedules, have been identified in the literature as being effective to developing terminal schedules of reinforcement.

Multiple schedules. Multiple schedules involve the use of at least two separate schedule components to place responding under stimulus control. A discriminative stimulus is used to signal when reinforcement is available (S^D or S+) and an S-delta (S^Δ or S-) is presented to signal that reinforcement is not available (Ferster & Skinner, 1957). During multiple schedule

procedures, the duration of the two schedules can be gradually manipulated so that the S+ component duration gradually decreases as the S- component duration increases (Hagopian et al., 2011). For example, following FCT, the FCR ("break") will produce the reinforcer for the majority of the session and be placed on extinction during the remainder of session (e.g., S+ for 9 min and S- for 1 min). As sessions progress, the S+ component will gradually decrease to 1 min while the S- component increases to 9 min.

Hanley and colleagues (2001) directly compared multiple-schedule and mixed-schedule procedures during schedule thinning procedures following FCT and extinction. During the multiple schedule, a white circle (S+) was used to indicate when participants could gain access to reinforcers by emitting the FCR (i.e., pressing the microswitch), whereas, a red rectangle (S-) indicated the unavailability of the reinforcer. At the beginning of the multiple-schedule procedure, the white circle (S+) was available for the majority of the session. Over time, they systematically decreased the duration the white card was available and increased the duration the red card (S-) was in effect. The mixed-schedule condition was different only in that no cards were present to indicate whether or not the FCR would result in the delivery of the reinforcer. Both procedures started with 45 s of the S+ component and alternated with 15 s of the S- component. For all participants, the multiple schedule procedure was more effective in maintaining the FCR and low levels of problem behavior even when the schedules were faded to 60 s of the S+ component and 240 s of the S- component. Results suggest that communicative responses can be brought under stimulus control and discriminative stimuli can be used to indicate when individuals can use their communicative response. This may be especially useful for teachers to indicate to students appropriate times to engage in communicative responses to access social reinforcers (e.g., attention or escape).

Previous literature has used the multiple-schedule arrangement as a means of thinning reinforcement schedules, while maintaining low rates of problem behavior (Tiger & Hanley, 2004; Hagopian, Boelter, & Jarmolowicz, 2011). The advantage of the multiple schedule is that it preserves the contingencies in place between the FCR and the functional reinforcer, while placing the FCR under stimulus control (Rooker, Jessel, Kurtz, & Hagopian, 2013). Additionally, the gradual exposure to the extinction period may allow participants to tolerate longer exposures to the establishing operation and reduce the likelihood of extinction bursts (Betz, 2013). However, one disadvantage to the multiple-schedule arrangement is that there are no contingencies in place to promote compliance.

Chained schedules. Chained schedules involve two or more schedules being presented in a sequential manner where only the terminal link of the chain produces access to the primary reinforcer and each link of the chain is signaled by a discriminative stimulus (Branch, 1977). In applied settings, demand fading may be arranged as a chained schedule to decrease the use of the FCR, while increasing rates of compliance with individuals whose problem behavior is maintained by escape from demands (Hagopian et al., 2011). Demand fading specifically consists of increasing the number of completed demands before the FCR will produce access to the reinforcer (Fisher et al., 1993).

Fisher et al. (1993) used demand fading as part of a treatment package to decrease rates of problem behavior for one participant. The instances of compliance necessary to gain access to escape from demands was gradually increased from 2 to 26. During demand fading, rates of problem behavior did not increase, while rates of break requesting decreased proportional to compliance requirements. This form of schedule thinning is particularly effective in allowing

participants the ability to access breaks with the use of the FCR, while still including a compliance contingency.

Hagopian and colleagues (1998) used demand fading to decrease the use of FCRs that were occurring at rates not manageable in the natural environment. During demand fading, the number of demands required were determined individually; however, the response requirements typically increased by one demand (e.g., 1, 2, 3, 4, 5, etc.). Brief praise and a redirection statement ("That's nice asking, but you need to do some more work") were delivered if break requests were emitted before the compliance contingency was met. On average, participants completed up to 10 demands before access to escape was available. Although demand fading was successful for many participants (7 of 12) , it resulted in increased rates of problem behavior, suggesting a weakening in the contingency in place between the FCR and the reinforcer.

Demand-fading procedures do not always involve distinct discriminative stimuli signaling the components of the schedule. The lack of salient signaling sometimes observed in applied settings during demand fading could impact treatment outcomes. Within the basic literature, signaling of the terminal link (i.e., likelihood of reinforcement) influences responding. For example, Branch (1977) trained pigeons to peck a key under a chained fixed-ratio 15 and a fixed-interval 25-s schedule of reinforcement and compared rates of key pecking in signaling (i.e., the outcomes of the chained schedules were signaled) and no signaling conditions. More key pecking occurred in conditions where the outcome of the chained schedule was signaled as opposed to conditions where it the outcomes were not signaled.

The chain schedule outcomes produced in the basic literature have been replicated in the applied literature evaluating problem behavior and rates of compliance with school-aged

children. Falcomata, White, Muething, and Fragale (2012) evaluated the effectiveness of a chained schedule within FCT as an intervention for decreasing rates of problem behavior. During the chained schedule procedure, the initial link to the chain was signaled by the therapist wearing a wristband and required the participant to first complete a number of math problems before the second link of the chain became available. The terminal link of the chain required the participant to emit the FCR ("wristband please") to gain access the discriminative stimulus (i.e., the participant wearing the wristband) and the primary reinforcer (i.e., 30 s of escape, access to high-preferred activities, and attention). The chained schedule was effective in maintaining rates of problem behavior to below baseline levels, while decreasing rates of the FCR.

Lalli, Casey, and Kates (1995) also investigated the effects of FCT, extinction, and chained schedules with three participants who engaged in problem behavior maintained by escape. Following FCT, researchers initiated a chained schedule phase. During this phase, a therapist placed a demand and only provided a break contingent on the completion of the task and the appropriate use of the FCR. The therapist delivered brief praise and a reminder of the contingency ("you have to do [task], then you can ask for a break") following premature break requests. Additionally, the FCR did not result in access to a break if it occurred within 10 s of the last instance of problem behavior. By the end of the study, participants were completing a total of 16 demands before their break request was honored. For all three participants, rates of problem behavior and the FCR remained low after the implementation of the chained schedule.

Modified Concurrent-Chain Arrangements

Measures of social validity are useful to help inform the practitioners' selection of interventions by examining the acceptability of an intervention with consumers. When examining potential treatment options for problem behavior, one measure of social validity is to

determine the preference of the participant whose behavior is directly exposed to the interventions. Modified concurrent-chain arrangements are one method for assessing participant preference for different schedules of reinforcement or different interventions (Davison & McCarthy, 1988; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997). During a concurrent-chain arrangement, at least two responses are simultaneous presented, each correlated with an intervention. A selection on the initial link is reinforced by access to the corresponding terminal-link schedule that produces the intervention and the contingencies associated with that intervention. The selection during the initial link indicates the participant's preference for the terminal-link schedule (Savastano & Fantino, 1996).

Hanley and colleagues (1997) used a modified concurrent-chains procedure to evaluate participants' preference for two function-based treatment procedures found to be equally effective in reducing problem behavior maintained by attention (FCT and noncontingent reinforcement (NCR)). An extinction procedure was implemented as a control. During the initial link, the participant pressed one of three switches that resulted in the presentation of the corresponding terminal link associated with FCT, NCR, or extinction. Preferences were identified for both participants and both participants allocated 70% of their responding to FCT during the initial link (suggesting a preference for FCT), suggesting that participants may prefer response-dependent (FCT) over response-independent reinforcement schedules (NCR).

Because concurrent-chain procedures have been identified as an effective method of evaluating preferences, they have been used to determine individuals' preferences for a variety of interventions, including redirection over response blocking (Giles, St. Peter, Pence, & Gibson, 2012), FCT with punishment over FCT without punishment (Hanley, Piazza, Fisher, & Maglieri, 2005), and choice of reinforcer over no choice (Tiger, Hanley, & Hernandez, 2006). The

versatility of the concurrent-chain procedure provides clinicians the ability to directly evaluate the social validity of an intervention by allow individuals to express preferences for interventions. Therefore, when interventions are found otherwise equal, preferences can be used to inform the interventions that are implemented in the natural environment.

Purpose

Schedule thinning is often necessary to make FCT interventions more manageable in the natural environment. Nevertheless, few studies have directly compared different scheduling thinning procedures. The purpose of the present study was to investigate the effects of chained schedules and multiple schedules on levels of problem behavior, the FCR, and compliance during schedule thinning. During Experiment 1, participants with escape-maintained behavior were trained to engage in an FCR ("break" request) to receive a break from work. Following FCT, a treatment evaluation was conducted to evaluate the two schedule thinning procedures (chained schedules and multiple schedules). During Experiment 2, preferences were evaluated using a modified concurrent-chains schedule to allow participants to select the intervention procedure (chained schedule, multiple schedule, or extinction) for each session.

Experiment 1

Participants and Setting

Four children with developmental disabilities participated. All participants were referred for the assessment and treatment of severe problem behavior. Nancy was a 4-year-old Caucasian female diagnosed with ASD. She had delayed communication skills (tact and mand repertories), but communicated vocally using either one or two-word phrases. Adam was a 6-year-old Caucasian male diagnosed with childhood apraxia and deletion of chromosome 5.0. He communicated vocally using full (5+ word) sentences. Derek was a 5-year-old African American

male diagnosed with developmental delay. He communicated vocally using simple three to five-word phrases. Kevin was a 5-year-old African American male diagnosed with autism spectrum disorder (ASD). He communicated using two to four-word phrases. All participants were ambulatory and could follow one-step directions. Teacher and parent report suggested that problem behavior was at least partially maintained by access to escape from demands.

Two to four appointments were conducted per week with each appointment consisting of three to six sessions. All sessions were conducted in a therapy room on an university campus, in a quiet area of the participant's school, or a quiet area of the participant's home.

Data Collection and Interobserver Agreement

Primary and secondary observers collected paper-and-pencil frequency data within 10-s intervals (i.e., bins) on problem behavior, independent and prompted communicative responses, and compliance. Problem behavior for each participant was operationally defined based on information gathered from interviews and observations. For Kevin and Derek, aggression was defined as any actual or attempted instance of punching, hitting, slapping, scratching, pinching, or kicking another individual from at least a 16 cm distance; any instance of pushing, shoving, grabbing, or throwing an object that made contact with another person. Biting was also included in Kevin's definition for aggression. For Adam, tantrums were defined as engaging in two or more of the follow responses within 2 s of each other: screaming (any vocalization above conversation level) or crying (with or without tears); protests (any statement of refusal); flopping (falling to the ground from a seated or standing position); or back arching when in a standing or sitting position. For Nancy, screaming was defined as emitting a vocalization above conversation level. Communicative responses were defined as the participant touching a break icon with any portion of his or her hand. Independent communicative responses were scored when the

participant emitted the correct response without the occurrence of problem behavior and in the absence of any prompts. Compliance was defined as the participant completing a demand independently or following a model prompt within 10 s of the initial directive. Data were collected on problem behavior, communicative responses, and compliance during all conditions, including baseline, treatment, and schedule-thinning procedures. Session duration was 10 min for all conditions.

Secondary observers included graduate and undergraduate research assistants who were trained by the experimenter to independently collect data. Training consisted of the experimenter vocally reviewing the written procedures with the observers. Observers were required to practice collecting data until acquiring 90% accuracy across three consecutive sessions to be considered reliable data collectors. Interobserver agreement (IOA) was calculated using the mean count-per-interval method (Cooper, Heron, & Heward, 2007). IOA was calculated by dividing the observation period into a series of 10-s intervals (i.e., bins), recording the number of occurrences of the behavior in each interval, and then calculating the proportion agreement between the two observers for each interval by dividing the smaller occurrence by the larger occurrence. The interval proportions were summed and divided by the total number of intervals and then multiplied by 100. IOA was obtained on 33.8% of sessions across all participants. Mean IOA was 96.1% (range, 72.1%-100%) for problem behavior, 95.6% (range, 71.8%-100%) for the FCR, 97.7% (range, 89.6%-100%) for compliance.

Procedural Fidelity

Procedural fidelity data were collected by trained graduate and undergraduate research assistants to assess the therapist's implementation of training procedures. Training consisted of the experimenter reviewing the procedures with the observers. Observers were required to collect

procedural fidelity data for a minimum of three sessions with at least 90% accuracy to be considered reliable data collectors. Observers collected data on the (1) therapist's correct delivery of demands; (2) use of three-step prompting for compliance; (3) using the prescribed prompts to train the communicative response; (4) implementing the correct consequence following problem behavior; (5) the delivery of the correct consequence following the communicative response (e.g., providing a break); and (6) following the prescribed criteria to change the schedule during schedule thinning. The percentage of procedural integrity was calculated by dividing the number of correct responses by the total number of opportunities to perform a skill and then multiplying by 100. Procedural fidelity was collected on 34.2% of sessions and averaged 98.3% (range, 95.8% to 100%) across all participants.

Experimental Design

A reversal design was used to demonstrate experimental control over the effects of FCT on problem behavior and the communicative response. A multielement design was used to compare the chained schedule and multiple schedule thinning procedures on rates of compliance, the communicative response, and problem behavior. Data analysis was performed by visual inspection of the graphed performance.

