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A PRELIMINARY INVESTIGATION ON IMPROVING FUNCTIONAL COMMUNICATION TRAINING BY MITIGATING RESURGENCE OF DESTRUCTIVE BEHAVIOR

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Abstract

Despite the effectiveness and widespread use of functional communication training (FCT), resurgence of destructive behavior can occur if the functional communication response (FCR) contacts a challenge, such as lapses in treatment integrity. We evaluated a method to mitigate resurgence by conducting FCT using a multiple schedule of reinforcement prior to extinction. After functional analyses of 2 boys' destructive behavior and treatment with FCT (Study 1), we compared levels of resurgence during an extinction challenge either after a typical FCT sequence or after exposure to schedule thinning in the context of a multiple-schedule arrangement (Study 2). Results for both participants suggested that schedule thinning using discriminative stimuli in a multiple schedule mitigated the resurgence of destructive behavior.

Keywords

behavioral momentum theory; destructive behavior; functional communication training; multiple schedules; resurgence; translational research

Functional communication training (FCT) as a treatment for destructive behavior has strong empirical support and has been cited as the most commonly implemented treatment prescribed from the results of a functional analysis (Call, Wacker, Ringdahl, & Boelter, 2005; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Kurtz et al., 2003; Matson, Dixon, & Matson, 2005; Tiger, Hanley, & Bruzek, 2008). Functional communication training is a differential-reinforcement-of-alternative-behavior (DRA) procedure that typically follows a functional analysis of problem behavior and teaches an individual to engage in a socially acceptable alternative to destructive behavior to gain access to a functional reinforcer (Carr & Durand, 1985; Fisher et al., 1993; Wacker et al., 1990).

Despite its widespread use and general effectiveness when implemented with high fidelity (Northup, Fisher, Kahng, Harrell, & Kurtz, 1997), questions remain about the efficacy of FCT during treatment challenges. For example, decreases in reinforcement rate relative to baseline (DeRosa, Fisher, & Steege, 2015) and shifts from dense to lean schedules of reinforcement during FCT (Volkert, Lerman, Call, & Trosclair-Lasserre, 2009) have been

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shown to produce reemergence, or resurgence, of destructive behavior. *Resurgence* is generally defined as the recurrence of a previously reinforced response (e.g., destructive behavior) when alternative reinforcement is challenged (e.g., extinction or schedule thinning; Leitenberg, Rawson, & Bath, 1970; Lieving, Hagopian, Long, & O'Connor, 2004; Lieving & Lattal, 2003; Pritchard, Hoerger, & Mace, 2014; Volkert et al., 2009; Winterbauer & Bouton, 2010). Resurgence is a potentially important topic to study in applied research because of the likelihood of lapses in treatment integrity in naturalistic environments. For example, individuals often emit the FCR at high rates and at times when it is difficult for the caregiver to provide reinforcement (Fisher et al., 1993; Hagopian, et al., 1998; Tiger, Hanley, & Heal, 2006). Thus, caregivers may expose the FCR to unplanned periods of extinction or low rates of reinforcement that may lead to resurgence of problem behavior (Volkert et al., 2009).

One potential strategy for mitigating resurgence is to provide experience with intermittent reinforcement for the FCR. That is, individuals who are specifically taught, using schedule thinning, to tolerate periods in which a functional reinforcer is unavailable (Betz, Fisher, Roane, Mintz, & Owen, 2013; Fisher, Greer, Querim, & DeRosa, 2014; Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Greer, Fisher, Saini, Owen, & Jones, 2016; Hanley, Iwata, & Thompson, 2001) may be less prone to resurgence of problem behavior. Results of recent research suggest that multiple schedules provide an effective method of increasing the practicality of FCT through schedule thinning (Betz et al., 2013; Greer et al., 2016; Hanley et al., 2001; Rooker, Jessel, Kurtz, & Hagopian, 2013). The results of Betz et al. (2013) further suggest the possibility that the discriminative control provided by multiple schedules, as opposed to schedule thinning per se, may prevent or mitigate resurgence of destructive behavior when the FCR is initially exposed to a relatively long period of extinction. For example, four of five participants engaged in marked resurgence of destructive behavior when Volkert et al. (2009) introduced extinction or lean schedules of reinforcement for the FCR following FCT. By contrast, Betz et al. rapidly lengthened the extinction component of multiple-schedule FCT (mult FCT) from periods that lasted 1 to 2 min to periods that lasted 4 to 8 min with four participants and did not observe resurgence with any of them. These results suggest that additional research is warranted to determine whether mult FCT may be implemented in ways that prevent or mitigate the resurgence of destructive behavior when the FCR is abruptly exposed to relatively long periods of extinction or to thin schedules of reinforcement.

