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Using Multiple Schedules During Functional Communication Training to Promote Rapid Transfer of Treatment Effects

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Abstract

Multiple schedules with signaled periods of reinforcement and extinction have been used to thin reinforcement schedules during functional communication training (FCT) to make the intervention more practical for parents and teachers. We evaluated whether these signals would also facilitate rapid transfer of treatment effects from one setting to the next and from one therapist to the next. With two children, we conducted FCT in the context of mixed (baseline) and multiple (treatment) schedules introduced across settings or therapists using a multiple baseline design. Results indicated that when the multiple schedules were introduced, the functional communication response came under rapid discriminative control, and problem behavior remained at near-zero rates. We extended these findings with another individual by using a more traditional baseline in which problem behavior produced reinforcement. Results replicated those of the previous participants and showed rapid reductions in problem behavior when multiple schedules were implemented across settings.

Keywords

functional analysis; functional communication training; differential reinforcement; mixed schedules; multiple schedules

Functional communication training (FCT) is the most commonly prescribed intervention when a functional analysis has determined that a person's problem behavior is reinforced by one or more social consequences (e.g., contingent attention, escape; Tiger, Hanley, & Bruzek, 2008). FCT typically consists of two major components: differential reinforcement of an alternative response (DRA) and extinction (EXT) of problem behavior. The target response for the DRA component involves a simple mand that specifies (and is reinforced by) the consequence identified by a functional analysis as the reinforcer for problem behavior. For example, if a functional analysis indicates that an individual's problem behavior is controlled by access to adult attention or escape from nonpreferred tasks, the individual would be taught to access attention or obtain breaks from nonpreferred tasks via specific mands (e.g., "Play please" or "Break please," respectively; Carr & Durand, 1985; Fisher & Bouxsein, 2011; Fisher, Kuhn, & Thompson, 1998; Fisher et al., 1993, 2005;

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Horner & Day, 1991; Kurtz, Boelter, Jarmolowicz, Chin, & Hagopian, 2011; Lalli, Casey, & Kates, 1995; Rooker, Jessel, Kurtz, & Hagopian, 2013; Wacker et al., 1990).

When FCT is initially introduced, the functional communication response (FCR) is typically reinforced with the consequence that previously reinforced problem behavior on a dense schedule (e.g., fixed-ratio 1; FR 1), which is advantageous in at least two ways. First, denser DRA schedules typically produce greater and more rapid reductions in problem behavior (Nevin & Shahan, 2011). Second, frequent access to the functional reinforcer via the FCR also weakens the establishing operation for problem behavior (Laraway, Snycerski, Michael, & Poling, 2003). Weakening the establishing operation for problem behavior through frequent reinforcement of the FCR can mitigate EXT effects (DeRosa, Fisher, & Steege, 2015; Lerman & Iwata, 1995; also see Amy's data in Figure 4 in Fisher et al., 1998), and this may be why FCT sometimes reduces problem behavior without this response contacting EXT (e.g., Horner & Day, 1991; Fisher et al.).

Results from early studies on the treatment of severe destructive behavior using FCT suggested that this intervention was least effective when it was introduced without EXT or punishment, somewhat more effective when it was combined with EXT, and most effective when it was combined with punishment (Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Wacker et al., 1990). These differences between FCT without EXT, FCT with EXT, and FCT with punishment were more pronounced following attempts to thin the schedule of reinforcement for the FCR in order to make the intervention more practical for the natural environment (e.g., home, school; Hagopian et al.). However, results from more recent investigations suggest that FCT with EXT can produce large and sustained reductions in severe destructive behavior, especially when reinforcement schedule thinning is (a) done in the context of a multiple schedule, (b) alternative sources of reinforcement are delivered when the functional reinforcer is unavailable, or both (e.g., Betz, Fisher, Roane, Mintz, & Owen; 2013; Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hagopian, Contrucci Kuhn, Long, & Rush, 2005; Rooker et al., 2013).

When reinforcement schedule thinning is done in the context of a multiple schedule, the first step in the process is to bring the FCR under discriminative control. As an example, Fisher et al. (1998) delivered reinforcement for the FCR on an FR 1 schedule in the presence of a discriminative stimulus (S^D; e.g., a picture card hung on the wall showing the child consuming the reinforcer) and programmed EXT of the FCR when the S^D was removed from the wall and placed out of sight (S^D absent or S^Δ). Problem behavior was on EXT both when the S^D was present and when it was absent. These periods of reinforcement (S^D present) and EXT (S^Δ) of the FCR lasted 30 s each, and they were alternated in a quasi-random fashion. Both children rapidly learned to request reinforcement via the FCR when the S^D signaled the FR 1 schedule and to not emit the FCR when the S^Δ signaled EXT. Although this procedure decreased reinforcer deliveries by about 50%, it was still not practical for use in the natural environment because parents would need to alternate the stimuli and deliver reinforcers about twice per minute.

Hanley, Iwata, and Thompson (2001) extended the use of multiple schedules during treatment of destructive behavior using FCT by demonstrating that the relative durations of the reinforcement and EXT components for the FCR could be gradually changed to a point where the overall schedule would be practical for implementation. That is, when the multiple schedule was initiated, each reinforcement component lasted 45 s and each EXT component lasted 15 s. The durations of these components were gradually changed until the terminal schedule was reached and a 1-min reinforcement component was alternated with a 4-min EXT component. Importantly, at the completion of reinforcement schedule thinning, reinforcer deliveries were relatively infrequent (i.e., decreased by about 90%), the strength of the FCR remained high in the presence of the S^D, and problem behavior maintained at near-zero levels.

Betz et al. (2013) offered two possible explanations for these important effects of the multiple-schedule, reinforcement-thinning procedure developed and evaluated by Hanley et al. (2001): (a) habituation or (b) rapid transfer of stimulus control. It is possible that by gradually extending the duration of the EXT component relative to the duration of the reinforcement component, the participants in the Hanley et al. study learned to tolerate (or habituate to) lengthy periods of nonreinforcement. Basic research on errorless discrimination training has shown that gradual introduction of the negative stimulus (S^Δ) often results in accurate discrimination without response bursting or the corollary emotional responses that often occur when EXT is abruptly introduced (see Terrace, 1963).

The second explanation of the Hanley et al. (2001) results offered by Betz et al. (2013) was the possibility that once discriminative control was well established (i.e., the FCR occurring almost exclusively in the presence of the S^D with low levels of problem behavior across both schedule components) rapid transfer of stimulus control from the initial to the terminal schedule was possible without proceeding through all of the intermediate steps implemented by Hanley et al. To examine this possibility, Betz et al. conducted a component analysis of reinforcement-schedule thinning for FCT within the context of a multiple schedule. In Experiment 2, they compared mixed and multiple schedules of FCT, which demonstrated that schedule-correlated stimuli were critical for establishing discriminative control of the FCR, thus replicating and extending the results of prior studies (Hanley et al.; Sidener, Shabani, Carr, & Roland, 2006; Tiger & Hanley, 2004). In Experiment 3, Betz et al. evaluated the two alternative explanations of the Hanley et al. results described above by immediately switching from rich to lean multiple schedules (i.e., from a mult FCT 60/60 to a mult FCT 60/240 with two cases) without proceeding though any of the intermediate steps implemented by Hanley et al. With two additional cases, Betz et al. switched from a rich mixed schedule of reinforcement (mix FCT 60/60) to a lean multiple schedule of reinforcement (mult FCT 60/240) for the FCR. In all four cases, they produced results comparable to those obtained in the Hanley et al. investigation without proceeding through the gradual reinforcement thinning steps. That is, following the rapid shifts from rich to lean schedules in the Betz et al. study, reinforcer deliveries were relatively infrequent (i.e., decreased by about 80%), the strength of the FCR remained high in the presence of the S^D, and problem behavior maintained at relatively low levels. These results were consistent with the hypothesis that the contingency-correlated stimuli in the multiple schedule facilitated rapid stimulus control during the transition from the rich to the lean schedules.

The Betz et al. (2013) results clearly demonstrated that rapid transfer of stimulus control from rich to lean multiple schedules of reinforcement during FCT is possible, at least with some cases. It should be noted, however, that Betz et al. provided contingency-specifying rules at the start of each mixed- and multiple-schedule session, and these rules probably facilitated rapid discriminative control, especially for two of the participants (Mikey and Henry). It is possible that multiple schedules of reinforcement during FCT may facilitate rapid transfer of stimulus control in other ways than just during reinforcement schedule thinning. For example, a common and longstanding problem in applied behavior analysis involves the transfer of treatment effects from the initial assessment or treatment context to other settings or from the primary therapist to other interventionists (e.g., Kazdin & Bootzin, 1972; Lang, Sigafoos, Lancioni, Didden, & Rispoli, 2010; Luczynski, Hanley, & Rodriguez, 2014; Rincover & Koegel, 1975).