Preference Assessment

A multiple-stimulus-without-replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was used to identify moderately to highly preferred tangible items for the tangible and control conditions of the functional analysis. Items used in the assessment were based on preferences reported during the initial interview. During the preference assessment, the therapist presented an array of seven items. The therapist instructed the participant to select an item and provided access to the selected item for 30 s. After the 30 s, the item was removed from sight.

The therapist rotated the remaining items and instructed the participant to select a new item. The therapist blocked any attempts to approach multiple items. If no item was selected within 5 s, the therapist restated the prompt to select an item. If the participant did not select an item within 5 s of the new prompt, the therapist ended the session and recorded all remaining items as "not selected." These procedures were continued until all seven items were selected. After all items were selected, the items were replaced in an array and the procedures repeated until all items were presented seven times. The percentage of selection for each item was calculated by dividing the number of times an item was selected by the number of trials that item was presented. The three items identified with the highest percentages of selection were considered moderately and highly preferred (depending on percentage) and used during the functional analysis.

Color Preference Assessment

Prior to beginning FCT, the therapist conducted a color preference assessment using a paired-stimulus preference assessment (Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992) to determine two moderately preferred colors. Cards (2.3 cm by 3.0 cm) were placed approximately 3 cm apart and 3 cm in front of the participant. The therapist delivered the directive, "Pick one" and allowed the participant to select one color. The next trial began after the participant selected a color. The therapist blocked any attempts to approach both cards. If no color was selected within 5 s, the therapist represented the trial. If the participant did not select either color within 5 s of representation, the therapist removed both colors and began the next trial. The percentage of selection for each color was calculated by dividing the number of times a color was selected by the number of trials that color was presented. The proportion was then multiplied by 100. The four colors selected with moderate percentages (identified as not falling

within the highest or lowest selection percentages) were considered moderately preferred and used as discriminative stimuli.

Functional Analysis

Prior to enrolling in the study, an interview was conducted with caregivers and other relevant parties (e.g., teachers and other caregivers) to gather information for a functional analysis. Questions focused on the frequency and severity of problem behavior and common antecedent and consequence events. This information was used to determine the test conditions for the functional analysis. The interviews also informed the items used during the preference assessment and the types of demands included in the escape condition.

A functional analysis based on procedures developed by Iwata et al. (1982/1994) and Wacker et al. (1990) was conducted with Adam, Derek, and Nancy to determine the function of their problem behavior. During the functional analysis, one to three test conditions (attention, escape, or tangible) and a control condition (play) were alternated. At the onset of the attention condition, the therapist stated, "I'm sorry, but I have some work to do." The therapist pretended to "work" and diverted her attention from the participant. The therapist provided 10 s of attention contingent on the occurrence of problem behavior. Attention was in the form of reprimands (e.g., "Stop it, don't do that!"), statements of concern (e.g., "You're hurting yourself!"), and physical attention (e.g., back rubs, pats on the back). All other non-targeted appropriate or inappropriate behavior was ignored.

At the onset of the escape session, the therapist stated "It's time to do some work." Two to three different categories of tasks were used, including motor imitation, one-step directions, and receptive identification. During the escape condition, the therapist presented directives using a three-step least-to-most prompting sequence (i.e., vocal, gestural/model, and physical prompts).

If no response occurred within 3 to 5 s of the initial directive or the participant responded incorrectly, the therapist restated the demand and modeled or gestured towards the correct response. If no response or an incorrect response occurred, the therapist restated the demand and physically guided the correct response. Brief neutral praise (e.g., "Good") was delivered following correct responses prior to the physical guidance prompt. Following the target behavior, the therapist stated, "Ok, you can take a break," removed the task materials, and oriented away from the participant for 30 s. All non-targeted inappropriate and appropriate behavior was ignored.

Prior to beginning the tangible condition, participants were allowed 2 min to engage with one to two highly preferred item(s). At the onset of the session, the items were removed and the therapist stated, "It's my turn." The therapist refrained from interacting with the participant and pretended to engage with the items. The therapist provided 30-s access to the items contingent on the target behavior. All instances of non-targeted inappropriate or appropriate behavior were ignored.

During the play condition, participants were given free access to three moderately to highly preferred items. At the start of the session, the therapist stated, "Here are some toys to play with." The therapist delivered praise, neutral statements, and play-related statements on a fixed-time (FT) 15-s schedule. Physical attention in the form of back rubs and pats and high 5s occurred on a FT 30-s schedule. All instances of target problem behavior or non-targeted inappropriate behavior were ignored. The therapist engaged with or responded to the participant for 5 to 10 s if he or she initiated play towards the therapist or asked a question.

A trial-based functional analysis was conducted with Kevin in the classroom based on the procedures described by Bloom, Iwata, Fritz, Roscoe, and Carreau (2011). During the trial-based

functional analysis, data were collected on the latency to first instance of target behavior and occurrence of target behavior during three test conditions (escape, attention, access) and their respective control conditions. Sessions were terminated following 30 s of the target behavior.

In the attention control condition, the therapist engaged in a conversation with and provided physical attention to Kevin, while avoiding demands and questions. In the attention test condition, classroom toys were available and the therapist removed her attention by saying, "Play here while I help a friend." The therapist delivered brief reprimands and redirective statements paired with brief physical attention following aggression. In the escape control condition, the therapist oriented away from Kevin and did not engage with Kevin or present any demands. During the escape test condition, therapist conducted sessions similar to the escape condition of the standard functional analysis and provided escape from demands for 30 s following the target behavior. During the tangibles control condition, Kevin was provided with free access to all classroom toys. The tangible test condition was similar to the tangible condition described above and Kevin was provided with access to tangibles for 30 s following the target behavior.

Baseline

Baseline sessions were identical to the escape condition of the functional analysis. No colored discriminative stimuli were present to signal baseline. The therapist began the session with the statement, "It is time to work now." The same demands used during the escape condition of the functional analysis were used during baseline. The therapist used three-step prompting (independent, model/gesture, physical guidance with 3-5 s between prompts) following no response and incorrect responses to obtain compliance. The therapist delivered

brief neutral praise (e.g., "Good") following compliance (independent or model). A 30-s break was provided following problem behavior. All instances of FCRs were ignored.

Functional Communication Training

At the start of every session, the therapist placed a 30 cm by 45 cm colored stimulus card on the table and made the statement "It is time to work. You can ask for a break by touching the card like this [model touching the break card]." During FCT, the therapist presented the same directives and used the three-step prompting hierarchy for compliance as outlined in baseline. All prompted and independent FCRs resulted in a 30-s break from demands. During the break, the therapist stated, "Okay, you can have a break," removed all materials, and orientated herself away from the participant. Any instance of problem behavior during the break resulted in the termination of the break and introduction of demands. At the end of the 30-s break, a new demand was presented. Brief praise (e.g., "Good") was delivered if the participant complied with the initial demand, independently or following a model prompt. Following the target behavior, the therapist prevented escape and immediately manually guided the correct response for the ongoing directive. All instances of non-target appropriate and inappropriate behavior were ignored.

An errorless most-to-least with progressive time-delay procedure was used to train participants to emit the communicative response (Fisher et al., 1993). During the initial stages of training, the therapist prompted the FCR with the most intrusive prompt immediately after a demand was presented (0-s delay to prompt). For example, the therapist delivered the directive and then immediately provided hand-over-hand guidance to touch the break card. The prompts were gradually faded based on participant performance (refer to Table 1). Criterion to increase the fading step was two consecutive sessions in which the rate of target problem behavior was at

least an 80% reduction relative to baseline. Criterion to decrease fading step was two consecutive sessions in which the rate of target problem behavior was at or above mean baseline levels. Mastery criterion was three consecutive sessions with an 80% reduction of problem behavior and all independent break requests.

FCT with Enhanced Breaks (Adam, Derek, and Kevin)

An FCT with enhanced breaks was conducted with Adam, Derek, and Kevin. During FCT with enhanced breaks, the therapist followed all of the procedures for FCT except that access to preferred items was provided during break periods. Preferred items were selected with a brief MSWO preference assessment at the start of each session and were delivered contingent on appropriate break requests. At the end of the break, the therapist neutrally removed the items and presented a new demand.

FCT with Contingent Directives (Nancy and Derek)

Contingent directives were added to FCT for Nancy and Derek. During FCT with contingent directives, the therapist followed all of the procedures for FCT except that the participant was manually guided through the completion of 8 to 12 directives following an occurrence of the target problem behavior. A new demand was presented after the last contingent directive was completed.

Schedule Thinning

During the schedule-thinning phase, two conditions (chained schedule and multiple schedules) were alternated. Both conditions included an S+ component (i.e., following a break request, the reinforcer was delivered) and an S- component (i.e., a break was not provided following a break request). The chained-schedule procedure required participants to earn the S+

component by complying with directives. During the multiple-schedule procedure, the S+ component was made available based on the passage of time.

The schedule values associated with each condition were thinned independently. Intermittent probes for higher schedule-thinning steps were conducted throughout the schedule-thinning phase for the chained schedule and the multiple-schedule conditions. If the probe at the higher step was successful, sessions continued at that successfully completed value. If the probe was unsuccessful, the next session was conducted at the last successful schedule value. For example, during the chained schedule thinning procedure, a probe for 20 instances of compliance was conducted after the participant met criterion to increase from a schedule value of 12 instances of compliance to 14 instances of compliance. If the probe of 20 instances was successful, sessions continued at the schedule value of 20 instances of compliance. If the probe was not successful, the next session was conducted at the schedule value of 12 instances of compliance.

Criterion to increase a schedule value was at least two consecutive sessions for that condition in which the rate of target behavior was at least an 80% reduction relative to baseline. Criterion to decrease the schedule value was at least two consecutive sessions across that condition in which the rate of target problem behavior was above the 80% reduction relative to baseline. Schedule thinning mastery criterion was at least three consecutive sessions in which target problem behavior was at least an 80% reduction relative to baseline at the terminal schedule value.

Chained Schedule. A circle-shaped card was used as the discriminative stimulus during the chained schedule. One 20 cm by 25 cm card was placed in a visible location on the table or floor of the session room. Cards were the respective color depending on the S+ component or S-

component. The S+ colored circle was the same colored used during FCT. A second color was used during the S- component. During the chained schedule thinning, access to the S+ component (a break was available following the communicative response) was contingent on compliance with a specified number of directives.

At the start of each session participants were notified of the contingencies in place with the statement, "On the [color] circle card rules, it's time to listen to teacher and do work. On the [color] circle card rules, you can ask for a break by touching the card like this [model touching the break card]." Each transition to the S- component or S+ component was accompanied by the statement, "You're on the [color] circle-card rules."

During both the S+ and S- components, the therapist delivered directives following the three-step prompting hierarchy as outlined in baseline. Nondescriptive praise (e.g., "good") was delivered following each instance of compliance (independently or after model prompt). Following target problem behavior, the therapist immediately manually guided the correct response. All instances of non-targeted appropriate or inappropriate behaviors were ignored.

S- component. During the S- component, the FCR did not produce escape from demands. The therapist provided brief praise and a redirection statement ("Nice asking, but right now it's time to work.") and gestured to the S- component colored circle following each instance of the FCR in the absence of problem behavior. Once the participant met the response requirement for compliance (refer to Table 2), the therapist delivered descriptive praise and presented the S+ colored circle. The response requirements to access the S+ component were gradually increased as participants progressed through the schedule-thinning procedures.

S+ component. Once the participant completed the response requirement, the circle card was switched to the S+ component color. During the S+ component, the FCR produced a 30-s

break from demands. Following the FCR, the therapist stated "Okay, you can have a break," oriented herself away from the participant, removed all materials, and provided access to tangibles (Adam, Derek, and Kevin only). A new demand was presented at the end of the 30-s break. Any instance of target problem behavior resulted in the termination of the break. After the specified duration in the S+ component (refer to Table 2), the therapist returned to the S- component.

Multiple schedules. A triangle-shaped card was used as the discriminative stimulus for the multiple schedule condition. One 20 cm by 25 cm card was placed in a visible location on the table or floor of the session room. The same color used during FCT was used in the S+ component during the multiple schedule, whereas a third color was used to signal the S- component (the same color was not used for the S- in the chained schedule and the S- in the multiple schedule). During the multiple-schedule procedure, access to the S+ component (availability of the reinforcer following the FCR) was contingent on elapsed time. Directives were delivered as outlined in baseline.

At the start of each session, participants were notified of the contingencies with the statement, "When we are on the [color] triangle card rules it's time to listen to teacher and do work. When we are on the [color] triangle card rules you can ask for a break by touching the card like this [model touching the break card]." Participants were notified of every change to the S- component and S+ component with the statement "We are now on the [color] triangle-card rules."

During both the S+ and S- components, the therapist delivered directives following the three-step prompting hierarchy as outlined in baseline. Nondescriptive praise (e.g., "good") was delivered following each instance of compliance (independently or after model prompt).

Following target problem behavior, the therapist immediately manually guided the correct response. All non-targeted appropriate and inappropriate behavior and target problem behavior were ignored.