Recent translational research might help to inform the development of applied technologies for mitigating resurgence of problem behavior in applied settings. For example, Nevin and Shahan (2011) refined Shahan and Sweeney's (2011) behavioral momentum theory framework for predicting response persistence and resurgence of destructive behavior following alternative reinforcement (e.g., DRA, noncontingent reinforcement). This framework has been used as a model for understanding variables that may contribute to treatment relapse in the form of resurgence of destructive behavior (Podlesnik & Shahan, 2009; Pritchard et al., 2014). Nevin and Shahan proposed the following equation to predict the degree of resurgence that should occur when alternative reinforcement is discontinued (i.e., during an extinction challenge) after treatment of destructive behavior with alternative reinforcement (e.g., following FCT):

$$\frac{B_t}{B_o}=10^{\left(\frac{-t(c+dr+pR_a)}{(r+R_a)^{0.5}}\right)}. \quad (1)$$

In Equation 1, response rates during extinction (B_t) are expressed as a proportion of the baseline response rate (B_o) and are dependent on the time in or sessions with extinction (t), the baseline reinforcement rate (r), and the rate of alternative reinforcement (R_a). Three additional parameters scale the independent effects of suspending the reinforcement contingency (c), removing reinforcers from the environment (d), and providing alternative reinforcement (p).

We used some of the predictions of Equation 1 in the current study to develop a test for the persistence of destructive behavior in the presence of a disruptor. First, Equation 1 predicts that higher rates of reinforcement during baseline (r) and during treatment (R_a) will each contribute to higher levels of resurgence during a posttreatment extinction challenge. In addition, Equation 1 predicts that a relatively short exposure to treatment (i.e., a low value for t) will increase the level of resurgence. Similarly, Equation 1 predicts that a large drop in the rate of alternative reinforcement from treatment to extinction (i.e., a large value for R_a that rapidly decreases) will increase the amount of resurgence. Finally, Nevin and Shahan (2011) suggest that delivering a few reinforcers on a time-based schedule during the extinction challenge should make the change from treatment to extinction less discriminable (thereby lowering the value of dr), which should increase resurgence (see Nevin & Shahan's, 2011, discussion of the study by Koegel & Rincover, 1977).

The purposes of the current investigation were threefold. We sought (a) to develop an extinction-challenge condition based on the assumptions of behavioral momentum theory (Nevin & Shahan, 2011), (b) to use that condition to test whether and to what extent mult FCT would prevent or mitigate resurgence of destructive behavior, and (c) to extend current translational research on resurgence of destructive behavior (Lieving et al., 2004; Mace et al., 2010; Marsteller & St. Peter, 2014; Volkert et al., 2009; Wacker et al., 2011, 2013). Toward that end, we used the predictions of Equation 1 to design a robust extinction challenge to test the effectiveness of mult FCT in preventing or mitigating resurgence of destructive behavior. That is, we (a) delivered a high rate of reinforcement for destructive behavior during baseline, (b) delivered a higher rate of reinforcement for the FCR during treatment, (c) implemented FCT for a short period before introducing the extinction challenge, (d) reduced the rate of reinforcement for the FCR to zero during the extinction challenge, and (e) delivered a small amount of alternative reinforcement on a time-based schedule during the extinction challenge to decrease the discriminability of the change from treatment to extinction.