One method of promoting generalization and rapid transfer of treatment effects involves programming common stimuli between the initial treatment room (or the initial interventionist) and the generalization settings or therapists (Stokes & Baer, 1977). For example, Durand (1999) showed that after FCT was implemented with each of four participants using a voice-output device in a classroom, treatment results readily generalized to community settings even though there were no programmed contingencies for problem behavior in those settings. Presumably, the voice-output device functioned as a common stimulus that promoted generalization from the training context to the generalization settings (see Falcomata & Wacker, 2013 for a discussion). It is similarly possible that the stimuli used to signal the availability (S^D) and unavailability (S^Δ) of reinforcement for the FCR in a multiple schedule might also function as common stimuli that could promote rapid transfer of FCT treatment effects from one setting to the next or from one therapist to the next. Therefore, the purposes of the current investigations were to examine the transfer of treatment effects of FCT using multiple schedules across different settings and therapists.

General Method

Subjects and Setting

Three ambulatory individuals referred for the assessment and treatment of destructive behavior or elopement participated. Scott was a 10-year-old boy diagnosed with stereotypic movement disorder with self-injurious behavior, adjustment disorder with disturbance of conduct and aggression, and autistic disorder. Scott engaged in emotional outbursts, aggression, property destruction, self-injury, and stereotypy. Although Scott’s functional analysis targeted aggression, property destruction, and self-injury, no instances of self-injury were observed. Therefore, only data on Scott’s aggression and property destruction are presented. Scott communicated using short sentences.

Corey was a 5-year-old boy diagnosed with pervasive developmental disorder – not otherwise specified and oppositional defiant disorder. Corey engaged in elopement and emotional outbursts that included aggression. Corey’s elopement was targeted first for treatment followed by a separate evaluation of his aggression. Specifically, Corey’s FCT evaluation for aggression (Study 1) began at the start of his participation in Study 2 for elopement, and he began Study 2 for aggression after the multiple schedule was in place across all three contexts for elopement in Study 2. Corey communicated using single words and two-word phrases.

Jacob was a six-year-old boy diagnosed with oppositional defiant disorder who engaged in aggression and property destruction. Jacob communicated using complete sentences.

Functional analysis sessions were conducted in 3-m by 3-m therapy rooms equipped with a table, chairs, and a one-way observation window with the exception of Corey's elopement evaluation. Corey's elopement was assessed and treated in a 3-m by 6-m therapy room, which contained a table, chairs, and a one-way observation window. This therapy room permitted Corey to elope from one side of the room to the other side using a divider that partitioned the room into two 3-m by 3-m rooms. A second therapist was positioned on the opposite side of the divider to implement any necessary consequences for elopement and FCRs and to prevent Corey from eloping further to unsupervised areas. Attempts to elope beyond the supervised area were blocked but were scored as elopement. This arrangement enabled Corey to safely elope multiple times throughout session without therapists suspending data collection to retrieve him following each instance of elopement. Rather, the therapist positioned in the room to which Corey eloped implemented the consequences for elopement and any other programmed contingencies (e.g., representing the establishing operation for elopement following reinforcement). Therefore, therapists alternated the responsibilities of carrying out the procedures described for each elopement condition.

Treatment evaluations were conducted across separate rooms (destructive behavior for Scott and Jacob and aggression for Corey) or across different therapists (elopement for Corey). Room A for Scott was the same 3-m by 3-m therapy room in which his functional analysis was conducted. Scott's Room B was a similar-sized room that also contained a table and chairs. Room C for Scott was the 3-m by 6-m therapy room used throughout Corey's assessment and treatment of elopement. Across settings, materials were available with which Scott could engage in property destruction.

Corey's treatment of elopement was evaluated across two male therapists (A and B) and one female therapist (C). Corey's treatment of aggression was evaluated across rooms. For Corey, Room A was the same therapy room in which his functional analysis of aggression was conducted. The 3-m by 6-m therapy room in which Corey's elopement was assessed and treated was partitioned and used as Rooms B and C for Corey's aggression treatment.

Jacob's treatment of destructive behavior was evaluated across three rooms. Room A for Jacob measured 3 m by 5.5 m and contained a table and chairs, and Rooms B and C were each 3 m by 3 m and contained a one-way observation window and a table and chairs. All settings contained materials with which Jacob could engage in property destruction.

Response Measurement and Interobserver Agreement

Trained data collectors measured frequency of destructive behavior or elopement and FCRs. Frequency data were later converted to a rate for data-analysis purposes. *Aggression* (Scott, Corey, and Jacob) was defined as any response that could harm another individual and included hitting, kicking, and pushing the therapist. *Property destruction* (Scott and Jacob) was defined as any response that could harm materials or the environment and included throwing materials, hitting or kicking objects, and overturning furniture. *Elopement* (Corey) was defined as passing through the plane of the divider that partitioned the room. Elopement was also recorded if Corey touched a doorknob with any part of his hand. The *FCR* for each child consisted of naming the reinforcer maintaining destructive behavior or elopement followed by the word "please." For example, Scott's FCR was "toys please." We calculated the relative rates of FCRs emitted during the reinforcement (S^D) and EXT (S^Δ) components by dividing the frequency of FCRs occurring in each component by the duration of the respective component.

Interobserver agreement was assessed by having a second observer independently collect data on 29% (range, 11% to 44%) of functional analysis sessions and on 30% (range, 19% to 50%) of treatment sessions. An agreement was defined as both observers recording the same number of responses per 10-s interval. Interobserver agreement coefficients were calculated by summing the number of agreement intervals, dividing that number by the total number of intervals, and then converting the proportion to a percentage. Mean interobserver agreement for aggression was 99% (range, 88% to 100%) for Scott, 99% (range, 87% to 100%) for Corey, and 98% (range, 87% to 100%) for Jacob. Interobserver agreement for property disruption averaged 100% (range, 93% to 100%) for Scott and 100% (range, 97% to 100%) for Jacob. Interobserver agreement for Corey's elopement averaged 100% (range, 93% to 100%). Mean interobserver agreement for FCRs during the S^D was 99% (range, 91% to 100%) for Scott, 98% (range, 87% to 100%) during Corey's treatment of elopement, 99% (range, 93% to 100%) during Corey's treatment of aggression, and 97% (range, 90% to 100%) for Jacob. Interobserver agreement for FCRs during the S^Δ averaged 100% (range, 98% to 100%) for Scott, 100% (range, 97% to 100%) during Corey's treatment of elopement, 100% during Corey's treatment of aggression, and 100% (range, 97% to 100%) for Jacob.

Study 1: FA and FCT Evaluation

A functional analysis was completed to identify the environmental variables maintaining each child's destructive behavior or elopement. Each child was taught an FCR that resulted in access to the reinforcer identified in the functional analysis to be responsible for maintaining his destructive behavior or elopement. Next, FCT was evaluated as a treatment for problem behavior using a reversal design.

Functional Analysis

A functional analysis was conducted with each child prior to FCT using procedures similar to those developed by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) with modifications described by Fisher, Piazza, and Chiang (1996). Functional analysis sessions lasted 5 min. Preferred materials were identified using paired-choice preference assessments (Fisher et al., 1992).

Ignore—Corey and Jacob's functional analyses included an ignore condition in which the child was alone with the therapist in a barren room. Destructive behavior or elopement produced no programmed consequence. For Corey's functional analysis of elopement, a second therapist located in the other room also ignored elopement during this condition.

Attention—The therapist interacted with the child for approximately 1 min prior to the start of the attention condition. During the attention condition, the therapist engaged in a solitary activity (e.g., reading a magazine) and provided statements of concern or reprimands for 20 s following destructive behavior or elopement. Low-to-moderately preferred materials were freely available throughout the session.

The attention condition was modified slightly for Corey's functional analysis of elopement such that only one therapist interacted with Corey prior to start of data collection. After 1 min, a second therapist entered the room in which Corey and the therapist were located, and the original therapist moved to the other room, leaving Corey with the second therapist. Therefore, the first instance of elopement resulted in 20 s of attention from the original therapist.

Play (control)—The therapist delivered continuous attention and access to preferred materials throughout the play condition. Approximately every 30 s, the therapist provided praise for appropriate play. No demands were placed on the child. Both therapists played with Corey in their respective rooms during the play condition of his functional analysis of elopement.