S- component. During the S- component, the FCR did not produce access to the reinforcer (escape). The therapist provided brief praise and a redirection statement ("Nice asking, but right now it's time to work") and gestured to the S- component colored triangle following each instance of the FCR. Once the specified duration elapsed, the therapist presented the S+ component card. The initial S- interval was set to 5 s and was gradually increased while the S+ interval decreased across fading steps (refer to Table 3).

S+ component. During the S+ component, all FCRs were followed with a 30-s break from demands. Following the FCR, the therapist stated, "Okay, you can have a break," oriented herself away from the participant, removed all materials, and provided access to tangibles (Adam, Derek, and Kevin only). A new demand was presented at the end of the 30-s break. The therapist terminated the break and presented a directive if the participant engaged in the target problem behavior. After the specified duration in the S+ component (refer to Table 3), the therapist returned to the S- component.

Results and Discussion

The results of the preference assessment indicated the following items for each participant as the two most highly preferred: dinosaurs and train for Derek; fire truck and airplane for Adam; and dinosaur and piano for Nancy. These tangible items were included in the play condition of the functional analysis for each participant. For Derek, high-preferred items (cars and dinosaurs) were used in the restricted access condition of the functional analysis. Kevin

was provided access to classroom toys during the restricted access condition of his functional analysis.

Figure 1 shows the results of the functional analysis for Nancy, Adam, and Derek. Nancy's screaming occurred at elevated levels during the escape condition compared to the control condition (top panel). The differentiation in the escape condition suggested that Nancy's screaming was maintained by escape from demands. Adam engaged in higher rates of tantrums in the escape condition compared to the play condition, indicating that Adam's tantrums were maintained by escape from demands (middle panel). Derek had elevated levels of aggression during the escape condition as compared to the control condition (bottom panel). This suggests that Derek's aggression was maintained by escape from demands.

Figure 2 depicts Kevin's functional analysis outcomes. During Kevin's functional analysis, aggression occurred during a higher percentage of escape test trials and tangible test trials compared to the respective control trials. The outcomes of Kevin's functional analysis indicated aggression was maintained by access to items and escape from demands.

Figure 3 displays levels of screaming (top panel), FCR (middle panel), and compliance (bottom panel) during Nancy's treatment evaluation. During baseline, Nancy engaged in moderate levels of screaming (M = 1.4 resp/min) and low levels of the FCR and compliance. An initial reduction in problem behavior was observed when FCT was implemented. However, there was variability and an increase in screaming across sessions (M = 0.6 resp/min). Contingent directives (CD) were added to FCT. Screaming decreased to near zero levels following the implementation of contingent directives. Levels of FCRs increased (M = 1.8 resp/min), but compliance remained at low levels during FCT and FCT + CD.

During the reversal to baseline, rates of screaming increased (*M* = 1.6 resp/min) and FCR and compliance decreased to low levels (Figure 3). The reintroduction of FCT + CD resulted in decreased rates of problem behavior (*M* = 1.2 resp/min; zero instances of screaming occurred during the last five sessions of phase). Rates of the FCR increased (*M* = 1.5 resp/min) and rates of compliance remained low.

Schedule thinning was implemented following FCT + CD (Figure 3). Nancy displayed relatively low rates of problem behavior during the multiple-schedule (*M* = 0.4 resp/min) and the chained-schedule (*M* = 0.3 resp/min) conditions. For both conditions, a gradual decrease in FCR rates was observed as schedule thinning progressed (*M* = 0.8 resp/min for multiple schedule; *M* = 0.4 resp/min for chained schedule). By contrast, compliance occurred at low levels at the start of schedule thinning for both conditions with a gradual increase first occurring in the chained schedule condition (*M* = 0.8 resp/min) and then the multiple schedule condition (*M* = 0.4 resp/min). Schedules of reinforcement were thinned to terminal values for the multiple schedule (270 s S-/30 s S+) and chained-schedule procedure (20 instances of compliance (S-)/30 s S+). Rates of screaming remained low for both conditions during the maintenance phase (*M* = 0.1 resp/min for multiple schedule; *M* = 0.04 resp/min for chained schedule). Low rates of the FCR and high rates of compliance (*M* = 0.8 resp/min for chained schedule; *M* = 0.4 resp/min for multiple schedule) occurred across conditions during the maintenance phase.

Figure 4 shows results from Adam's treatment assessment for tantrums (top panel), FCR (middle panel), and compliance (bottom panel). During baseline, Adam engaged in moderate rates of tantrums (*M* = 0.9 resp/min) and low levels of the FCR. Rates of compliance were variable with one high point occurring during the second baseline session (*M* = 3.9 resp/min). FCT was introduced and tantrums decreased to zero levels and the FCR increased (*M* = 1.9

resp/min). Compliance remained variable, but low, throughout FCT (*M* = 0.5 resp/min). During the reversal to baseline, rates of tantrums increased (*M* = 1.4 resp/min), FCR decreased to zero levels, and compliance remained low (*M* = 0.3 resp/min). Following the reintroduction of FCT, Adam's rates of tantrums decreased (*M* = 0.1 resp/min), FCR increased (*M* = 1.7 resp/min), and compliance remained at low levels.

Schedule thinning was implemented following FCT for Adam (Figure 4). Initially, low rates of tantrums were observed in the multiple schedule and chained schedule. However, as schedule thinning progressed, increases in tantrums were observed during the chained schedule at thinning step 8 (10 instances of compliance (S-) /180 s S+) and in the multiple schedule at thinning step 7 (90 s S-/210 s S+). FCT was reintroduced to decrease rates of problem behavior. Enhanced breaks were added to FCT during which Adam had access to preferred tangible items. During FCT with enhanced breaks, problem behavior immediately decreased to zero levels.

Schedule thinning was reinitiated with Adam following the FCT with enhanced breaks (Figure 4). At the start of schedule thinning, problem behavior remained low. However, increases in problem behavior occurred in both conditions as leaner schedules of reinforcement were introduced. Tantrums increased at step 7 (8 instances of compliance (S-)/210 s S+) for the chained-schedule condition and step 8 (120 s S-/180 s S+) for the multiple-schedule condition. Thinning steps for the chained schedule condition were reduced to step 5 (5 instances of compliance (S-)/255 s S+) and gradually increased based on decreases in problem behavior. Periodic probes to higher thinning steps were successful and resulted in rapid schedule thinning at the end of the schedule-thinning phase. Terminal schedule thinning values were achieved in both conditions. However, Adam reached the terminal schedule value in the multiple schedule

before the chained schedule. He required an additional five sessions in the chained schedule to reach the terminal value.

Across the schedule-thinning phase, Adam's rates of the FCR decreased and rates of compliance gradually increased (Figure 4). Rates of compliance between the two conditions were comparable, (M = 2.1 resp/min for multiple schedule; M = 1.8 resp/min for chained schedule), with high rates occurring at the end of schedule thinning. During maintenance sessions, rates of problem behavior (M = 0.03 resp/min for multiple schedule; M = 0.03 resp/min for chained schedule) and FCR remained low, and rates of compliance remained high (M = 6.5 resp/min for multiple schedule; M = 6.6 resp/min for chained schedule).

Figure 5 displays results from Derek's treatment evaluation for aggression (top panel), FCR (middle panel), and compliance (bottom panel). During baseline, an increasing trend in high rates of aggression was observed (M = 2.8 resp/min). Zero rates of FCR and compliance occurred during baseline. During FCT, aggression decreased with some periodic variable rates. Aggression decreased to low levels for the last six sessions of the phase (M = 0.7 resp/min). Rates of the FCR increased and remained variable (M = 1.6 resp/min), whereas, relatively low rates of compliance occurred throughout FCT (M = 0.6 resp/min). During the reversal to baseline, aggression increased (M = 1.8 resp/min), FCR decreased to zero rates, and compliance remained low (M = 0.9 resp/min). During the second FCT phase, aggression initially increased and then rapidly decreased to low levels (M = 0.9 resp/min). The FCR increased (M = 1.6 resp/min) and compliance remained low (M = 0.2 resp/min).

The first attempt at schedule thinning with Derek occurred following FCT (Figure 5). During schedule thinning, rates of aggression remained variable for the multiple schedule (M = 0.7 resp/min) and chained schedule (M = 0.8 resp/min) conditions and increased for both

conditions as schedule thinning progressed. The FCR remained relatively high and stable across sessions for both schedule-thinning procedures (*M* = 1.7 resp/min for multiple schedule; *M* =1.8 resp/min for chained schedule). Rates of compliance increased slightly during the multiple schedule and chained schedule (*M* = 0.5 resp/min for chained schedule; *M* = 0.3 resp/min for multiple schedule).

Following an unsuccessful attempt at schedule thinning, a reversal to FCT was conducted to reduce and stabilize Derek's rates of problem behavior (Figure 5). During the return to FCT, two components were added: contingent directives and an enhanced break where Derek receiving access to preferred items during breaks. Immediate reductions in problem behavior were observed (*M* = 0.1 resp/min).

During the second attempt at schedule thinning, terminal values were achieved for the multiple schedule and chained-schedule conditions (Figure 5). Periodic probes to leaner schedules facilitated schedule thinning for both conditions. Rates of aggression initially increased at the onset of schedule thinning. However, aggression gradually decreased to low levels for both conditions (*M* = 0.2 resp/min for multiple schedule; *M* = 0.2 resp/min for chained schedule). High rates of FCR were initially observed across conditions with a decrease occurring throughout schedule thinning with the multiple schedule (*M* = 1.5 resp/min) and chained schedule (*M* = 1.5 resp/min) conditions. Rates of compliance gradually increased during the multiple schedule and chained-schedule conditions (*M* = 1.6 resp/min in multiple schedule; *M* = 1.3 resp/min in chained schedule).

During maintenance, sessions were conducted using terminal values for the multiple schedule (270 s S-/30 s S+) and chained schedule (20 instances of compliance (S-)/30 s S+) procedures (Figure 5). Derek's aggression initially increased across procedures. Rates of

aggression decreased in the chained schedule condition (*M* = 0.6 resp/min) and maintained at consistently lower levels compared to the multiple schedule condition (*M* = 0.9 resp/min). Levels of compliance were variable during maintenance for both conditions. Overall, higher rates of compliance occurred during chained schedule (*M* = 2.5 resp/min) than the multiple schedule (*M* = 0.8 resp/min).

Figure 6 shows results from Kevin's treatment evaluation for aggression (top panel), FCR (middle panel), and compliance (bottom panel). During baseline, Kevin engaged in high rates of aggression (*M* = 2.1 resp/min), zero rates of the FCR, and variable rates of compliance (*M* = 1.6 resp/min). Kevin engaged in low rates of aggression (*M* = 0.2 resp/min) and high rates of the FCR (*M* = 2.5 resp/min) during FCT with enhanced breaks. Compliance remained low during FCT with enhanced breaks (*M* = 0.1 resp/min). During the reversal to baseline, rates of aggression immediately increased (*M* = 3.5 resp/min) and rates of the FCR decreased (*M* = 2.8 resp/min). Compliance remained low (*M* = 0.04 resp/min). During the return to FCT with enhanced breaks, relatively low rates of aggression (*M* = 0.5 resp/min), high rates of the FCR (*M* = 2.4 resp/min), and low rates of compliance (*M* = 0.02 resp/min) were observed.

The final phases in Figure 6 depict Kevin's rates of problem behavior, FCR, and compliance during schedule thinning. Variable rates of aggression occurred during both the multiple schedule (*M* = 0.5 resp/min) and chained schedule (*M* = 0.5 resp/min) conditions. FCR rates were variable during schedule thinning (*M* = 3.3 resp/min for the multiple schedule; *M* = 3.2 resp/min for the chained schedule). Relatively low rates of compliance were observed in the chained schedule (*M* = 0.8 resp/min) with higher, but variable, rates of compliance in the multiple schedule (*M* = 2.9 resp/min) condition. Kevin moved to a different school following the end of the school year and was unable to continue attending appointments. As a result, terminal

values were not reached with Kevin. Schedules of reinforcement were thinned to step 7 for the multiple schedule (90 s S-/210 s S+) and step 5 for the chained schedule (5 instances of compliance (S-)/255 s S+).

In summary, FCT with extinction (Adam, Derek, Kevin) or with punishment (Nancy) was effective in reducing rates of problem behavior and increasing rates of the FCR for all four participants. Following FCT, the effects of the chained schedule and multiple-schedule procedures on rates of compliance, the FCR, and problem behavior were compared. For two participants (Nancy and Adam), both schedule-thinning procedures maintained low rates of problem behavior. For Derek, the chained schedule procedure was more effective at maintaining low rates of problem behavior. Both schedules resulted in appropriately equal rates of compliance for Adam. Compliance maintained at higher levels in the chained schedule for Nancy and Derek compared to the multiple-schedule procedure. The effects of chained schedules and multiple schedules on problem behavior and compliance were comparable for Kevin.

Only one attempt at schedule thinning was necessary for Nancy to achieve the terminal schedule for both thinning procedures. For Adam and Derek, high and variable rates of problem behavior reemerged during the initial schedule thinning. One possible explanation for the resurgence of problem behavior may be due to the extinction periods introduced in the multiple schedule and chained-schedule procedures as the duration to the S+ component decreased. Previous studies on resurgence during FCT found that increases in problem behavior can occur when reinforcement of the FCR is withheld or thinned too rapidly (Hagopian et al., 1998; Volker, Lerman, Call, & Trosclair-Lasserre, 2009).