GENERAL METHOD

Participants and Settings

Two children, who had been referred for the assessment and treatment of destructive behavior, participated in the current study. Ben, a 5-year-old boy who had been diagnosed

with unspecified disruptive behavior, impulse control, and conduct disorder, displayed aggression as his primary target response. Ben spoke in full sentences. Alex, a 7-year-old boy who had been diagnosed with autism spectrum disorder and intellectual developmental disorder, displayed self-injurious behavior, aggression, property destruction, and pica. We targeted his self-injurious behavior and aggression in the current investigation and subsequently treated his other destructive behavior. Alex emitted few words and communicated primarily by leading adults to preferred items. He received 1 mg of risperidone in the morning and 0.5 mg in the evening throughout the study. Both children were ambulatory. We conducted all sessions in padded (Alex) or nonpadded (Ben) therapy rooms (3 m by 3 m) that contained a table, chairs, any necessary session materials (e.g., demand task materials, preferred stimuli), a one-way observation panel, and a two-way intercom system.

Response Measurement and Interobserver Agreement

Data collectors used laptop computers to collect frequency data on each child's destructive behavior as well as FCRs. *Aggression* (Ben and Alex) included hitting or kicking the therapist from a distance of 15.2 cm or greater and biting or throwing objects at the therapist. *Self-injurious behavior* (Alex) included head banging or self-hitting from a distance of 7.6 cm or greater and self-biting. Session-termination criteria remained in place throughout the study for safety purposes (Betz & Fisher, 2011). Neither participant met the termination criteria at any point in the study. We selected the FCR topography based on the language skills of each child and collected frequency data on its occurrence. We selected a vocal FCR (i.e., “my turn please”) for Ben and a card touch for Alex (i.e., touching an index card with a picture of Alex eating food).

We obtained interobserver agreement by having a second data collector simultaneously yet independently collect data on 44% of sessions. To calculate interobserver agreement, we divided sessions into 10-s intervals and recorded an agreement for each interval in which the observers recorded the same number of responses. We then divided the number of agreement intervals by the total number of intervals in each session and converted each number to a percentage. Agreement coefficients averaged 97% (range, 74% to 100%) and 99% (range, 73% to 100%) during the functional analysis, 98% (range, 80% to 100%) and 98% (range, 33% to 100%) during the FCT evaluation, and 96% (range, 63% to 100%) and 98% (range, 71% to 100%) during the resurgence evaluation for Ben and Alex, respectively.

Preference Assessments

Therapists identified preferred stimuli for each participant using one of two methods. For Ben, therapists conducted a paired-stimulus preference assessment using caregiver-nominated toys (Fisher, Piazza, Bowman, & Amari, 1996; Fisher et al., 1992) before initiating Study 1. From those results, we selected an iPad as Ben's preferred stimulus. For Alex, caregivers reported that he would eat most edible items and that he would often engage in destructive behavior to access restricted edible items. Therefore, therapists conducted a single trial of a multiple-stimulus-without-replacement preference assessment (DeLeon et al., 2001; DeLeon & Iwata, 1996) to identify Alex's preferred edible item for use

in the upcoming session. Therapists repeated this brief preference assessment before each session.

Study 1: Functional Analysis and FCT Evaluation

Functional Analysis

We implemented functional analyses based on those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) with the modifications described by Fisher, Piazza, and Chiang (1996). To facilitate discrimination between functional analysis conditions, we paired each condition with a unique, color-correlated shirt worn by the therapist throughout the session (Conners et al., 2000). The functional analysis continued until we identified one or more clear functions for each child's destructive behavior. Alex's functional analysis began with a multielement design and progressed to a pairwise comparison (tangible vs. control) in a reversal design (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). In the results below, we present only Alex's data from the reversal design. All sessions lasted 5 min.

Ignore—During the ignore condition (data shown for Ben only), the therapist remained present but ignored the participant throughout the session. The participant had no access to preferred stimuli during this condition.

Attention—During the attention condition (data shown for Ben only), the therapist interacted with the participant for approximately 1 min before the start of the session. The attention session began with the therapist withdrawing attention and then reading a magazine. The therapist provided 20-s access to attention (e.g., soothing comments, reprimands) after each instance of aggression. The participant had continuous access to a low-preference stimulus.

Toy play—During toy play, the therapist provided continuous access to the high-preference stimuli while she delivered descriptive praise (e.g., “You play this game really well!”) every 30 s.