Escape—An escape condition was included in Corey and Jacob's functional analyses. During this condition, the therapist used a three-step (verbal, model, physical) prompting sequence to guide the child to comply with academic or cleaning tasks. A 20-s break from instructions was provided following destructive behavior or elopement. During Corey's functional analysis of elopement, the therapist in the room to which Corey eloped implemented escape for 20 s and then began issuing demands during the escape condition.

Tangible—The therapist delivered approximately 1-min access to preferred materials prior to the start of the tangible condition. During the tangible condition, the therapist restricted access to the items and provided 20-s access following destructive behavior or elopement. The tangible condition was modified for Corey's functional analysis of elopement such that a second therapist removed access to Corey's preferred items by walking the items to the other room. Elopement resulted in 20-s access to the preferred items, and reinforcement terminated with the first therapist removing the items in a similar manner.

FCT Evaluation

Following the functional analysis, each child was taught an FCR designed to replace destructive behavior or elopement, and we then measured rates of problem behavior during FCT. The functional analyses showed that problem behavior for all children was maintained at least in part by access to preferred materials. Therefore, we compared levels of problem behavior during FCT with levels observed during baseline, which was the same as the tangible condition conducted during each child's functional analysis.

Baseline (tangible)—The baseline condition for each child's FCT evaluation was identical to the procedures in the tangible condition of the functional analysis. Tangible sessions lasted 5 min.

Pretraining—Pretraining sessions were 10 trials each. During pretraining with Scott and Corey, we taught each child to emit an FCR by restricting access to preferred materials (i.e., presenting the establishing operation for problem behavior) while providing the rule, "If you would like to play with (reinforcer), you need to say '(reinforcer) please'." Emission of the FCR resulted in praise and 20-s access to the reinforcer. Destructive behavior or elopement resulted in no programmed consequence. For Jacob, we conducted pretraining without the use of the rule and included a progressive prompt delay to teach Jacob to emit the FCR. If Jacob had not independently emitted the FCR by the end of the specified delay (0 s, 2 s, 5 s, or 10 s), the therapist said, "Say, '(reinforcer) please'." The prompt delay increased following every two sessions in which destructive behavior remained below a 90% reduction from baseline. For Corey's elopement pretraining, a second therapist re-presented access to his preferred materials by walking the items to Corey following FCRs. Pretraining continued until each child reliably emitted the FCR following the presentation of the establishing operation (i.e., on 90% or greater of trials) with near-zero rates of destructive behavior or elopement.

FCT—Prior to the start of the FCT condition, each child was given 1- to 2-min access to his preferred materials. Functional communication training began by removing access to the preferred materials, delivering the rule to emit the FCR (Scott and Corey only), and then providing the restricted materials for 20 s following FCRs. Problem behavior produced no programmed consequence. A second therapist walked Corey's preferred items to him following FCRs during his FCT evaluation for elopement. This condition also lasted 5 min.

Results and Discussion

Functional Analysis—Functional analysis results for Scott, Corey, and Jacob are depicted in Figure 1. Scott engaged in aggression and property destruction during the attention and tangible conditions of the functional analysis, suggesting his destructive behavior was maintained by social positive sources of reinforcement (Figure 1, first panel). However, Scott engaged in variable rates of destructive behavior during both conditions. Therefore, we collected additional functional analysis data using a pairwise design (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). Scott displayed high and stable rates of destructive behavior in the tangible condition and zero rates in the play condition, indicating that his destructive behavior was sensitive to tangible reinforcement.

We conducted separate functional analyses for Corey's elopement and aggression. During the functional analysis of elopement, Corey engaged in consistently higher levels of elopement during attention and tangible conditions (Figure 1, second panel). Rates of elopement during escape and ignore conditions decreased across functional analysis sessions, suggesting Corey's elopement was maintained by social positive reinforcement.

Corey engaged in little to no aggression during the first five series of his functional analysis of aggression (Figure 1, third panel). Because Corey was reported to aggress toward caregivers outside the clinic, we trained his caregiver to implement each test condition of the functional analysis. No aggression was observed during the caregiver-conducted functional analysis sessions. To better capture the conditions under which Corey engaged in aggression, Corey's primary staff collected descriptive data on the antecedent and consequent events surrounding destructive behavior while Corey was at home. Descriptive-assessment data indicated that Corey engaged in destructive behavior primarily when caregivers withheld idiosyncratic, highly preferred video games. We then included these specific video games during staff-conducted tangible and play conditions of the functional analysis conducted with Corey. However, we observed no aggression during the descriptive-assessment informed functional analysis until Corey's caregiver served as a therapist. Corey emitted higher levels of aggression when caregivers withheld Corey's video games during the tangible condition relative to when he had continuous access to the same video games during the play condition, suggesting that Corey's aggression was maintained by social positive reinforcement in the form of access to preferred games.

Similar to the results from Corey's functional analysis of aggression, Jacob engaged in near-zero rates of destructive behavior across functional analysis conditions (Figure 1, fourth panel). Jacob's caregiver indicated that Jacob historically displayed destructive behavior when reinforcement was withheld for more extended periods of time. Therefore, we doubled Jacob's session duration from 5 min to 10 min and observed elevated and increasing rates of destructive behavior in the tangible and escape conditions and zero levels of destructive behavior in the play condition. For all participants, we targeted the tangible function of the problem behavior with FCT.

FCT—Figure 2 depicts each child's responding during the baseline and FCT conditions of the FCT evaluation. For Scott and Corey, data for the first baseline phase of the FCT evaluation were pulled from the tangible condition during the last phase of each child's functional analysis. Additional tangible-condition sessions were conducted with Jacob to establish a baseline for his FCT evaluation.

Following pretraining, Scott generally exhibited low rates of destructive behavior and high rates of FCRs during FCT (Figure 2, top panel). The response patterns observed during the first baseline and FCT phases were replicated in the subsequent baseline and FCT phases, respectively. For Corey's FCT evaluation for elopement, he engaged in high rates of elopement during both baseline phases and near-zero rates of elopement during both FCT phases (second panel). Corey also emitted consistent and high rates of FCRs during FCT. For Corey's FCT evaluation of aggression, he exhibited elevated rates of aggression during both baseline phases and near-zero rates of aggression during both FCT phases (third panel). Corey also emitted consistent and high rates of FCRs during FCT. Jacob engaged in higher rates of destructive behavior during baseline sessions when compared to those observed during FCT (fourth panel). Destructive behavior decreased to low rates and FCRs increased to high rates when FCT was implemented with Jacob. Prior to their participation in Studies 2 (Scott and Corey) or 3 (Jacob), all children had at least some exposure to FCT using multiple schedules (hereafter, mult FCT; mixed schedules hereafter abbreviated mix FCT). For example, Corey's attention function of elopement was treated using mult FCT before Corey's tangible function was targeted in the current evaluation, and Jacob participated in a separate evaluation that compared variations of mult-FCT procedures on levels of destructive behavior.

Study 2: Transfer of FCRs Across Contexts

Scott and Corey participated in Study 2. The purpose of this study was to extend the findings of Betz et al. (2013) by examining the transfer of treatment effects when mult FCT was sequentially introduced across settings and therapists.

Procedure

Mix FCT (60/60)—Mix FCT was similar to pretraining; however, reinforcement was available for the FCR on an FR-1 schedule during one half of the 60-s intervals and unavailable during the remaining intervals. Destructive behavior or elopement resulted in EXT during both components. Additionally, the verbal statement used in pretraining was modified. Prior to the start of each mix FCT session, children were told, “Sometimes when you say ‘(reinforcer) please’ you can have (reinforcer), and sometimes when you say ‘(reinforcer) please’ you will not be able to have (reinforcer).”

Each mix FCT session began with a 60-s period in which reinforcement was available, followed by a 60-s EXT period. Thereafter, the remaining reinforcement and EXT components in each session were alternated in a quasi-random fashion. An equal number of reinforcement and EXT components were implemented until 10 min had elapsed or until the last scheduled component was completed, whichever occurred first. Therefore, mix FCT (60/60) sessions lasted approximately 10 min.

Mult FCT (60/60)—Mult FCT was identical to mix FCT except that a discriminative stimulus in the form of a yellow wristband worn by the therapist was used to signal the availability of reinforcement, and its absence was used to signal periods of EXT. In addition, at the start of each mult FCT (60/60) session, the therapist provided the rule, “When I have the yellow wristband on, if you say ‘(reinforcer) please’ you can have the (reinforcer).” With Scott, the verbal cue, “Scott, the yellow wristband is on/off” was later added to alert Scott to the presence or absence of the yellow wristband without specifying the reinforcement contingency in effect. The same procedures used to end mix FCT (60/60) sessions were also used during mult FCT (60/60). Therefore, the durations of mult-FCT (60/60) sessions were approximately 10 min.