Another possible explanation for the reemergence of Adam's problem behavior was intermittent appointment attendance. Increases in problem behavior were observed when

attendance was not regular during the first attempt at schedule thinning. Adam regularly attended appointments during the second phase of schedule thinning, suggesting that the frequency of treatment sessions may impact treatment success.

Experiment 1 replicated Fisher et al. (1993) and Hagopian et al. (1998) showing that FCT with extinction may not be a sufficient treatment for problem behavior maintained by negative reinforcement. In the current study, one participant (Nancy) required FCT with punishment (contingent directives) for FCT to be effective in reducing screaming. All participants required supplementary treatment components in the form of contingent directives (Nancy and Derek), a return to a denser schedule (Adam and Derek), and enhanced breaks (Adam, Derek, and Kevin) to reduce and maintain low rates of problem behavior during schedule thinning and maintenance. Similar to Hagopian et al. (1998), problem behavior increased with two participants (Adam and Derek) when schedule thinning was conducted. Following a return to FCT with enhanced breaks and punishment (contingent directives; Derek only) schedule thinning was reintroduced. These findings replicate other studies showing the necessity and improved efficacy of FCT with punishment with some participants (Hanley, Piazza, Fisher, & Maglieri, 2005).

Results from the current study also provide support for the use of enhanced breaks to increase the potency of breaks as reinforcers. Enhanced breaks were used to reduce and maintain rates of problem behavior for Adam, Derek, and Kevin. To date, few studies have evaluated the use of positive reinforcement with individuals with problem behavior maintained by social negative reinforcement or those with multiply maintained problem behavior (social negative and positive reinforcement). Slocum and Vollmer (2015) compared the effects of positive and negative reinforcement on compliance by delivering functional (escape from demands) and nonfunctional (access to edibles) reinforcement contingent on compliance. Similarly, Carter

(2010) compared the effects of escape extinction to different positive reinforcers (high-preference edible item, low-preference edible item, or high-preferred tangible item) for compliance. Positive reinforcement in the form of access to high-preferred edibles was more effective than contingent escape in reducing rates of problem behavior and increasing rates of compliance. Both studies delivered positive reinforcement contingent on compliance and did not assess the effects of using positive reinforcement when delivered with the functional reinforcer following the FCR. The present study adds to the literature on this topic in two ways. First, tangible items were used to enhance the breaks as opposed to the delivery of edibles for compliance. Although edibles are potent reinforcers, they are frequently not used in school settings because of teacher concerns or school policies. The use of tangibles to increase the value of breaks may be more socially acceptable while still resulting in an effective intervention. Second, positive reinforcement was delivered contingent on appropriate requests for break and not compliance. This sort of arrangement may be particularly beneficial when evaluating chained schedules, because access to an enhanced break is directly related to compliance. This could increase compliance while also providing the individual with socially acceptable means (a request for a break) to access the functional reinforcer.

A functional analysis conducted outside the current study indicated that Adam's problem behavior was maintained by access to tangible items and escape from demands. The functional analysis conducted with Kevin also found his problem behavior to be maintained by access to tangible items and escape from demands. For these two participants, the addition of enhanced breaks may have addressed the access to tangible function of their problem behavior.

During Experiment 1, multiple schedule and chain schedules were effective to thin schedules of reinforcement. For two participants, multiple and chain schedules were equally

effective (i.e., the same number of sessions were required to reach terminal values). For one participant, schedule thinning to the terminal schedule occurred with less sessions in the multiple schedule than the chained schedule. The purpose of Experiment 2 was to evaluate participants' preferences for these two procedures as a measure of social validity.

Experiment 2

Participants and Settings

Three participants (Derek, Adam, and Nancy) from Experiment 1 participated in Experiment 2. All sessions were conducted in a therapy room on an university campus, in a quiet area of the participant's school, or a quiet area of the participant's home.

Data Collection and Interobserver Agreement

Primary and secondary observers used paper-and-pencil data sheets to collect data on participant selections on a trial-by-trial basis (i.e., participant selection opportunities). Selection was defined as touching a card with a finger or hand. IOA was collected using the point-by-point method (Kazdin, 2011). IOA was calculated by dividing the number of agreements for each trial by the number of agreements and disagreements. The proportion was then multiplied by 100. An agreement was scored if both observers coded the same condition selection (e.g., both agree that the participant selected the chained schedule procedure) and a disagreement if the observers' records did not match. IOA was collected 46.2% of trials across participants. Mean IOA was 100% across all participants.

Procedural Fidelity

Procedural fidelity data were collected by the reliable observers from Experiment 1. Observers collected data on (1) the therapist's presentation of the procedures using the initial link stimuli cards; (2) the implementation of the correct selected procedure; (3) the therapist's correct

delivery of demands; and (4) the delivery of the correct consequence following participants' responding. Procedural integrity was calculated by dividing the number of correct responses by the total number of opportunities to perform a skill and then multiplied by 100. Procedural fidelity was collected on 36.5% of trials and averaged 99.2% (range, 96.7%-100%) across all participants.

Control Exposure

Prior to conducting the modified concurrent-chain procedure, participants were exposed to the control extinction condition. Control exposure sessions were conducted to account for potential novelty effects of the new condition. One 20 cm by 25 cm black hexagon card was used to signal the control extinction condition. At the start of each session, the therapist placed the black hexagon card in a visible location on the table or floor of the session room and made the statement, "We're now on the hexagon card rules. It's time to listen and work." The same three-step prompting procedure used in the other conditions (baseline, FCT, and schedule thinning) was used to obtain compliance. For each participant, the number of exposure sessions were yoked to the number of chained schedule sessions run in the maintenance phase. During the control condition neither problem behavior nor the FCR produced escape. The therapist refrained from commenting following instances of compliance.

Modified Concurrent-Chain Procedure

At the start of each session, participants were seated 1.5 m from a table with the discriminative stimuli for the chained-schedule condition card (circle), the multiple-schedule condition card (triangle), and the extinction condition card (hexagon) placed directly in front of the participant approximately 15 cm apart. The hexagon card served as a control. Selecting the hexagon card resulted in a period of extinction in the terminal link in which escape was

unavailable for problem behavior and the communicative response (i.e., no break was delivered for the FCR and problem behavior). Selecting the circle card resulted in the chained-schedule condition during which the S+ was available for 30 s following 20 instances of compliance. Selecting the triangle card resulted in the multiple-schedule condition during which the S- component was in effect for 270 s and the S+ component was in effect for 30 s. The chained schedule and multiple schedule were implemented as described in Experiment 1.

Prior to starting the assessment, the therapist conducted three forced-choice exposure trials (one for each procedure). During the forced exposure trials, only one card was available (e.g., first trial the circle card was available; the second trial the triangle card was available; the third trial the hexagon card was available). The therapist instructed the participant to select the [shape] card with the statement "Pick one." Once the participant selected the card, the therapist implemented a 5-min session following the procedures outlined for the corresponding condition. The therapist repeated forced-choice exposure trials after every 10 selection trials.

Following the exposure trials, the therapist arranged the three cards approximately equal distance from each other and from the participant. The therapist instructed the participant to select one condition with the statement, "Do you want the [shape] card rules, the [shape] card rules, or the [shape] card rules? Pick one." Once the participant selected a card, the other cards were removed from view. The therapist implemented a 5-min session following the procedures corresponding with that condition. For example, if a participant selected the triangle card, the subsequent session followed procedures for the multiple-schedule condition.

After the session, the cards were represented and the therapist presented a new trial with the instruction for the participant to select a condition. After the session began, the therapist ignored requests to change the condition. A minimum of 10 trials was conducted with each

participant. Additional trials (maximum 30 sessions) were conducted until a differentiated preference was observed.

Results and Discussion

Figure 7 displays the results of the modified concurrent preference assessment for Nancy, Adam, and Derek. During the concurrent-chains assessment, Nancy did not select the control condition and selected the chained schedule on two trials (middle panel). Nancy allocated the majority of her selections to the multiple schedule and consistently selected the multiple schedule condition across the last six opportunities in the assessment. Nancy's selections indicated a preference for the multiple schedule condition.

At the onset of the preference assessment, Adam selected the chained schedule, multiple schedule, and control condition once (Figure 7, top panel). Following the initial trials, Adam exclusively selected the chained schedule. Adam's selections indicated a preference for the chained-schedule condition.

Derek selected all three conditions, including the control condition (Figure 7, bottom panel). The pattern of selection suggested that Derek was not discriminating between the conditions. For the last several appointments, the condition selected first by Derek was consistently selected throughout the appointment. The preference assessment was terminated once the 30-session termination criteria were met. No conclusions can be drawn about Derek's preferences for the multiple or chained schedules.

Although previous literature has evaluated participants' preferences for treatments for attention-maintained problem behavior (e.g., Hanley et al., 1997; Hanley et al., 2005), little research has evaluated participants' preferences for treatments for escape-maintained problem behavior. Experiment 2 replicated and extended the results of prior studies that used modified

concurrent-chains assessments to determine participants' preference for treatment packages for 2 of 3 participants. Assessment outcomes identified preferences for Nancy (multiple schedule) and Adam (chained schedule). However, for one participant, Derek, discriminated responding did not occur and resulted in arbitrary responding. Although exposure to the extinction control condition was conducted, it is possible that additional exposure to the extinction control condition would have helped to increase discriminated responding. In addition, it is possible that the colored cards were not salient stimuli that facilitated discrimination between conditions. Finally, because all conditions involved the presentation of work, it is possible that all conditions were aversive and Derek had a general nonpreference for all conditions. Future research should continue to evaluate procedures for identifying preferences for treatment options with individuals with escape-maintained behavior.

Hanley et al. (1997) evaluated participant preferences for two function-based treatments (FCT and NCR) and found that participants preferred the response-dependent (FCT) to response independent (NCR) reinforcement procedure. Contrary to Hanley et al. (1997), only one participant in the current study preferred the response-dependent (chained schedules) over the response-independent (multiple schedule) delivery of the S+. The variability in findings may be due to differences in participant compliance rates. Nancy's compliance rate was not sufficient to access the S+ during the terminal value of the chained schedule procedure (i.e., Nancy rarely engaged in 20 instances of compliance within a 10-min session). This may have influenced her preference for the time-based contingencies of the multiple-schedule procedure. For Adam, rates of compliance during the chained schedule were sufficient to access the S+ and allowed Adam to contact more frequent reinforcement in the chained schedule compared to multiple-schedule condition. One hypothesis for the current findings is that preferences were based on procedures

that produced a greater amount of reinforcement (Catania, 1963). Additional replications are necessary to determine the variables that affect participants' preferences for certain schedule-thinning procedures. Future research might also assess participant characteristics that influence preferences for certain treatment procedures through the analysis of patterns of responding in additional replications. For example, additional replications may provide evidence that participants with larger skill repertories prefer the chained-schedule procedure and individuals with limited skills prefer the multiple-schedule procedure. Researchers could also evaluate changes in preferences over time. This information could be used to determine how procedures are implemented in the natural environment.

General Discussion

Few studies have directly compared the effects of different schedule-thinning procedures on levels of problem behavior, the FCR, and compliance. In Experiment 1, four participants with problem behavior maintained by escape from demands were taught to access escape using an FCR. Following FCT, chained schedule and multiple schedules were compared during schedule thinning. The chained schedules and multiple schedules were both effective at maintaining low rates of problem behavior for Nancy and Adam. Both procedures were initially effective at maintaining low rates of problem behavior for Derek, but increases in aggression were observed in the multiple-schedule procedure during maintenance sessions. Variable rates of aggression were observed with Kevin across schedule thinning conditions. Higher rates of compliance occurred during the chained-schedule condition for Derek and Nancy. Compliance was approximately equal during the chained and multiple schedules for Adam. The multiple-schedule procedure produced higher, but variable, rates of compliance for Kevin; however, schedules were not thinned to terminal values.

The present study adds to the literature on the use of multiple schedules with problem behavior maintained by social negative reinforcement. To date, the majority of studies evaluating multiple schedules have used the procedure with problem behavior maintained by social positive reinforcement (Fisher et al., 1998; Hagopian et al., 2005; Hanley et al., 2001; Jarmolowicz, DeLeon, & Contrucci-Kuhn, 2009). For example, Betz et al. (2013) thinned levels of reinforcement using multiple schedules following FCT for four individuals with problem behavior maintained by attention and access to tangibles. Schedules were thinned to terminal values (240 s S-/ 60 s S+). On the contrary, Hagopian et al. (2004) attempted to use multiple schedules to thin the schedule of reinforcement for one participant with problem behavior maintained by escape. The multiple-schedule procedure was not effective in thinning the schedule of reinforcement to terminal values while maintaining low rates of problem behavior. The current study demonstrated that the multiple-schedule procedure was able to maintain low rates of problem behavior while decreasing rates of the FCR during schedule thinning. However, the low levels of problem behavior did not maintain for one participant (Derek). These findings diverge from Hagopian et al. (2004) and expand the literature by providing evidence that multiple schedules can be used to decrease use of the FCR with problem behavior maintained by social negative reinforcement.