Escape—During the escape condition (data shown for Ben only), the therapist required the participant to complete two types of demands (i.e., ones identified as either high probability or low probability based on an assessment conducted as a part of a separate investigation). In both escape conditions, the therapist used a least-to-most (verbal, model, physical) prompting procedure to guide the participant to comply with instructions. Destructive behavior resulted in a 20-s break from demands.

Tangible—Before the session, the therapist gave the participant 1-min access to his high-preference stimulus. The session began with the therapist removing the stimulus and representing it after each instance of destructive behavior (20-s reinforcement interval for Ben; one edible item for Alex).

FCT Evaluation

Following each child's functional analysis, we evaluated the efficacy of FCT as treatment. Baseline and FCT sessions lasted 5 min, whereas pretraining sessions consisted of 10 trials each but also lasted approximately 5 min.

Baseline—Baseline was identical to the tangible condition of each child's functional analysis.

Pretraining (data not displayed)—Pretraining consisted of teaching each child to emit a functionally equivalent yet socially appropriate communication response (i.e., the FCR); destructive behavior was no longer reinforced (i.e., extinction). The therapist did this by presenting the establishing operation for destructive behavior (i.e., removing the preferred stimulus) while simultaneously prompting the child to emit the FCR. For Ben, the therapist vocally prompted the FCR by saying, “Ben, say ‘my turn please.’” For Alex, the therapist physically guided him to touch the FCR card. For both children, the therapist immediately represented the preferred stimulus (20-s access for Ben and one edible item for Alex) after the FCR. Pretraining sessions consisted of 10 trials each, and we used a progressive prompt delay similar to that described by Charlop, Schreibman, and Thibodeau (1985) to transfer stimulus control from the controlling prompt (i.e., the vocal prompt for Ben or physical guidance for Alex) to the presentation of the establishing operation. The prompt delay increased (0 s, 2 s, 5 s, 10 s) after every two sessions with zero instances of destructive behavior and continued until each child emitted the FCR independently for 80% of trials with low to zero rates of destructive behavior for two consecutive sessions. To prevent adventitious reinforcement of destructive behavior, the therapist implemented a 3-s changeover delay (COD; Herrnstein, 1961). That is, the therapist withheld reinforcement if destructive behavior occurred within 3 s of the FCR, and the child was required to emit another FCR without destructive behavior to access reinforcement.

FCT—This condition was identical to pretraining, except the therapist no longer implemented the progressive prompt delay, and sessions lasted 5 min rather than being trial based.

Results and Discussion

Functional analysis results for Ben and Alex are displayed in Figure 1. For Ben, we observed zero instances of aggression during four consecutive ignore sessions that preceded the multielement functional analysis. Ben engaged in consistently elevated rates of aggression during escape and tangible conditions and near-zero rates in the attention and toy-play conditions. Because we observed Ben's aggression outside sessions during low-attention conditions with his caregiver and with staff members, we conducted the pairwise analysis with the attention and toy-play conditions in the final phase of his functional analysis to rule in or rule out whether contingent attention reinforced his problem behavior. Ben emitted higher rates of aggression in the attention condition than in the toy-play condition in this final phase. Together, these results suggest that multiple sources of social reinforcement maintained Ben's aggression. We targeted the tangible function of aggression for treatment. For Alex, we observed consistently higher rates of destructive behavior during the tangible

condition than in the play condition, suggesting that contingent access to preferred tangible items maintained his destructive behavior.

Figure 2 displays the results of the FCT evaluation. Ben and Alex emitted elevated rates of destructive behavior and near-zero rates of the FCR before pretraining. During pretraining (data not shown), both participants displayed low rates of problem behavior and increasingly high rates of independent FCRs. Ben completed pretraining in eight sessions, and Alex completed pretraining in 14 sessions. After pretraining, rates of destructive behavior for both participants decreased, and we observed higher rates of the FCR during FCT. We then conducted treatment reversals to replicate baseline and treatment levels of responding for each child. Both boys displayed marked reductions in destructive behavior and elevated rates of the FCR with the FCT procedures. We initiated Study 2 after completion of the FCT evaluations.