Mult FCT (60/300)—Increasing the duration of the EXT component of mult FCT is a commonly used method to thin the schedule of reinforcement following FCT (Hanley et al., 2001). Scott alone was exposed to a mult FCT schedule in which each reinforcement component lasted 60 s and each EXT component lasted 300 s; this condition otherwise was identical to mult FCT (60/60). In addition, mult FCT (60/300) sessions lasted approximately 12 min (i.e., two 60-s reinforcement components and two 300-s EXT components).

Results and Discussion

Figure 3 shows the evaluation of treatment transfer of mult FCT for Scott. During the baseline phases conducted in Rooms C, A, and B in which FCRs were reinforced on a mix

FCT (60/60) schedule, Scott engaged in low-to-zero rates of destructive behavior and FCRs. When mult FCT (60/60) was initially introduced in Room C, little change in the rates of destructive behavior or FCRs were observed. However, in Session 21 (the sixth session conducted in Room C) the verbal cue was introduced, and high rates of the FCR were observed during the reinforcement component (when the therapist wore the wristband) and low rates of the FCR were observed during the EXT component (when the wristband was out of sight). In addition, when mult FCT (60/60) was sequentially introduced into Room A and then Room B, FCRs increased immediately in the reinforcement component of the multiple schedule but not in the EXT component. In addition, destructive behavior remained at low-to-zero rates. That is, the treatment effects of mult FCT (60/60) immediately transferred and were readily apparent in the very first session conducted in Room A and in Room B with Scott.

The final phase of Scott's treatment evaluation consisted of increasing the duration of the EXT component of the multiple schedule from 60 s to 300 s. During mult FCT (60/300), Scott continued to discriminate between multiple-schedule components, emitting higher rates of FCRs during the reinforcement component relative to those in the EXT component. Scott's destructive behavior increased during mult FCT (60/300), but these increases appeared sporadic and transient across rooms.

Figure 4 shows Corey's elopement and FCRs during mix FCT (60/60) and mult FCT (60/60) across therapists C, B, and A in the top, middle, and bottom panels, respectively. During mix FCT (60/60), Corey initially emitted roughly equal rates of FCRs during reinforcement and EXT components across therapists, suggesting that Corey had difficulty discriminating between the components of the mixed schedule. Rates of FCRs decreased across mix FCT (60/60) sessions with each therapist. When mult FCT (60/60) was first introduced with therapist C, Corey showed gradual improvements in his discrimination between schedule components. Similar to the results observed with Scott, Corey showed immediate increases in the rate of FCRs emitted during the reinforcement component when mult FCT (60/60) was sequentially introduced with Therapist B and Therapist C, whereas rates of the FCR remained low during the EXT component of mult FCT (60/60). In addition, elopement remained at low-to-zero rates throughout mult FCT (60/60). Thus, similar to Scott, the treatment effects of mult FCT (60/60) on Corey's elopement immediately transferred and were readily apparent in the very first session conducted with Therapist B and Therapist C.

Corey's aggression and FCRs during mix FCT (60/60) and mult FCT (60/60) across Rooms A, C, and B are shown in the top, middle, and bottom panels of Figure 5, respectively. During mix FCT (60/60), Corey emitted zero FCRs and zero instances of aggression during both the reinforcement and EXT components across all three rooms. When mult FCT (60/60) was first introduced in Room A, Corey immediately emitted high rates of the FCR in the reinforcement component and relatively low rates in the EXT component. In addition, he emitted low-to-zero rates of aggression in both components. These effects were replicated when mult FCT (60/60) was sequentially introduced into Rooms C and B.

Quantitative Analysis of Stimulus Control—One goal of this study was to determine whether mult FCT implemented in one context facilitated the transfer of treatment effects to subsequent contexts. Because rates of destructive behavior remained low across mix- and mult-FCT conditions for both children, we analyzed the rapidity with which FCRs transferred across contexts. To test this, we first calculated the mean and standard deviation of the rate of FCRs in the presence of the S^D in the first context of mult FCT (60/60) or data from the second phase of the top panels of Figures 3 through 5. Next, using this information, we calculated the rate of FCRs that corresponded to the 66th percentile (or to a z-score of .43) for each child. This produced a target rate of FCRs to which we compared response rates across contexts when mult FCT (60/60) was implemented. Target rates were 2.4 for Scott, 2.7 for Corey's elopement analysis, and 2.9 for Corey's aggression analysis. Using these target rates, we identified the first session in which the rate of FCRs during mult FCT (60/60) equaled or exceeded the target rate across each context for each participant.

The first session in which the target rate of FCRs was reached in each context for each participant is denoted with an asterisk in Figures 3 through 5. As can be seen, the target rate was reached in the fourth, eighth, and third sessions of the first context for Scott, Corey (elopement; across therapists), and Corey (aggression; across rooms), respectively, thus indicating somewhat gradual acquisition of the FCR in the first context. By contrast, the target rate was reached in the very first session of the second and third contexts for each of the three applications, thus indicating rapid transfer of the mult-FCT effects to new contexts.

The chance probability of observing this target rate in a given session (e.g., the first session of a phase) is approximately .33 (1 - .67), based on when it was reached in the first context for each application. Using the binomial test, the probability of observing six consecutive events, each with an individual probability of approximately .33, is remote ($Z = 3.47$; $p < .001$). These results indicate that although relatively high rates of FCRs were acquired gradually in the first context with mult FCT (60/60), these same high rates occurred immediately when mult FCT (60/60) was later implemented in the second and third contexts, and these findings were unlikely to be due to chance.

Study 3: Transfer of Problem Behavior Reduction Across Contexts

Scott and Corey engaged in near-zero rates of problem behavior throughout the mix- and mult-FCT conditions in Study 2, despite infrequently contacting reinforcement during the mix-FCT sessions (both children engaged in few FCRs in the reinforcement component of the mixed schedule). Low rates of problem behavior during the mix-FCT condition for both boys precluded our ability to determine what, if any, effect mult FCT may have had on problem behavior and whether mult FCT may have also facilitated reductions in problem behavior when mult FCT was implemented across contexts.

The overall low levels of problem behavior (and FCRs) during the mix-FCT condition in Study 2 were possibly due to the method in which we implemented mult FCT in the other contexts. Mult FCT included a single discriminative stimulus (i.e., a yellow wristband) that was used by the therapist to signal the availability of reinforcement for the FCR. The wristband was then removed from the therapist's wrist and placed out of sight during the EXT component. Recall, however, that the mix-FCT condition (similar to the EXT component of mult FCT) did not include a wristband to signal when reinforcement was and was not available. Therefore, when mult FCT was implemented in the first context (and the child began to discriminate the reinforcement contingency for FCRs signaled by the presence of the wristband and the absence of the reinforcement contingency for FCRs when the wristband was not visible), mix FCT sessions were identical to the EXT component of mult FCT. Problem behavior remained on EXT throughout mix- and mult-FCT sessions. It is possible that this similarity between conditions might have suppressed the rates of FCRs and problem behavior in mix-FCT sessions, particularly as the child's behavior came under stimulus control of the yellow wristband (and its absence) during mult FCT.

Another limitation of Study 2 was that schedule thinning beyond 60 s of EXT for the FCR was attempted with only one child (Scott). We rapidly extended the duration of the EXT component for Scott fivefold with only transient increases in destructive behavior. In Study 3, we addressed these issues within the context of Jacob's treatment of destructive behavior by: (a) discontinuing the use of mix FCT (as the baseline) and replacing it with a more traditional baseline condition, (b) adding a second colored wristband to signal the unavailability of reinforcement during the EXT component of mult FCT, and (c) conducting a replication of the rapid schedule-thinning progression used with Scott. Jacob was the only child who participated in Study 3.

Procedure

Baseline (tangible)—Jacob's baseline condition was identical to the procedures in the tangible condition of the functional analysis. That is, destructive behavior resulted in 20-s access to Jacob's highly preferred tangible item, and FCRs produced no programmed consequence. Jacob's baseline sessions lasted 10 min.