Experiment 1 also replicated results of prior studies showing that chained schedules are effective at maintaining low rates of problem behavior, decreasing the use of the FCR, and increasing rates of compliance (e.g., Falcomanta et al., 2012; Lalli et al., 1995). For example, Fisher et al. (1993) gradually increased the response requirements for one participant with problem behavior maintained by escape from demands. Rates of problem behavior maintained at low levels as compliance requirements increased. Similarly, Lalli et al. (1995) demonstrated the

effects of the chained schedule with two participants with escape-maintained problem behavior. Rates of problem behavior remained low as the response requirement increased. In the current study, low rates of problem behavior were observed for three participants throughout the chained-schedule thinning procedure. A gradual decrease in rates of the FCR was also observed for three participants as the response requirement increased. These findings suggest that chained schedules are an effective strategy to maintain low rates of problem behavior while reducing rates of the FCR to manageable levels.

One purpose of the present study was to evaluate the effects of the chained-schedule procedure on compliance. An advantage of the chained-schedule procedure is that it allows participants to access breaks while still including a contingency for compliance. In the present study, an inverse relationship was observed between rates of compliance and rates of the FCR for three participants (Nancy, Adam, and Derek). Specifically, as rates of compliance increased, rates of the FCR decreased to low levels. Although the chained schedule was effective at increasing rates of compliance following schedule thinning, variable levels of compliance were observed during maintenance sessions for two participants (Nancy and Derek). Future studies should investigate potential modifications that may facilitate the maintenance of high, stable rates of compliance during chained schedules. For example, future research could evaluate the use of a visual representation of response requirements to earn access to the S+. Visual depictions of response requirements have improved rates of compliance in previous research (e.g., Lalli, Casey, Goh, & Merlino, 1994) and may be beneficial in maintaining stable rates of compliance following the chained-schedule thinning procedure. One strategy to incorporate visual aids might be to use a chart with the response requirement depicted with numbered boxes.

In this example, the therapist would mark the boxes within session as compliance occurs until the response requirement is fulfilled.

During the current study, rates of compliance increased in the multiple-schedule condition even though there were no contingencies in place for compliance (i.e., the participant was not required to comply to earn access to the S+). One potential reason for the increases in compliance is that the contingencies present in the chained schedule carried over to the multiple-schedule condition. Specifically, the multielement design used in the current evaluation may have resulted in difficulty discriminating between the two conditions. Additional research is necessary to evaluate the effects of multiple schedules on rates of compliance when implemented following FCT with escape-maintained problem behavior.

Preferences for the two schedule-thinning procedures were evaluated for three participants (Adam, Derek, and Nancy) during Experiment 2. Preferences varied across participants. One participant preferred the multiple schedule, one participant preferred the chained schedule, and one participant had difficulties discriminating between the conditions. Results replicated the findings of previous studies that the modified concurrent-chains arrangement can be used to determine participants' preferences for treatment procedures (Davison & McCarthy, 1988; Giles et al., 2012; Hanley, et al., 1997; Hanley, et al., 2005; Luczynski & Hanley, 2009).

Previous studies used the concurrent-chains procedure to determine preferences for individuals with problem behavior maintained by social-positive reinforcement (attention, access to tangibles). For example, Luczynski and Hanley (2009) used a concurrent-chains arrangement to determine if participants preferred the delivery of attention using a DRA or NCR procedure. Seven of the eight participants preferred the DRA procedure, suggesting a potential preference

for response-contingent delivery of reinforcers rather than response-independent delivery. To date, few studies have used concurrent-chains procedures to evaluate preferences for treatment procedures for problem behavior maintained by social-negative reinforcement. The evaluation of preferences for treatment for behavior maintained by social-negative reinforcement may present challenges, given an individual's history of avoiding demands. Arrangements designed to assess preferences with these individuals are themselves demands and may evoke escape-maintained problems behavior. The present study extends the use of concurrent-chains procedures by evaluating treatment preferences with individuals with escape-maintained problem behavior. The concurrent-chains arrangement used in the current study was effective in determining preferred schedule-thinning procedures for two of three participants.

Other social validity measures should be investigated in future studies. For example, teacher and therapist preferences for the two schedule-thinning procedures should be evaluated. Gabor, Fritz, Roath, Rothe, and Gourley (2016) used a concurrent-chains procedure to determine caregiver preferences for three interventions for problem behavior maintained by social positive reinforcement (NCR, DRA, and DRO). Contrary to the speculation that caregivers may prefer the NCR procedure due to the low response effort required to implement the procedure, caregivers preferred the DRA procedure compared to the DRO or NCR procedures. These findings provided evidence for the continued assessment of the social validity of treatment packages. In addition, identifying a preferred schedule-thinning procedure based on participant preference or teacher and therapist preference may increase the likelihood that procedures found to be effective during treatment evaluations are used in the natural environment.

Future research should evaluate the levels of treatment integrity with which staff implement chained and multiple schedules in the natural environment. Treatment integrity is the

degree to which an intervention is implemented as intended (DiGennaro, Martens, & Kleinnann, 2007; DiGennaro Reed, Reed Catania, & Maquire, 2011). Evaluating treatment integrity is important given that the effects of poor treatment integrity may result in poor treatment outcomes (DiGennaro, Martens, & McIntyre, 2005). For example, Wilder, Atwell, and Wine (2006) assessed the effects of three levels of treatment integrity on compliance (100%, 50%, 0%). For both participants, the highest level of treatment integrity (100%) was associated with the highest levels of compliance. Compliance with demands in the 0% integrity condition occurred at or below baseline levels. These findings further highlight the negative impacts of poor treatment integrity.

Results of the current study should be interpreted relative to the following limitations. First, the idiosyncratic preferences identified during the preference assessment may reduce the generality of the conclusions that can be made regarding preferences for the multiple-schedule and chained-schedule thinning procedures. Second, it is possible that carryover effects from the chained and multiple schedules occurred because of the multielement design used to compare the schedules. Future studies could address potential carryover effects by using a different experimental design to evaluate the effects of the two schedule-thinning procedures. For example, a reversal design, where the multiple-schedule condition and the chained-schedule condition are evaluated within separate phases, may be used to avoid potential across-session carryover effects. However, sequence effects would be a consideration with a reversal design. Another potential strategy to reduce potential carryover effects is to use more salient discriminative stimuli to signal the two schedule-thinning procedures. For example, researchers have used different colored cards and rooms (Hanley et al., 2004), floral leis (Tiger & Hanley, 2004), bracelets (Betz et al., 2013), and therapists (Lalli et al., 1995) to signal different treatment

conditions. Future research may further promote discrimination between the two schedule-thinning procedures by using larger stimulus cards or combining stimuli (e.g., colored cards and shirts and different therapists).

Another potential limitation of the current study is the number of steps outlined for each schedule-thinning procedure. Even with the use of the probes ahead, the number of session necessary to thin schedules of reinforcement to terminal values may be difficult for clinicians to conduct in the applied settings. Prior studies evaluating schedule-thinning procedures have demonstrated cases where gradual schedule thinning was not necessary (e.g., Betz et al., 2013; Greer et al., 2016; Hagopian et al., 2004). Contrary to prior findings, the resurgence of problem behavior occurred with two participants following the start of schedule thinning (Adam and Derek). These results suggest that it would be unlikely that rapid schedule thinning would have been successful for these participants. Given the potential benefits of rapid schedule thinning (e.g., reduced number of treatment sessions), future studies should identify participant characteristics or prerequisite skills that may predict when rapid schedule thinning would be successful.

In summary, determining the most effective procedures for thinning the use of the FCR and increasing rates of compliance following FCT continues to be important for treatment outcomes with individuals who engage in severe problem behavior to escape demands. In Experiment 1, the effects of multiple schedule and chained-schedule thinning procedures on rates of problem behavior, FCR, and compliance were compared. Results provided evidence for the continued use of the multiple schedule and chained schedule procedures to maintain low rates of problem behavior while reducing rates of the FCR to manageable levels. In addition, Experiment 2 replicated the previous research that the modified concurrent-chains arrangement can be used

to identify preferences for treatment interventions. Findings from the concurrent-chains assessment indicated one participant preferred the multiple-schedule procedure, one participant preferred the chained schedule, and one participant had indiscriminate responding. Results suggest that the concurrent-chains arrangement can be used to determine treatment preferences for problem behavior maintained by social-negative reinforcement.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Barlow, D. H., & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis*, 12, 199-210. doi: 10.1901/jaba.1996.29-213

Beare, P. L., Severson, S., & Brandt, P. (2004) The use of positive procedure to increase engagement on-task and decrease challenging behavior. *Behavior Modification*, 28, 28-44. doi: 10.1177/0145445503259217

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*, 1-21. doi: 10.1002/jaba.30

Bloom, S. E., Iwata, B. A., Fritz, J. N., Roscoe, E. M., & Carreau, A. B. (2013). Classroom application of a trial-based functional analysis. *Journal of Applied Behavior Analysis*, 44, 19-31. doi: 10.1901/jaba.2011.44-19

Branch, M. N. (1977). Signalled and unsignalled percentage reinforcement of performance under a chained schedule. *Journal of Experimental Analysis of Behavior*, *25*, 71-83. doi: 10.1901/jeab.1977.27-71

Brown, K. A., Wacker, D. P., Derby, M., Peck, S. M., Richman, D. M., Sasso, G. M.,Harding, J. W. (2000). Evaluating the effects of functional communication training in the presence and absence of establishing operations. *Journal of Applied Behavior Analysis*, *33*, 53-71. doi: 10.1901/jaba.2000.33-53

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

Catania, A. C. (2013). Concurrent performances: A baseline for the study of reinforcement magnitude. *Journal of the Experimental Analysis of Behavior*, 6, 299-300. doi: 10.1901/jeab.1963.6-299

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Davison, M. & McCarthy, D. (1988). *The matching law: A research review*. Hillsdale, NJ: Lawrence Eribaum Associates.

Day, H., Horner, R. H., & O'Neill, R. E. (1994). Multiple functions or problem behaviors: Assessment and intervention. *Journal of Applied Behavior Analysis*, *27*, 279-289. doi: 10.1901/jaba.1994.27-279

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, *29*, 519-533. doi: 10.1901/jaba.1996.29-519

DiGennaro, F. D., Martens, B. K., & Kleinmann, A. E. (2007). A comparison of performance feedback procedures on teachers' treatment implementation integrity and students' inappropriate behavior in special education classrooms. *Journal of Applied Behavior Analysis*, *40*, 611-615. doi:10.1901/jaba.2007.40-447

DiGennaro, F. D., Martens, B. K., & Kleinmann, A. E. (2005). Increasing treatment integrity through negative reinforcement: Effects on teacher and student behavior. *School Psychology Review*, 34, 220-231.

DiGennaro Reed, F. D., Reed, D. D., Catania, C. N., & Maquire, H. (2011). A parametric analysis of errors of commission during discrete-trial training. *Journal of Applied Behavior Analysis*, *44*, 611-615. doi:10.1901/jaba.2011.44-611

Durand, V. (1999). Functional communication training using assistive devices: Recruiting natural communities of reinforcement. *Journal of Applied Behavior Analysis*, *32*, 247-267. doi: 10.1901/jaba.1999.32-247

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,* 187-198. doi: 10.1002/(SICI)1099-078

Falcomata, T. S., White, P., Muething, C. S. & Fragale, C. (2012). A functional communication training and chained schedule procedure to treat challenging behavior with multiple functions. *Journal of Developmental and Physical Disabilities*, *24,* 529-538. doi: 10.1007/s10882-012-9287-z

Fenerty, K. A., & Tiger, J. H. (2010). Determining preschoolers' preferences for choice-making opportunities: Choice of task versus choice of consequence. *Journal of Applied Behavior Analysis*, *43*, 503-507. doi: 10.1901/jaba.2010.43-503

Ferster, C. B. & Skinner, B. F. (1957). *Schedules of Reinforcement*. East Norwalk, CT: Appleton-Century Crofts.

Fisher, W. W., Kuhn, D. E., & Thompson, R. H. (1998). Establishing discriminative control of responding using functional and alternative reinforcers during functional communication training. *Journal of Applied Behavior Analysis, 31,* 543–560. doi: 10.1901/jaba.1998.31-543

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, 25, 491-498. doi: 10.1901/jaba.1992.25-491

Fisher, W. W., Piazza, C., Cataldo, M., Harrell, R., Jefferson, G., & Conner, R. (1993). Functional communication training with and without extinction and punishment. *Journal of Applied Behavior Analysis*, *26,* 23–36. doi: 10.1901/jaba.1993.26-23

Fisher, W. W., Thompson, R. H., Hagopian, L. P., Bowman, L. G., & Krug, A. (2000). Facilitating tolerance of delayed reinforcement during functional communication training. *Behavior Modification*, *24,* 3-29. doi: 10.1177/0145445500241001

Fyffe, C. E., Kahng, S. W., Fittro, E., & Russell, D. (2004). Functional analysis and treatment of inappropriate sexual behavior. *Journal of Applied Behavior Analysis*, *37*, 401-404. doi: 10.1901/jaba.2004.37-401

Gabor, A. M., Fritz, J. N., Roath, C. T., Rothe, B. R., & Gourley, D. A. (2016). Caregiver preference for reinforcement-based interventions for problem behavior maintained by positive reinforcement. *Journal of Applied Behavior Analysis*, 49, 1-13. doi: 10.1002/jaba.286

Giles, A. F., St. Peter, C. C., Pence, S. T., & Gibson, A. B. (2012). Preference for blocking or response redirection during stereotypy treatment. *Research in Developmental*

Disabilities, 33, 1691-1700.