Study 2: Evaluating the Effect of Mult FCT on Resurgence of Destructive Behavior

The purpose of Study 2 was to evaluate the extent to which establishing discriminative control over the FCR during mult FCT would decrease later resurgence of destructive behavior. We hypothesized that extended periods of extinction that were signaled by the same stimulus previously used during mult FCT to indicate periods of extinction for the FCR (i.e., the S^{Δ}) might mitigate resurgence of problem behavior.

Design

We evaluated resurgence following two forms of FCT using a modified ABAB reversal design in which each A phase included a sequence of three subphases (i.e., baseline, mult FCT, extinction challenge with S^{Δ} present) and each B phase included a sequence of three subphases (i.e., baseline, traditional [trad] FCT, extinction challenge with no S^{Δ} present). The mult FCT sequence (A) served as the test sequence in which the S^{Δ} remained present during FCT and throughout the extinction challenge. The trad FCT sequence (B) served as the control sequence in which no S^{Δ} was present during FCT or the extinction challenge. We counterbalanced the order of the two sequences across the two participants, so that Alex experienced the mult FCT sequence (A) first, followed by the trad FCT sequence (B), then followed by a second mult FCT sequence (A), and finally a second trad FCT sequence (B). Ben experienced the trad FCT and mult FCT sequences in the opposite order (i.e., BABA).

For purposes of experimental control, each sequence was associated with a specific room and set of colored materials (i.e., one room had blue light covers, blue poster boards on the walls, the therapist wore a blue scrub top, and when applicable, we used a blue FCR card; in the other room, we used yellow light covers, poster boards, scrub tops, and when applicable, a yellow FCR card; Conners et al., 2000; Mace et al., 2010). We also counterbalanced these contextual discriminative stimuli across the two participants.

Procedure

Prebaseline training—Before each baseline phase, we conducted one to three training sessions (data not shown) to thin each participant's destructive behavior from a fixed-ratio (FR) 1 to a variable-interval (VI) 40-s schedule of reinforcement. In basic research on behavioral momentum, VI schedules are typically used instead of ratio schedules to control the rate of obtained reinforcement. We thinned the reinforcement schedule for destructive behavior by delivering reinforcement according to a progressive-ratio schedule (FR 1, FR 2, FR 4, FR 6, etc.) until each reinforcer delivery was approximately 40 s apart, at which point we transitioned to a VI 40-s schedule.

Baseline—Baseline was identical to the tangible condition of the functional analysis in Study 1, except (a) the therapist delivered reinforcement following destructive behavior on a VI 40-s schedule to produce approximately 90 reinforcers per hour, and (b) sessions lasted 10 min. We used a relatively dense reinforcement schedule for destructive behavior in baseline to increase the likelihood of observing resurgence of destructive behavior in the corresponding extinction condition (Nevin & Shahan, 2011; Shahan & Sweeney, 2011).

Trad FCT—We conducted the trad FCT condition using procedures identical to the FCT condition in Study 1, except (a) the therapist delivered reinforcement following the FCR on a VI 20-s schedule to produce approximately 180 reinforcers per hour, and (b) sessions lasted 10 min. This reinforcement schedule corresponds to a 200% increase in the density of reinforcement available for the FCR during FCT compared to the reinforcement schedule used for destructive behavior in baseline (similar to Mace et al., 2010). Destructive behavior remained on extinction. Before each session, the child was told, “This [FCR] works like the [FCR] in the other room. But I will not give you [functional reinforcer] if you are doing [destructive behavior].” As in Study 1, we used a 3-s COD to prevent adventitious reinforcement of a chained response of destructive behavior immediately followed by an FCR. We implemented trad FCT until destructive behavior decreased by at least 90% from baseline for two consecutive sessions.

Mult FCT—During the mult FCT condition, the therapist signaled the availability (S^D) and unavailability (S^Δ) of reinforcement for the FCR using a multiple schedule. The discriminative stimuli used in mult FCT consisted of colored index cards worn on a lanyard by the therapist. We correlated the reinforcement component with a green index card and the extinction component with a red index card. Each card was continuously visible throughout the duration of the respective component. Before each session, the child was told, “When the green card is out [showing green card], this means you can [emit FCR] like this [modeling FCR], and you can have [functional reinforcer], but when the red card is out [showing red card], you cannot have [functional reinforcer], even if you try to [emit FCR]. I will not switch it back to green until you are not doing [destructive behavior].” The FCR resulted in 20-s access to reinforcement (Ben) or one edible item (Alex) according to a FR 1 schedule during the S^D component of mult FCT, whereas the FCR produced no programmed consequences (i.e., extinction) during the S^Δ component. Destructive behavior produced no programmed consequence in both components.