Mult FCT (60/60)—Mult FCT was conducted as described for Scott and Corey in Study 2 with four exceptions. First, the therapist wore a green wristband during the reinforcement component to signal the availability of reinforcement for the FCR. When the reinforcement component ended and the EXT component began, the therapist removed the green wristband (placing it out of sight) and replaced it with a red wristband to signal the unavailability of reinforcement. The green wristband was again displayed (and the red wristband removed and placed out of sight) when the reinforcement component started anew. Second, we included a 3-s changeover delay to prevent the possibility of reinforcing Jacob's destructive behavior by signaling the reinforcement component or providing reinforcement immediately following destructive behavior. Third, results from a separate evaluation (as part of another investigation) suggested that levels of Jacob's destructive behavior remained lowest when attention was provided during periods in which access to the functional reinforcer for destructive behavior (access to preferred tangible items) was unavailable (i.e., during EXT). Therapist-delivered attention during the EXT component typically consisted of talking about preferred topics (e.g., sports, music, and hobbies), but occasionally included tickles and other forms of physical interaction. Fourth, we modified the rule that therapists provided to Jacob to include clarification of the contingencies in effect during the EXT component. Prior to each session, the therapist stated, "Jacob, when I have the green bracelet on, if you say '(reinforcer) please' you can have the (reinforcer). When I have the red bracelet on, you have to wait for the (reinforcer), but we can talk and play. If you hit, kick, or throw things, it will take longer for me to put the green bracelet back on." We included this last sentence to account for the 3-s changeover delay. Sessions lasted approximately 10 min.

Mult FCT (60/300)—We extended the duration of the EXT component for Jacob from 60 s to 300 s during mult FCT (60/300). The duration of the reinforcement component remained 60 s, and all other procedures were identical to mult FCT (60/60). Sessions lasted approximately 12 min.

Results and Discussion

Figure 6 shows the results of the evaluation of treatment transfer of mult FCT for Jacob. In baseline, Jacob exhibited high rates of destructive behavior and low rates of FCRs when access to preferred tangible items was delivered following destructive behavior. When we first implemented mult-FCT (60/60) in Room B (top panel), we observed an immediate increase in the rate of FCRs emitted during the S^D component (but not during the S^Δ component), but a gradual decrease in the rate of Jacob's destructive behavior. Next, when we introduced mult FCT (60/60) in Room C, Jacob's destructive behavior decreased more rapidly (relative to the first context, Room B). In addition, Jacob emitted a consistently high rate of FCRs when the therapist signaled the reinforcement component using the green wristband and low-to-zero rates of FCRs when the therapist wore the red wristband to signal the EXT component. Finally, when mult FCT (60/60) was implemented in Room A, we observed zero instances of destructive behavior in the first session of the multiple schedule and near-zero rates throughout the mult-FCT (60/60) phase. Again, as in the prior rooms, Jacob emitted FCRs almost exclusively in the reinforcement component of the multiple schedule in Room A.

Beginning in Room B, we rapidly leaned the multiple schedule from mult FCT (60/60) to mult FCT (60/300), and the treatment effects observed in the mult-FCT (60/60) condition maintained despite the abrupt decrease in the number of reinforcement deliveries. This finding was then replicated across Rooms C and A, respectively.

To determine whether mult FCT implemented in the first context with Jacob (Room B) facilitated the transfer of treatment effects to subsequent contexts (Rooms C and A), we analyzed the results of mult FCT in the first context and extended these findings to the subsequent contexts. This calculation was identical to that used to evaluate Scott and Corey's data in Study 2 with two exceptions. First, unlike Scott and Corey, Jacob engaged in elevated rates of problem behavior during baseline. Therefore, we analyzed the degree to which mult FCT facilitated reductions in Jacob's destructive behavior across contexts. Second, and related to the first exception, assessing reductions in destructive behavior across contexts instead of increases in FCRs required us to slightly modify how the target rate was calculated for Jacob. Because we examined reductions in problem behavior rather than increases in the FCR, we used the 33rd percentile (rather than the 66th percentile), which still corresponds to a z-score of .43. All other procedures used to calculate the target rate were identical to those used in Study 2. Thus, the target rate for Jacob (based on reaching a reduction in destructive behavior in the first mult-FCT context equal to or lesser than the 33rd percentile of response rates in that context) was .32. This target rate was first reached in the fifth session in the first context (Room B), the third session in the second context (Room C), and the first session of the last context (Room A). These findings suggest that the procedures used in mult FCT, including the discriminative stimulus used to signal the components of the multiple schedule, facilitated transfer of treatment effects across rooms for Jacob. The asterisks used in Figure 6 denote the sessions in which this target rate was first observed.

General Discussion

In Study 1, functional analyses of Scott's and Jacob's destructive behavior and Corey's elopement and aggression indicated that each of these responses was maintained at least in part by tangible reinforcement. FCT consistently produced low-to-zero rates of destructive behavior (Scott and Jacob), elopement (Corey), and aggression (Corey). When mix FCT (60/60) was introduced for Scott and Corey in Study 2, the children showed low and undifferentiated rates of the FCR between the reinforcement and EXT components, indicating that the FCR was not under good schedule control. By contrast, when mult FCT (60/60) was introduced in the first context, Scott and Corey showed marked increases in the rates of the FCR in the presence of the S^D (a yellow wristband) that signaled the reinforcement component and relatively low rates when the absence of the S^D signaled the EXT component. More importantly, when mult FCT (60/60) was introduced in the second and third contexts, treatment effects immediately transferred, indicating that the FCR was under control of the schedule-correlated stimuli. In Study 3, Jacob showed consistently high rates of destructive behavior and low rates of the FCR in baseline. By contrast, Jacob showed markedly lower rates of destructive behavior and clear increases in FCRs in the presence of the S^D when mult FCT (60/60) was first introduced. In addition, when we systematically introduced the discriminative stimuli associated with each component of the multiple schedule in two other contexts, reductions in Jacob's destructive behavior occurred more rapidly (just as the effects on discriminated FCRs transferred more rapidly during the second and third applications in Study 2). Finally, when we lengthened the EXT component fivefold in mult FCT (60/300) in each of the three contexts, Jacob continued to show near-zero levels of destructive behavior and high levels the FCR in the presence of the S^D and low levels in the presence of the S^{Δ}.

These findings contribute to the treatment literature on FCT in several ways. First, we replicated results from prior studies demonstrating that FCT when combined with EXT can produce large and rapid reductions in problem behavior when a functional analysis has determined that those responses were reinforced by social consequences (e.g., tangible reinforcement; Betz et al., 2013; Kurtz et al., 2003; Wacker et al., 2005). We similarly replicated results of prior investigations showing the importance of schedule-correlated stimuli for establishing stimulus control of the FCR during treatment of problem behavior using FCT (by comparing mixed and multiple schedules of reinforcement for the FCR during FCT; Betz et al.; Hanley et al., 2001). We also replicated prior results showing that multiple schedules during FCT can facilitate maintenance of treatment effects when fading from richer to leaner schedules of reinforcement. Finally, we extended the findings of prior research on using multiple schedules during FCT by showing that the schedule-correlated stimuli used to signal the reinforcement and EXT components facilitated rapid transfer of the FCT treatment effects from one context to the next or from one therapist to the next.

These results have clear applied relevance. When a child's problem behavior is treated in one context (e.g., a university-based clinic) and then the treatment is transferred to other contexts (e.g., home, school, restaurant, grocery store), the child may display behavior that produced reinforcement in those contexts in the past (e.g., problem behavior) rather than the newly acquired replacement response (i.e., the FCR), a phenomenon referred to as renewal of problem behavior (Kelley, Liddon, Ribeiro, Greif, & Podlesnik, 2015). Such failures to generalize treatment may be more likely when transferring FCT procedures that do not contain schedule-correlated stimuli, as FCRs may persist during periods of extinction, thereby weakening the strength of the FCR and occasioning problem behavior. Alternatively, FCRs may not occur reliably while reinforcement is available, which may also produce problem behavior when reinforcement is later made unavailable. For example, Drasgow, Halle, and Ostrosky (1998) taught an appropriate replacement mand (signing "Please") in one stimulus context to three children with severe language delays who previously manded for preferred items primarily by reaching for, grabbing at, or leading an adult to the item. The participants continued to display reaching, grabbing, and leading rather than the replacement mand in the generalization contexts until these pre-existing mands repeatedly contacted EXT in those contexts and only the replacement mand produced reinforcement. The current results suggest that by bringing the replacement response (the FCR) under the control of an S^D in a multiple schedule and introducing that S^D with the treatment into the novel or generalization contexts, the S^D will increase the likelihood that the FCR will rapidly occur and contact reinforcement in those new settings. Future researchers might consider replicating the procedures of Drasgow et al. with and without bringing the replacement mand under stimulus control with a multiple schedule and then alternately introducing treatment into the generalization contexts with and without the schedule-correlated stimuli of the multiple schedule.