Greer, B. D., Fisher, W. W., Saini, V., Owen, T.M., & Jones, J. K., (2016). Functional communication training during reinforcement schedule thinning: An analysis of 25 applications. *Journal of Applied Behavior Analysis*, 49, 105-121. doi: 10.1002/jaba/265

Hagopian, L. P., Boelter, E. W., & Jarmolowicz, D. P. (2011). Reinforcement schedule thinning following functional communication training: Review and recommendations. *Behavior Analysis in Practice*, *4*, 4-16.

Hagopian, L. P., Fisher, W. W., Sullivan, M. T., Acquisto, J., & LeBlanc, L. A. (1998). Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis*, *31*, 211-235. doi:10.1901/jaba.1998.31-211.

Hagopian, L. P., Kuhn, S. A. C., 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*, 177-193. doi: 10.1901/jaba.2005.43-04

Hagopian, L. P., Toole, L. M., Long, E. S., Bowman, L. G., & Lieving, G. A. (2004). A comparison of dense-to-lean and fixed lean schedules of alterntive reinforcement and extinction. *Journal of Applied Behavior Analysis*, 37, 323-337. doi: 10.1901/jaba.2004.37-323

Hanley, G. P., Iwata, B. A., & Thompson, R. H. (2001). Reinforcement schedule thinning following treatment with functional communication training. *Journal of Applied Behavior Analysis*, *4,* 17–38. doi: 1 0.1901/jaba.2001.34-17

Hanley, G. P., Piazza, C. C., Fisher, W. W., Contrucci, S. A., & Maglieri, K. A. (1997).

Evaluation of client preference for function-based treatment packages. *Journal of Applied Behavior Analysis*, *30,* 459-473. doi: 10.1901/jaba.1997.30-459

Hanley, G. P., Piazza, C. C., Fisher, W. W., & Maglieri, K. A. (2005). On the effectiveness of and preference for punishment and extinction components of function-based interventions. *Journal of Applied Behavior Analysis*, *38,* 51-65.

Horner, R. H., & Day, H. (1991). The effects of response efficiency on functionally equivalent competing behaviors. *Journal of Applied Behavior Analysis*, *24,* 719- 732. doi: 10.1901/jaba.1991.24-719

Ingram, K., Lewis-Palmer, T., & Sugai, G. (2005). Function-based intervention planning: Comparing the effectiveness of FBA function-based and non-function-based intervention plans. *Journal of Positive Behavior Interventions*, *7,* 224-236. doi: 10.1177/10983007050070040401

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,* 197-209. doi: 10.1901/jaba.1994.27-197

Iwata, B.A., Pace, G. M., Cowdery, G. E., & Miltenberger, R. G. (1994). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis*, *27,* 131-144. doi: 10.1901/jaba.1994.27-131

Jarmolowicz, D. P., DeLeon, I. G., & Contrucci Kuhn, S. A. (2009). Functional communication during signaled reinforcement and/or extinction. *Behavioral Interventions*, 24, 265-273. doi: 10.1002/bin.288

Jarmolowicz, D. P. & Lattal, K. A. (2013). Delayed reinforcement and fixed-ratio performance. *Journal of the Experimental Analysis of Behavior*, *100,* 370-395. doi: 10.1002/jeab.48

Kazdin, A. (2011). *Single-case research designs: Methods for clinical and applied settings* (2nd ed.). New York, NY: Oxford University Press.

Kelley, M. E., Lerman, D. C., & Van Camp, C. M. (2002). The effects of competing reinforcement schedules on the acquisition of functional communication. *Journal of Applied Behavior Analysis*, *35,* 59-63. doi: 10.1901/jaba.2002.35-59

Lalli, J. S., Casey, S., Goh, H., & Merlino, J. (2013). Treatment of escape-maintained aberrant behavior with escape extinction and predictable routines. *Journal of Applied Behavior Analysis*, 27, 705-714. doi: 10.1901/jaba.1994.27-705

Lalli, J. S., Casey, S., & Kates, K. (1995). Reducing escape behavior and increasing task completion with functional communication training, extinction and response chaining. *Journal of Applied Behavior Analysis*, *28*, 261-268. doi: 10.1901/jaba.1995.28-261

Lattal, K. A. (1984). Signal functions in delayed reinforcement. *Journal of the Experimental Experimental Analysis of Behavior*, *42,* 239-253. doi: 10.1901/jeab.1984.42-239

Lecavalier, L., Leone, S., & Wiltz, J. (2006). The impact of behavior problems on caregiver stress in young people with autism spectrum disorders. *Journal of Intellectual Disability Research*, 50, 172-183. doi: 10.1111/j.1365-2788.2005.00732.x

LeGray, M. W., Dufrene, B. A., Mercer, S., Olmi, D. J., & Sterling, H. (2013). Differential reinforcement of alternative behavior in center-based classrooms: Evaluation of pre-

teaching the alternative behavior. *Journal of Behavioral Education*, *22*, 85-102. doi: 10.1007/s10864-013-9170-8

Lerman, D. C., & Iwata, B. A. (1993) Descriptive and experimental analysis of variables maintaining self-injurious behavior. *Journal of Applied Behavior Analysis*, *26,* 293-319. doi: 10.1901/jaba/1993.26.293

Lerman, D. C., & Iwata, B. A. (1996) Developing a technology of the use of operant extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29,* 345-382. doi: 10.1901/jaba.1996.29-345

Libby, M. E., Weiss, J. S., Bancroft, S., & Ahearn, W. H. (2008). A comparison of most-to-least and least-to-most prompting on the acquisition of solitary play skills. *Behavior Analysis in Practice*, *1,* 37-43. doi: PMC2846579

Luczynski, K. C., & Hanley, G. P. (2013). Do children prefer contingencies? An evaluation of the efficacy of and preference for contingent versus noncontingent social reinforcement during play. *Journal of Applied Behavior Analysis*, 42, 511-525. doi: 10.1901/jaba.2009.42-511

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

Matson, J. L., Sipes, M., Horovitz, M. Worley, J. A., Shoemaker, M. E., & Kozlowski, A. M. (2011). Behaviors and corresponding functions addressed via functional assessment. *Research in Developmental Disabilities, 32,* 625-629. doi: 10.1016/j.ridd.2010.12.011

Michael, J. (1993). Establishing operation. *The Behavior Analyst, 16,* 191-206. Retrieved from https://www.abainternational.org/journals/the-behavior-analyst.aspx

Olson, S. L., & Hoza, B. (2010). Preschool development antecedents of conduct problems in children beginning school. *Journal of Clinical Child Psychology*, 22, 60-67. doi: 10.1207/s15374424jccp2201_6

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

Peck, S. M., Wacker, D. P., Berg, W. K., Cooper, L. J., Brown, K. A., Richman, D., & Millard, T. (1996). Choice-making treatment of young children's severe behavior problems. *Journal of Applied Behavior Analysis, 29,* 263-290. doi: 10.1901/jaba.1996.29-263

Pence, S. T., Roscoe, E. M., Bourret, J. C., & Ahearn, W. H. (2009). Relative contributions of three descriptive methods: Implications for behavioral assessment. *Journal of Applied Behavior Analysis*, *42,* 425-446. doi: 10.1901/jaba.2009.42-425

Petscher, E. S., Rey, C., & Bailey, J. S. (2009). A review of empirical support for different reinforcement of alternative behavior. *Research in Developmental Disabilities*, *30,* 409-425. doi: 10.1016/j.ridd.2008.08.008

Piotrkowski, C. S., Botsko, M., & Matthews, E. (2001). Parents' and teachers' beliefs about children's school readiness in a high-need community. *Early Childhood Research Quarterly*, *15,* 537-558.

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

Savastano, H. I. & Fantino, E. (1996). Differences in delay, not ratios, control choice in concurrent chains. *Journal of Experimental Analysis of Behavior*, *66,* 97-116. doi: 10.1901/jeab.1996.66-97

Shirley, M. J., Iwata, B., Kahng, S. W., Mazaleski, J. L., & Lerman, D. C. (1997). Does functional communication training compete with ongoing contingencies of reinforcement? An analysis during response acquisition and maintenance. *Journal of Applied Behavior Analysis*, *30,* 93-104. doi: 10.1901/jaba.1997.30-93

Shriver, M. D., Anderson, C. M., & Proctor, B. (2001). Evaluating the validity of functional behavior assessment. *School Psychology Review*, *30,* 180-192.

Slocum, S. K., & Vollmer, T. R. (2015). A comparison of positive and negative reinforcement for compliance to treat problem behavior maintained by escape. *Journal of Applied Behavior Analysis*, 48, 563-574. doi: 10.1002/jaba.216

Taylor, J. & Miller, M. (1997). When timeout works some of the time: The importance of treatment integrity and functional assessment. *School Psychology Quarterly*, *12,* 4-22.

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,* 333-338. doi: 10.1901/jaba.2007.56-06

Tiger, J. H. & Hanley, G. P. (2004). Developing stimulus control of preschooler mands: An analysis of schedule-correlated and contingency-specifying stimuli. *Journal of Applied Behavior Analysis*, *34,* 517-521. doi: 10.1901/jaba.2004.37-517

Tiger, J. H., Hanley, G.P., & Bruzek, J. (2008). Functional communication training: A review and practical guide. *Behavior Analysis in Practice*, *1,* 16-23. doi: 10.1901/.2006.158-04

Tiger, J. H., Hanley, G. P., & Hernandez, E. (2006). An evaluation of the value of choice with preschool children. *Journal of Applied Behavior Analysis*, 39, 1-16. doi: 10.1901/jaba.2006.158-04

Umbreit, J., Lane, K. L., Dejud, C. (2004). Improving Classroom Behavior by Modifying Task Difficulty: Effects of increasing the difficulty of too-easy tasks. *Journal of Positive Behavior Interventions*, *6,* 13-20. doi: 10.1177/10983007040060010301

Volkert, V. M., Lerman, D. C., Call, N. A., & Trosclair-Lasserre, N. (2009). An evaluation of resurgence during treatment with functional communication training. *Journal of Applied Behavior Analysis*, 42, 145-160. doi: 10.1901/jaba.2009.42-145

Vollmer, T. R., & Iwata, B. A. (1992). Differential reinforcement as treatment for behavior disorders: Procedural and functional variations. *Research in Developmental Disabilities*, *13*, 393-417.

Vollmer, T. R., Iwata, B. A., Zarcone, J. R., Smith, R. G., & Mazaleski, J. L. (1993). The role of attention in the treatment of attention-maintained self-injurious behavior: Noncontingent reinforcement and differential reinforcement of other behavior. *Journal of Applied Behavior Analysis, 26*, 9-21. doi:10.1901/jaba.1993.26-9

Wacker, D. P., Steege, M. W., Northup, J., Saso, G. M., Berg, W., Reimers, T., & Donn, L. (1990). A component analysis of functional communication training across three topographies of severe behavior problems. *Journal of Applied Behavior Analysis, 23,* 417-429. doi:10.1901/jaba.1990.23-417

Wilder, D. A., Atwell, J., & Wine, B. (2013). The effects of varying levels of treatment integrity on child compliance during treatment with a three-step prompting procedure. *Journal of Applied Behavior Analysis,* 39, 369-373. doi: 10.1901/jaba.2006.144-05

Table 1

Prompting Hierarchy for Non-Vocal Communicative Response

Step	Prompt Delay	Prompt	Access to Break
0	0-s delay (immediate)	Model touching card	Correct request for "break" before or after prompt
1	1-s delay	Model touching card	Correct request for "break" before or after prompt
2	2-s delay	Model touching card	Correct request for "break" before or after prompt
3	3-s delay	Model touching card	Correct request for "break" before or after prompt
4	4-s delay	Model lifting pointer finger	Correct request for "break" before or after prompt
5	5-s delay	Model lifting pointer finger	Correct request for "break" before or after prompt
6		Independent	Independent and correct responding at any point in session

Table 2

Chained Schedule Thinning Steps

Steps	Compliance Requirement	S+ Duration
1	1 instances	4 min 55 s
2	2 instances	4 min 50 s
3	3 instances	4 min 45 s
Probe to 7	8 instances	3 min 30 s
4	4 instances	4 min 30s
5	5 instances	4 min 15 s
6	6 instances	4 min
Probe to 10	14 instances	2 min
7	8 instances	3 min 30 s
8	10 instances	3 min
9	12 instances	2 min 30 s
Probe to 13	20 instances	30 s
10	14 instances	2 min
11	16 instances	1 min 30 s
12	18 instances	1 min
13	20 instances	30 s

Table 3

Multiple Schedule Thinning Steps

Steps	S- Duration	S+ Duration
1	5 s	4 min 55 s
2	10 s	4 min 50 s
3	15 s	4 min 45 s
Probe to 7	1 min 30 s	3 min 30 s
4	30 s	4 min 30s
5	45 s	4 min 15 s
6	1 min	4 min
Probe to 10	3 min	2 min
7	1 min 30 s	3 min 30 s
8	2 min	3 min
9	2 min 30 s	2 min 30 s
Probe to 13	4 min 30 s	30 s
10	3 min	2 min
11	3 min 30 s	1 min 30 s
12	4 min	1 min
13	4 min 30 s	30 s