The initial mult FCT schedule consisted of 60 s with the S^D present and 30 s with the S^Δ present. After two consecutive sessions with rates of destructive behavior at least 90% below the baseline mean, the therapist increased the mult FCT schedule to 60 s with the S^D present and 240 s with the S^Δ present. In all mult FCT sessions, we presented one S^D component at the start of the session followed by one S^Δ component. Thereafter, we presented the remaining S^D and S^Δ components in a quasirandom fashion (with no more than two identical components occurring consecutively). Sessions lasted 10 min.

We used the same 3-s COD as described for the previous conditions, but we added a 3-s COD to prevent adventitious reinforcement of destructive behavior by the transition from the S^Δ to the S^D in mult FCT. That is, if the participant displayed destructive behavior just before a scheduled transition from the S^Δ to the S^D, we delayed the transition until 3 s elapsed without destructive behavior. We implemented mult FCT until destructive behavior decreased by at least 90% from baseline for two consecutive sessions at the terminal interval durations.

Extinction challenge—We used Equation 1 to develop a test of whether presentation of the S^Δ used previously in the context of mult FCT could mitigate or prevent resurgence of destructive behavior. During the extinction challenge for the control sequence (i.e., with trad FCT), (a) we discontinued reinforcement for the FCR, (b) destructive behavior continued to produce no programmed consequences, and (c) we delivered a small number of reinforcers on a variable-time (VT) 200-s schedule (which produced one or two reinforcer deliveries per 10-min session). We delivered reinforcers on this VT schedule to make the change from treatment to extinction less discriminable (therefore lowering the value of dr in Equation 1 and increasing the likelihood of resurgence). We conducted the extinction challenge for the test sequence (i.e., with mult FCT) identical to the one for the control sequence, except that we included the S^Δ from mult FCT used in the prior phase.

Data Analysis

We analyzed the results in two ways. First, we compared the rates of destructive behavior during the extinction challenges that followed trad FCT and mult FCT to evaluate the clinical relevance of the results. Second, to account for differences in baseline response rates across sequences, we compared levels of resurgence following trad FCT and mult FCT expressed as a proportion of baseline levels of responding. This second method of analyzing levels of response persistence is commonly used in basic and translational studies related to behavioral momentum theory (e.g., Mace et al., 2010; Nevin, Tota, Torquato, & Shull, 1990). We calculated the proportion of baseline responding by averaging rates of destructive behavior observed during each session of the extinction challenge within each sequence type (e.g., averaging the first session from both challenge phases in the mult FCT sequence, averaging the first session from both challenge phases in the trad FCT sequence). We then divided those session averages by the average rate of destructive behavior obtained across the corresponding baselines for each sequence. This method enabled us to examine overall levels of and trends in resurgence produced by both sequences while accounting for baseline response rates for each sequence.

Results and Discussion

Figure 3 shows the rates of destructive behavior, FCRs, and reinforcer deliveries during the test (i.e., with mult FCT) and control (i.e., with trad FCT) sequences for Ben. Ben emitted relatively high rates of destructive behavior across baseline phases and variable rates of the vocal FCR. He experienced similar reinforcement rates across baseline phases. Both trad and mult FCT conditions decreased levels of destructive behavior with relatively more immediate suppression of responding in the mult FCT condition, despite the rapid thinning of the reinforcement schedule. Rates of the FCR maintained across trad and mult FCT conditions, and we observed a higher rate of FCRs during the trad FCT condition than in the mult FCT condition. Ben experienced slightly higher reinforcement rates during trad FCT (M = 1.1 reinforcers per minute) than in mult FCT (M = 1.0 overall; M = 0.6 after schedule thinning). During the extinction challenge, we observed resurgence of destructive behavior only after the trad FCT condition. Ben engaged in near-zero rates of destructive behavior when the S^{Δ} was continuously visible during the extinction challenges that followed mult FCT. Ben's use of the FCR declined across extinction challenges in both sequences, and the VT schedule produced low, consistent, and equivalent reinforcement rates in each extinction challenge (Figure 3, bottom).