One limitation of the current investigation is that we did not evaluate the effects of the S^D independent of the reinforcement contingencies. That is, each time the S^D (the yellow or green wristband) was introduced into a new room or with a new therapist, it was always correlated with reinforcement of the FCR. By contrast, Piazza, Hanley, and Fisher (1996) correlated blocking of cigarette pica with a purple card and the absence of blocking with a yellow card. They subsequently switched between the purple and yellow cards using a reversal design without implementing the blocking procedure. This analysis demonstrated that introduction of the purple card immediately reduced pica to zero without implementation of the blocking procedure. Future investigators may wish to similarly test the effects of the S^D following mult FCT without implementing the reinforcement contingency for the FCR. However, the results are likely to be different from those observed by Piazza et al. because participants exposed to mult FCT are likely to display the FCR when the S^D is introduced and quickly learn that it no longer produces reinforcement. By contrast, the participant in the Piazza et al. study did not display cigarette pica in the presence of the purple card and thus did not learn that it was no longer correlated with the response-blocking procedure.

A second limitation of the current research is that the transfer effects of mult FCT were only evaluated from one room to the next or from one therapist to the next within a clinic setting. Future research should evaluate the extent to which comparable treatment-transfer effects to those observed in the current investigation would occur when mult FCT is transferred from the clinic to a typical community setting (e.g., home, school, a restaurant) or from clinic therapists to routine care providers (e.g., parent, teacher).

A third limitation of the current investigation is that verbal cues (i.e., "Scott, the yellow wristband is on/off") or contingency-specifying stimuli (e.g., "Jacob, when I have the green bracelet on, if you say '(reinforcer) please' you can have the (reinforcer). When I have the red bracelet on, you have to wait for the (reinforcer), but we can talk and play. If you hit, kick, or throw things, it will take longer for me to put the green bracelet back on.") were used with all children to facilitate stimulus control of the schedule-correlated stimuli used in the multiple schedule (i.e., the yellow bracelet and its absence in Study 2 and the green and red bracelets in Study 3). These statements included acknowledging the reinforcement schedule for the FCR when the S^D was present (Scott, Corey, and Jacob), stating that the S^D was present or absent (Scott), and describing the absence of reinforcement for FCRs when the S^Δ was visible and the presence of a changeover delay for problem behavior (Jacob). These statements likely improved discrimination for at least some of the children (i.e., those who accurately discriminate and follow rules). Additional data are needed on the extent to which multiple schedules of reinforcement during FCT facilitate rapid transfer of stimulus control both with and without verbal cues and contingency-specifying rules.

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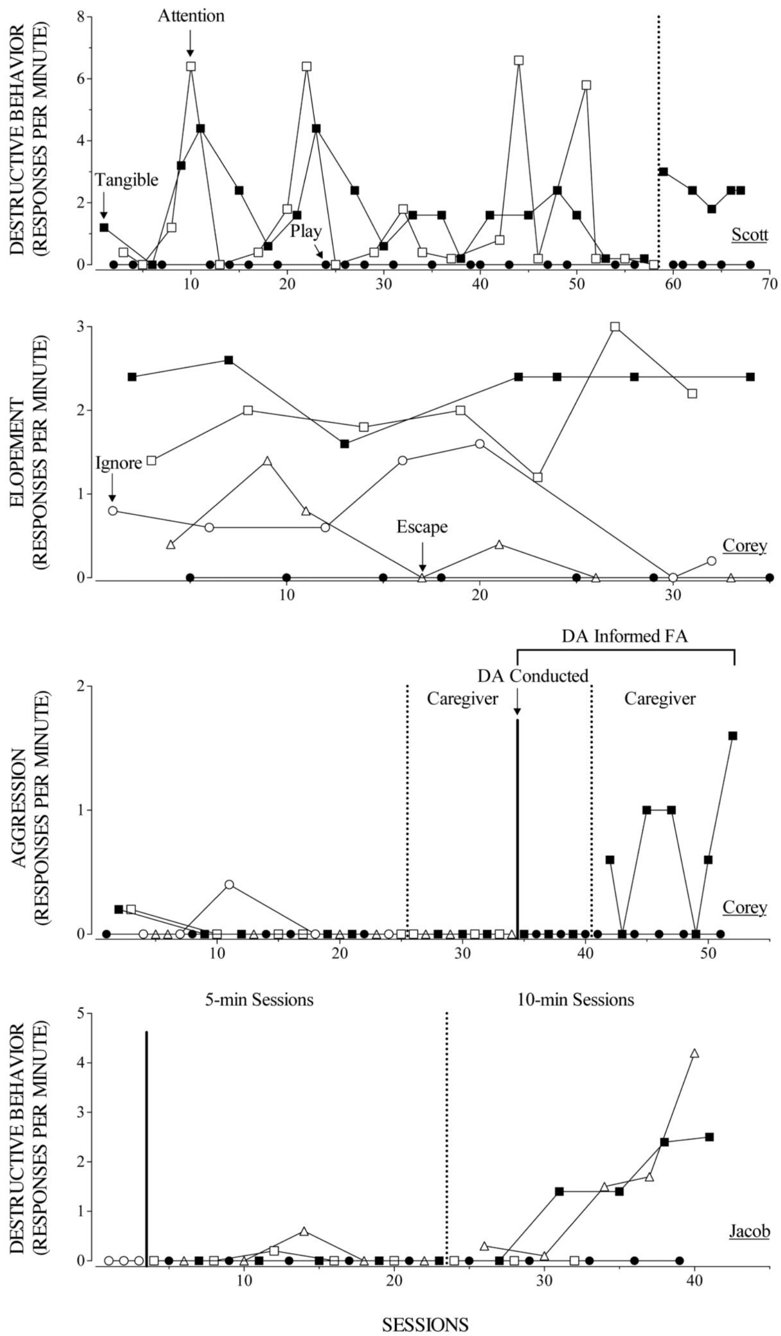

Figure 1.

Responses per minute of destructive behavior during Scott's functional analysis (first panel), elopement during Corey's functional analysis of elopement (second panel), aggression during Corey's functional analysis of aggression (third panel), and destructive behavior during Jacob's functional analysis (fourth panel). Preferred video games were included during tangible and play conditions following session 34 of Corey's functional analysis of aggression.

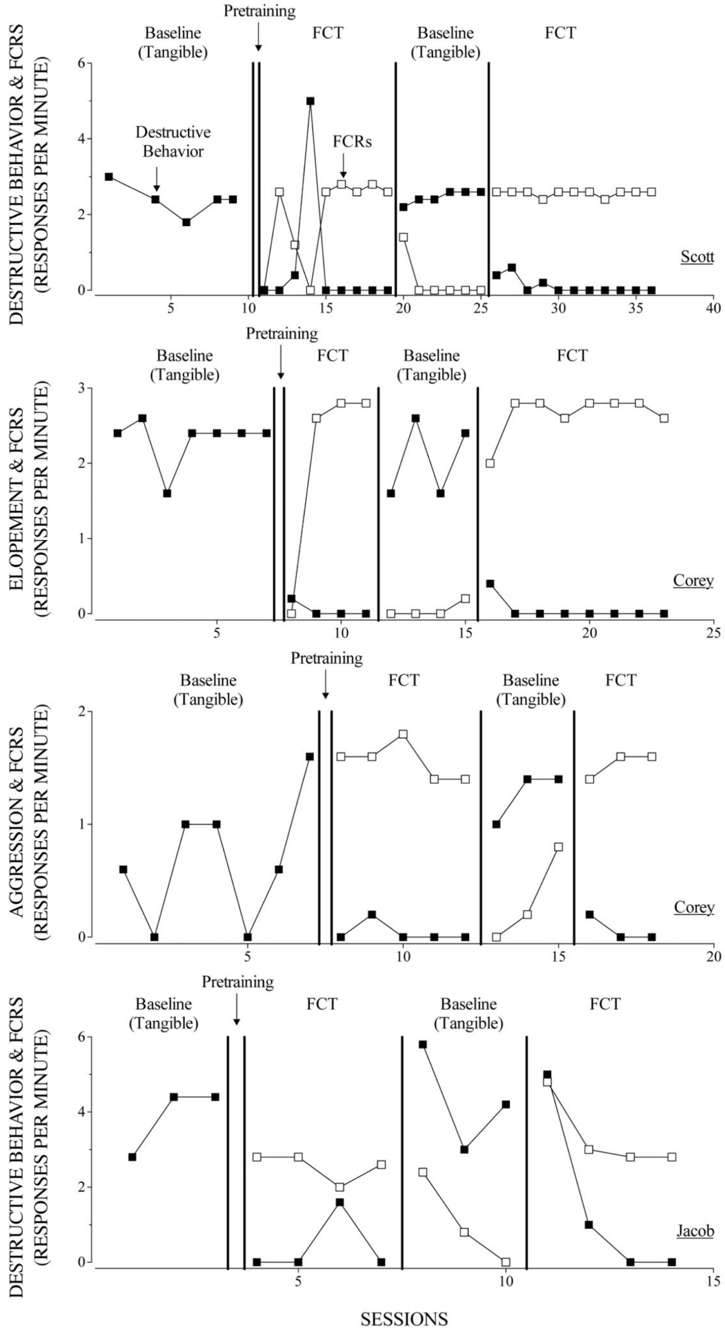

Figure 2.