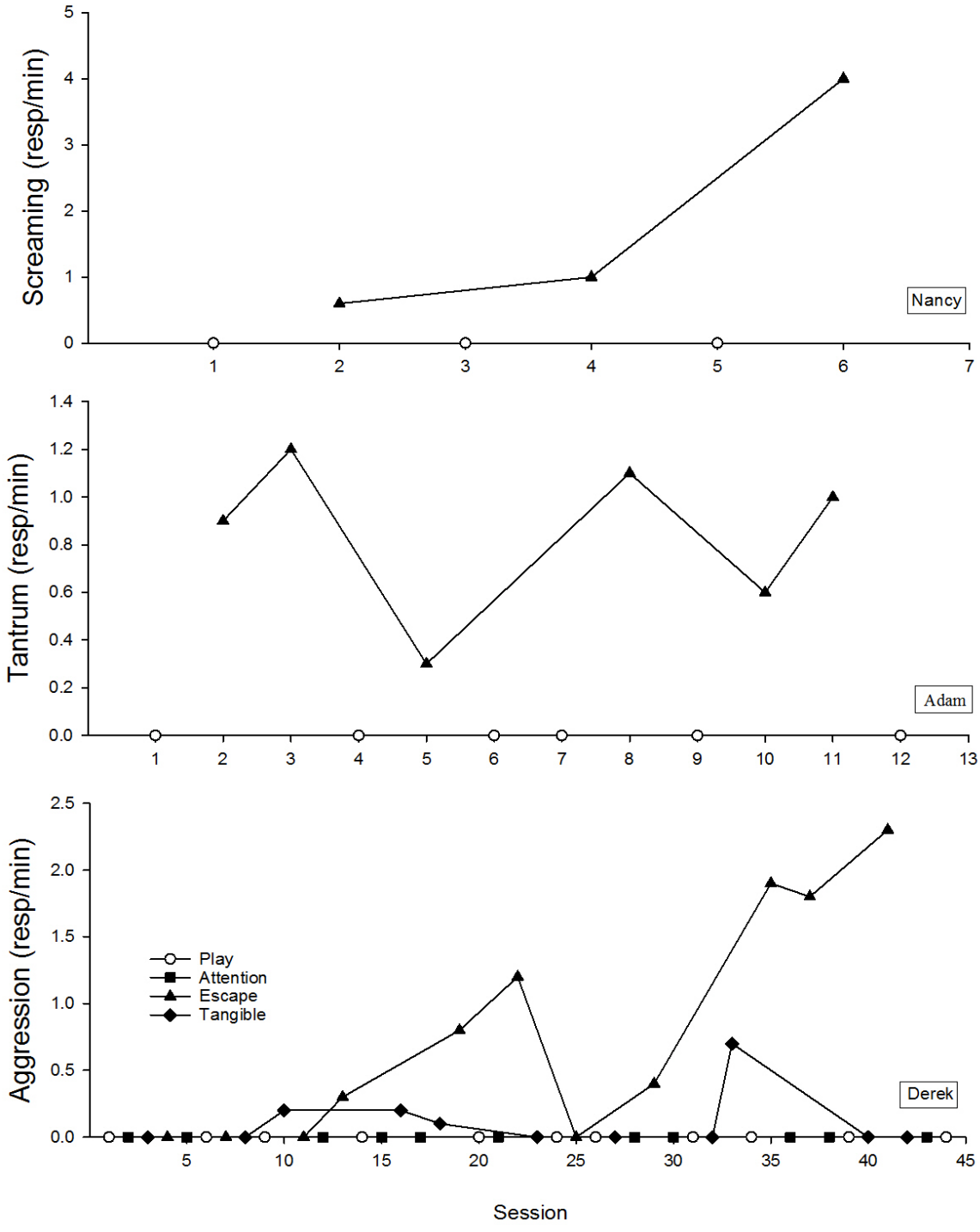

Figure 1. Depicts rates of target responses across session during functional analyses for Nancy (top panel), Adam (middle panel), and Derek (bottom panel)

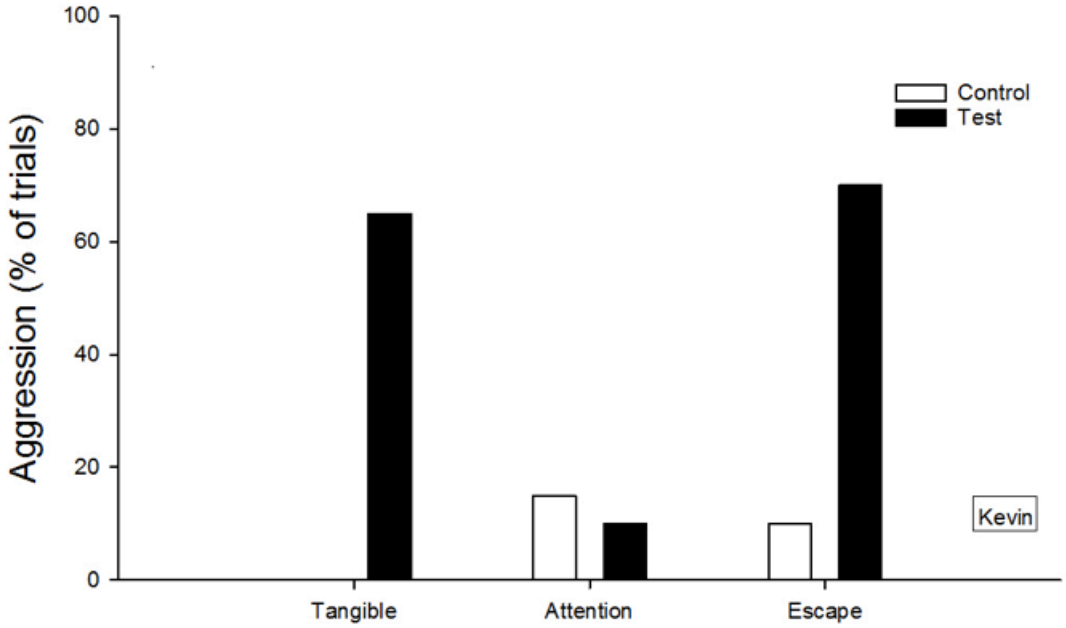

Figure 2. Percentage of trials with aggression across conditions for Kevin

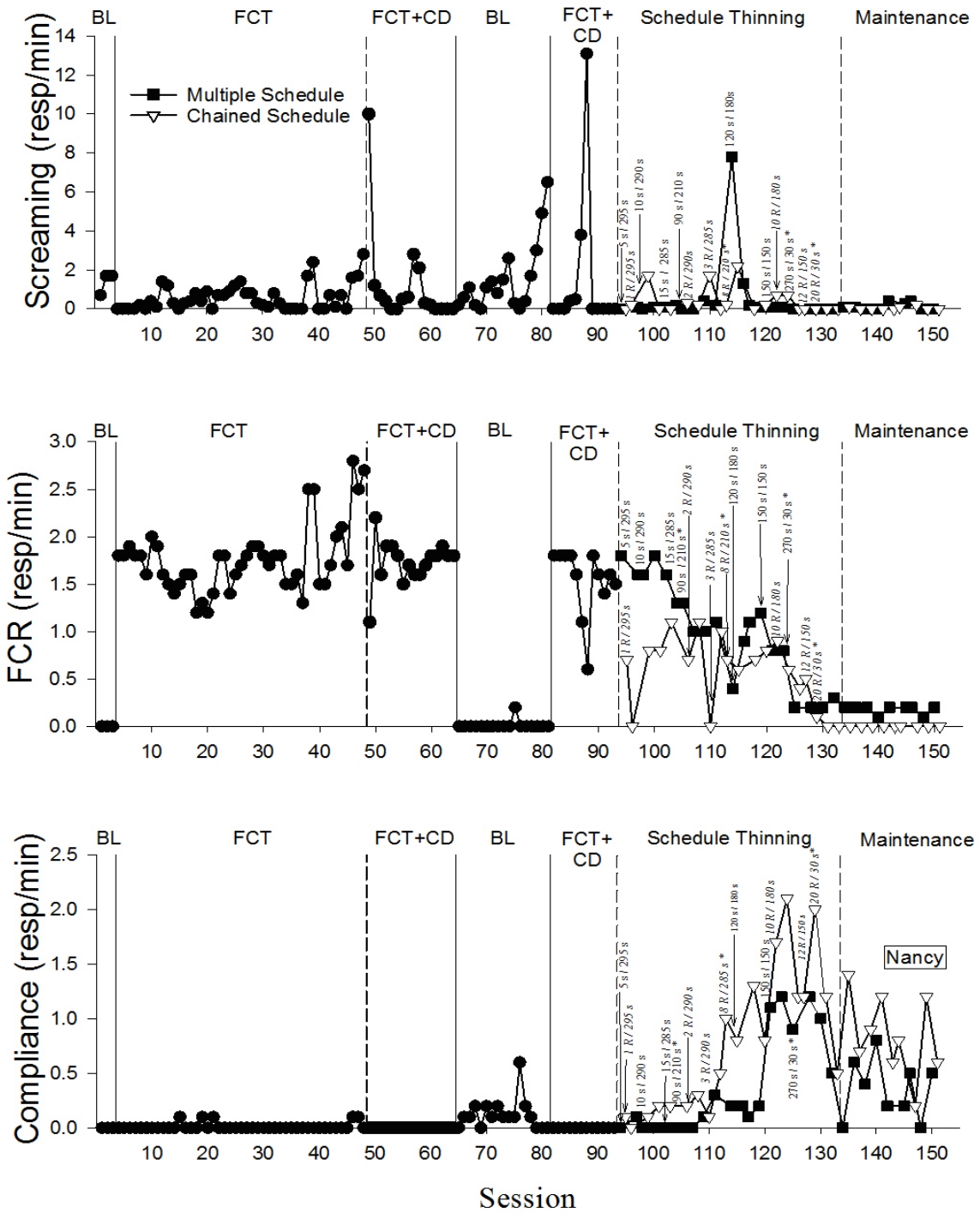

Figure 3. Depicts rates of screaming (top panel), FCR (middle panel), and compliance (bottom panel) across sessions during baseline, FCT, FCT with contingent directives (FCT + CD), schedule thinning, and maintenance for Nancy

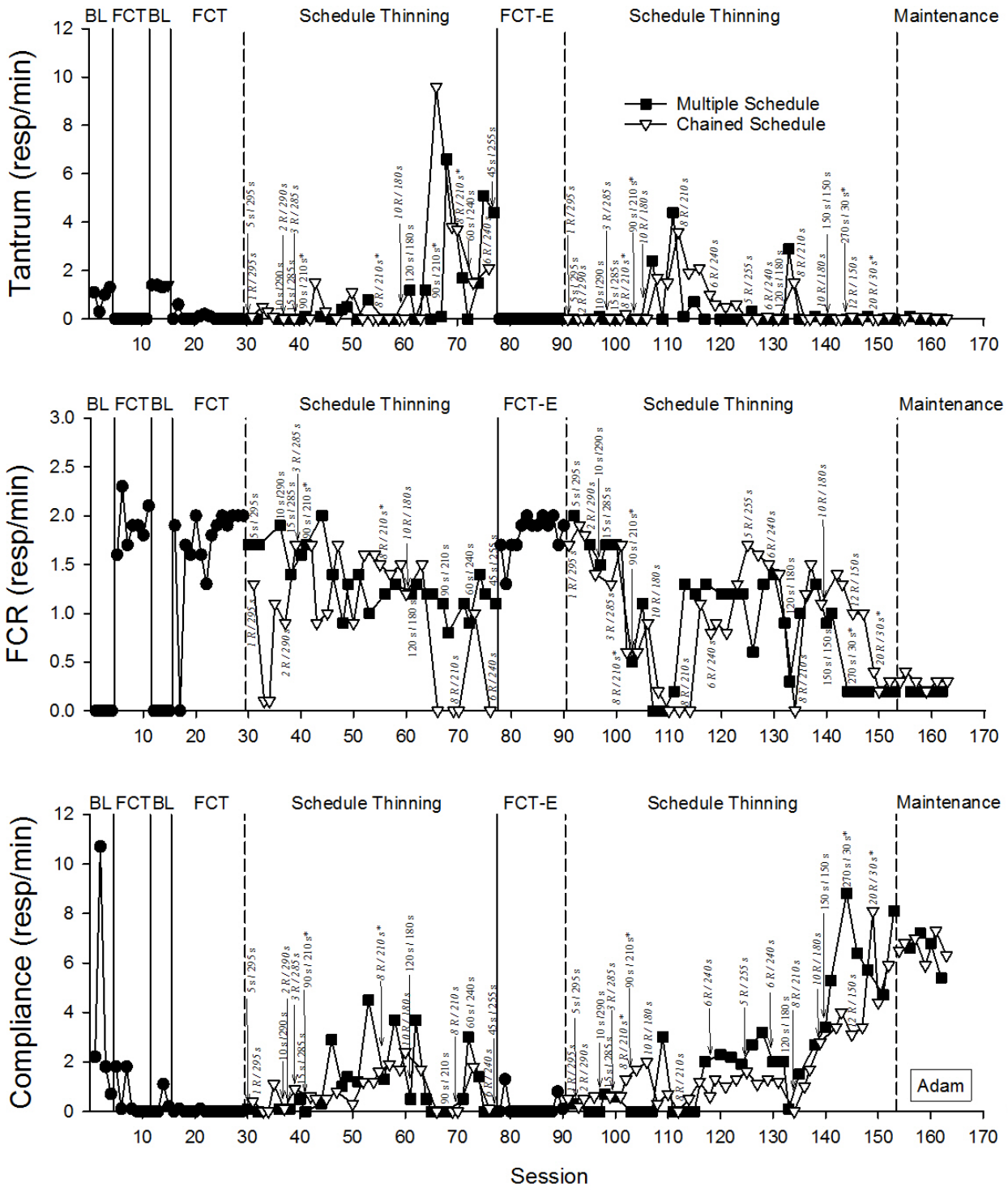

Figure 4. Depicts rates of tantrums (top panel), FCR (middle panel), and compliance (bottom panel) across sessions during baseline, FCT, FCT with enhanced breaks (FCT-E), schedule thinning, and maintenance for Adam