Figure 4 shows the rates of destructive behavior, FCRs, and reinforcer deliveries during the test (i.e., with mult FCT) and control (i.e., with trad FCT) sequences for Alex. Alex engaged in elevated and increasing rates of destructive behavior across baseline phases. Because we prevented access to the FCR card across baseline phases (which was not possible with Ben's vocal FCR), Alex had no opportunity for FCRs to contact extinction in baseline. Similar to Ben's results, mult FCT and trad FCT effectively decreased Alex's high rates of destructive behavior, even as we thinned the reinforcement schedule in the mult FCT condition. Alex emitted moderate to high rates of the FCR across each type of FCT. Destructive behavior decreased more gradually and slowly in the final trad FCT condition than in the first trad FCT condition, and we observed a correspondingly high and escalating rate of FCRs in this final condition. Alex experienced slightly higher rates of reinforcement in the mult FCT condition (M = 2.4 overall; M = 1.8 after schedule thinning) than in trad FCT (M = 1.5). The first comparison of resurgence following mult FCT and trad FCT showed more pronounced and sustained resurgence of destructive behavior after the trad FCT condition than after the mult FCT condition. The second comparison of resurgence produced less conclusive results, with approximately equal rates of destructive behavior across the final two challenge phases. Alex's use of the FCR declined across all challenge phases.

Figure 5 displays levels of resurgence of destructive behavior expressed as a proportion of baseline levels of responding during the challenge phases following the trad and mult FCT conditions. When the therapist continuously signaled the unavailability of reinforcement during the challenge condition following mult FCT, Ben's destructive behavior remained at near-zero rates. However, when this S^{Δ} was absent from the extinction challenge (i.e., after trad FCT), destructive behavior persisted at higher proportional rates and for a larger number of sessions. Alex's proportional rates of destructive behavior showed a pattern similar to Ben's. That is, we observed lower proportional rates of destructive behavior in the challenge sessions that followed mult FCT (with S^{Δ}) than in those that followed trad FCT (no S^{Δ}).

In summary, we found both trad FCT and mult FCT to be effective treatments for destructive behavior with both children, with relatively quicker reductions during mult FCT. Both treatments increased the rate of each child's FCRs, with relatively higher FCR rates with trad FCT. However, when an extinction challenge followed trad FCT and mult FCT, we observed considerably lower levels of resurgence of destructive behavior when the therapist signaled the unavailability of reinforcement using the S^{Δ} (i.e., following mult FCT). Challenge sessions that followed trad FCT (without the S^{Δ}) produced resurgence of destructive behavior.

GENERAL DISCUSSION

In Study 1, we assessed and treated behavior maintained by positive reinforcement in the form of access to tangible items. Results replicated past research on FCT showing that functional communication increased and problem behavior decreased with the introduction of differential reinforcement and extinction. In Study 2, we demonstrated that schedule thinning in the context of a multiple schedule before extinction mitigated resurgence relative to a condition in which we did not implement signaled schedule thinning. We developed this procedure to test the predictions of Equation 1 (Equation 7 in Nevin & Shahan, 2011). Results suggested that the combination of a history of schedule thinning and the presentation of the S^{Δ} (used in the multiple schedule) during extinction mitigated resurgence of problem behavior. In summary, the current results provide direct evidence that schedule thinning in the context of a multiple schedule can prevent or mitigate resurgence when both destructive and alternative behaviors are exposed to extinction.

We designed the extinction challenge in the current study to represent an analogue of denied reinforcement in a natural context (e.g., when a caregiver cannot provide attention for an extended period because he or she is on the phone, or when a teacher cannot provide a break from an academic task during an important educational assessment). Similar to the results of Volkert et al. (2009), when an extinction challenge followed trad FCT, we observed resurgence of destructive behavior in three of four applications. However, when we included the S^{Δ} from the prior mult FCT phase during the extinction challenge, we did not observe resurgence in any of the four applications.