Responses per minute of destructive behavior and FCRs during baseline and FCT conditions of Scott's FCT evaluation of destructive behavior (first panel), Corey's FCT evaluations of elopement (second panel) and aggression (third panel), and Jacob's FCT evaluation of destructive behavior (fourth panel).

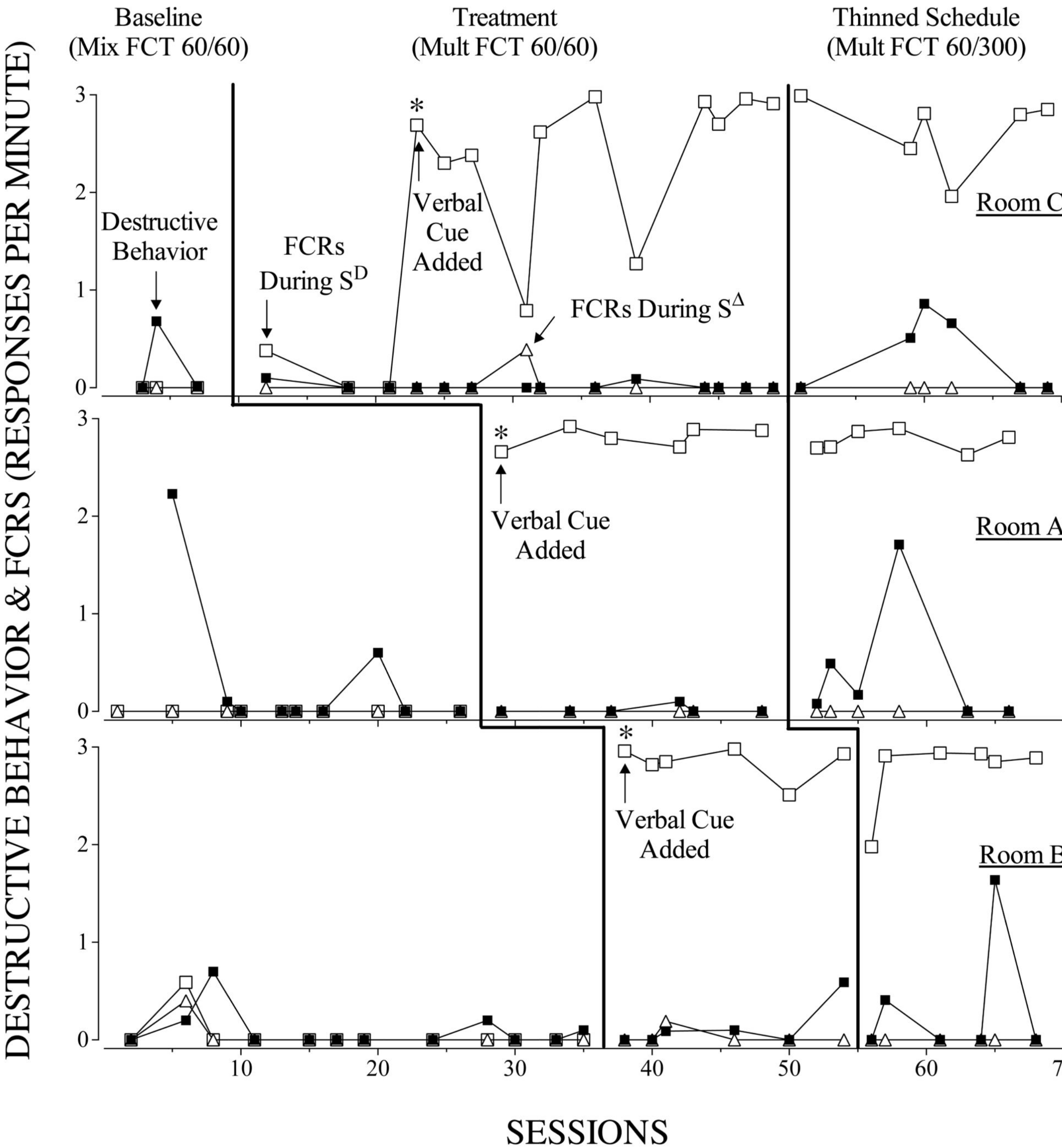

Figure 3.

Responses per minute of destructive behavior and FCRs during baseline, treatment, and thinned schedule across rooms C, A, and B for Scott. Functional communication responses are separated by reinforcement (S^D) and extinction (S^Δ) components. Asterisks denote sessions in which target rates of FCRs were first observed in each room.

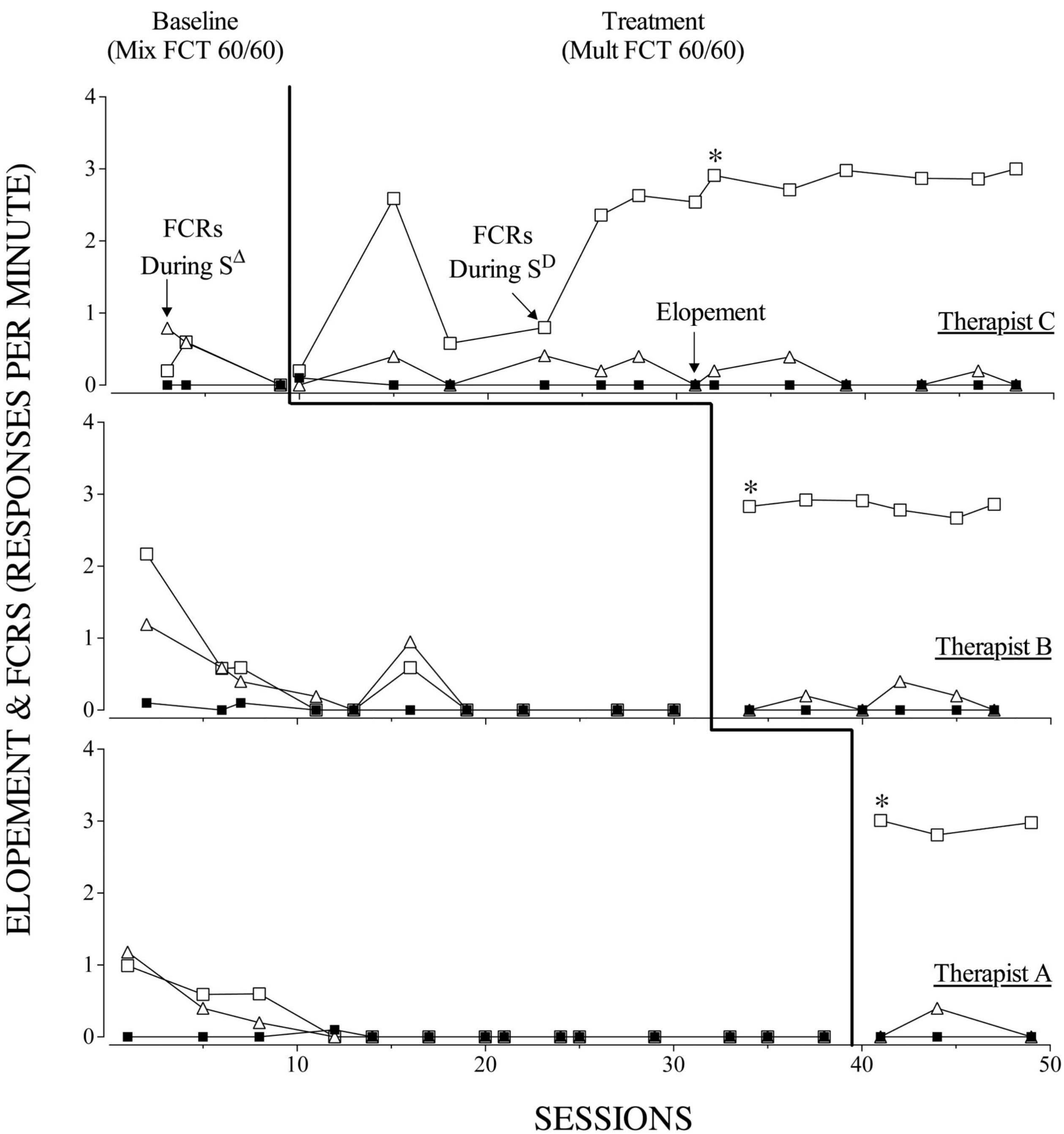

Figure 4.