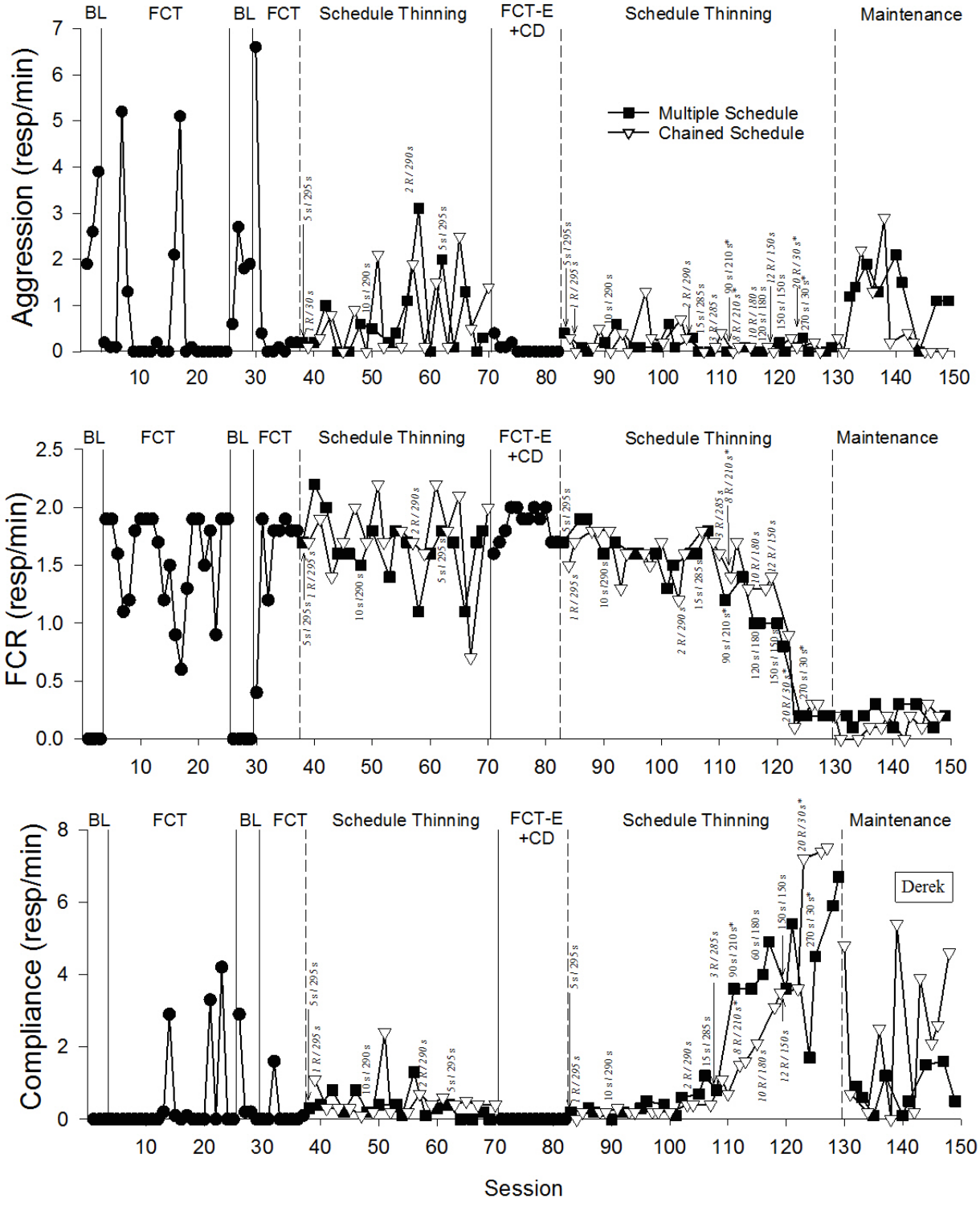

Figure 5. Depicts rates of aggression (top panel), FCR (middle panel), and compliance (bottom panel) across sessions during baseline, FCT, FCT with enhanced breaks and contingent directives (FCT-E+CD), schedule thinning, and maintenance for Derek

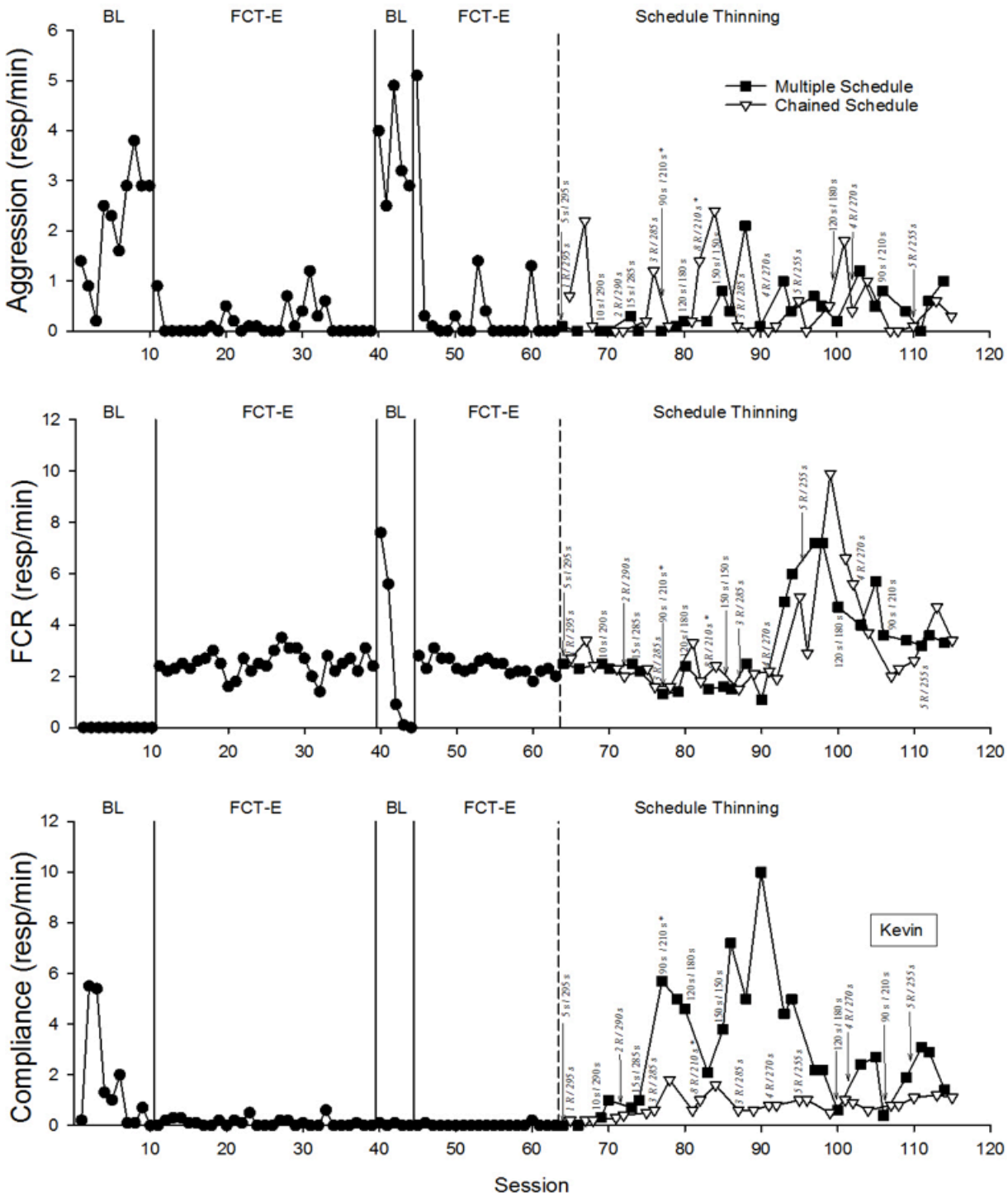

Figure 6. Depicts rates of aggression (top panel), FCR (middle panel), and compliance (bottom panel) across sessions during baseline, FCT, FCT with enhanced breaks (E), and schedule thinning for Kevin

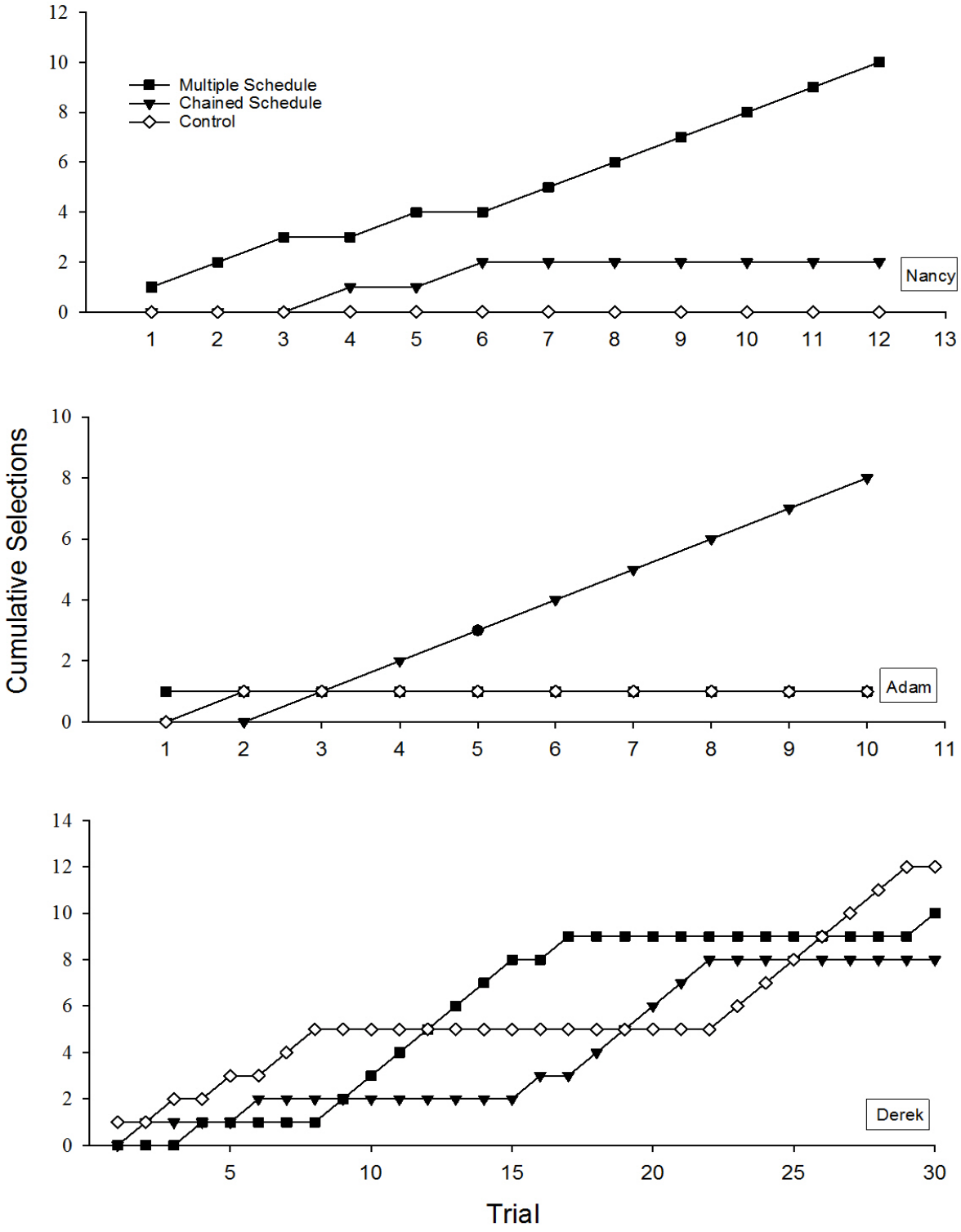

*Figure 7.*Cumulative selections across trials for Nancy (top panel), Adam (middle panel), and Derek (bottom panel)