Responses per minute of elopement and FCRs during baseline and treatment across therapists C, B, and A for Corey. Functional communication responses are separated by reinforcement (S^{D}) and extinction (S$^{\Delta}$) components. Asterisks denote sessions in which target rates of FCRs were first observed with each therapist.

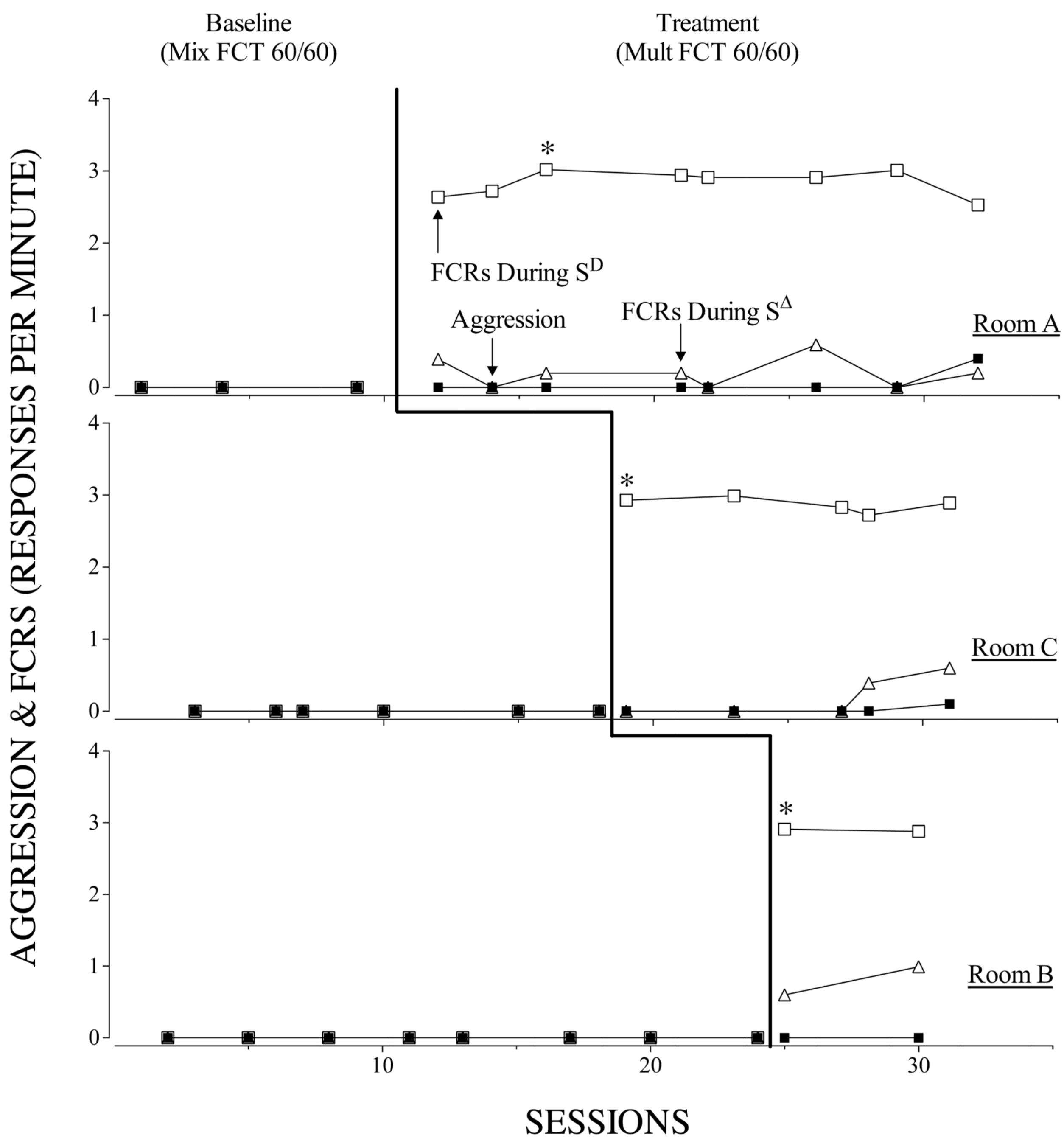

Figure 5.

Responses per minute of aggression and FCRs during baseline and treatment across rooms A, C, and B for Corey. Functional communication responses are separated by reinforcement (S^D) and extinction (S^{Δ}) components. Asterisks denote sessions in which target rates of FCRs were first observed in each room.

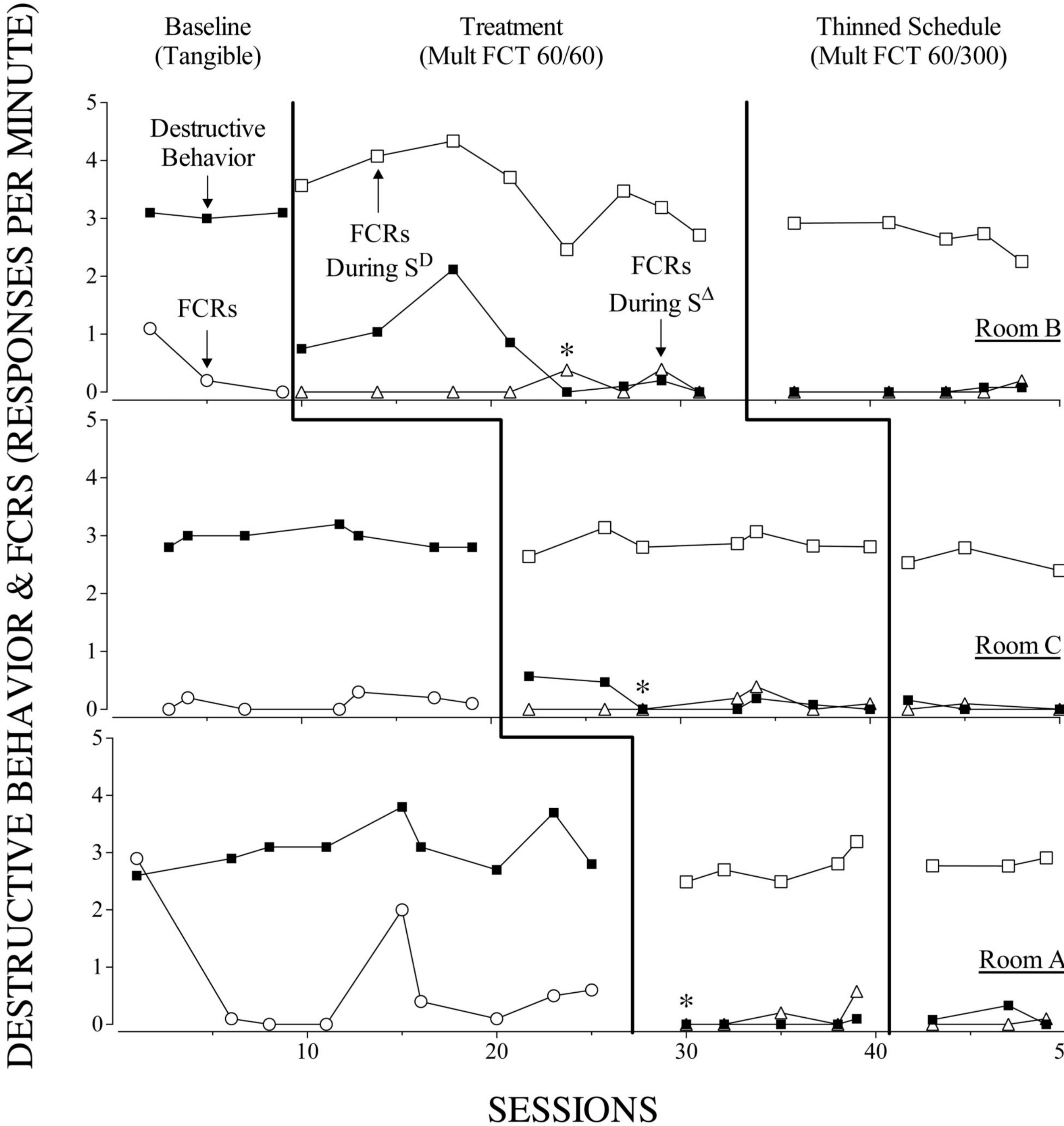

Figure 6.

Responses per minute of destructive behavior and FCRs during baseline, treatment, and thinned schedule across rooms B, C, and A for Jacob. Functional communication responses are separated by reinforcement (S^D) and extinction (S^Δ) components. Asterisks denote sessions in which target rates of destructive behavior were first observed in each room.