One interesting feature of the trad FCT treatment is that we did not observe resurgence of destructive behavior during the final (fourth) extinction challenge conducted with Alex. These results are not surprising, because behavioral momentum theory predicts that successive exposures to periods of differential reinforcement, each followed by successive periods of extinction, should result in progressively lower levels of resurgence. For example, Wacker et al. (2011) conducted a series of phases of FCT followed by periods of extinction for the FCR and found high levels of resurgence during the initial extinction challenges but progressively lower levels of resurgence with each successive challenge, results consistent with the quantitative predictions of behavioral momentum theory. Thus, Wacker et al.'s results suggest that one way to address the problem of resurgence is to expose the individual to extinction challenges repeatedly after treatment with FCT. Our current results suggest that another potential method of addressing the problem of resurgence is to bring the FCR under clear discriminative control using mult FCT and then to present the S^{Δ} during subsequent

extinction challenges. Future researchers should test whether initiating treatment with mult FCT and then presenting the S^{Δ} in a series of successive extinction challenges (similar to those conducted by Wacker et al.) might mitigate or prevent resurgence early on in the sequence. Furthermore, researchers should evaluate the effect of treatments like mult FCT under a variety of conditions that typically give rise to resurgence of problem behavior in order to minimize the likelihood that treatment relapse will occur when caregivers implement the treatment at home.

Despite our promising results, Study 2 included several limitations that should be addressed in future research. First, although the number of FCT sessions that preceded the extinction challenges were comparable across conditions for Ben, Alex experienced more than double the number of FCT sessions during mult FCT than he did in trad FCT during the first AB phase. Shahan and Sweeney (2011) suggest that resurgence will decrease as time in extinction (e.g., FCT in the current study) increases. Therefore, the lack of resurgence observed during Alex's first extinction challenge could have been attributable to the high number of FCT sessions that preceded the challenge. Future research on resurgence should equate the number of FCT sessions conducted before the extinction challenge, especially if FCT also includes an extinction component. Second, although we controlled for rates of reinforcement across baseline and challenge sessions during both the test and control sequences, rates of reinforcement differed slightly across mult and trad FCT treatment phases, and rates of reinforcement decreased during treatment with mult FCT (i.e., during schedule thinning) but not with trad FCT. Behavioral momentum theory predicts that relatively higher rates of reinforcement during treatment are likely to produce higher levels of resurgence during a subsequent extinction challenge. Thus, it is possible that these differences in reinforcement rates for the two treatments affected levels of destructive behavior during the extinction challenges more so than the presence or absence of the S^{Δ} from mult FCT. However, this seems unlikely in the current analyses because the treatment that resulted in the highest level of reinforcement differed for each participant. Ben experienced slightly higher rates of reinforcement during trad FCT, whereas Alex experienced higher rates of reinforcement during mult FCT. Nevertheless, future studies on the effectiveness of mult FCT for preventing or mitigating resurgence of destructive behavior during periods of extinction for the FCR should equate the rates of reinforcement during the test and control treatments more precisely, perhaps with a yoking procedure.

Across all challenge sessions, we implemented a VT 200-s schedule of reinforcement to decrease the discriminability in the transition from treatment (i.e., mult or trad FCT) to extinction, thereby enhancing the resurgence effect. However, it is also possible that this thin reinforcement schedule may have resulted in a different form of relapse, called *reinstatement.* Studies on reinstatement typically involve response-independent reinforcement during extinction (e.g., Franks & Lattal, 1976; Podlesnik & Shahan, 2009) that then results in the recurrence of a previously extinguished response. Therefore, it is plausible that any recurrence of destructive behavior observed in the challenge sessions of the current study could be attributable to reinstatement rather than exposure to extinction alone.

Another limitation of Study 2 lies in the inability of the S^{Δ} of the multiple schedule to rapidly suppress rates of Alex's FCRs during the challenge sessions of the mult FCT sequence. Unlike Ben, Alex's use of the FCR persisted for several sessions before it was eventually extinguished in both extinction challenges of the mult FCT sequence. If the stimulus control afforded by the S^{Δ} successfully mitigated resurgence of problem behavior (as it appears to have done with both participants), it should also decrease rates of the FCR. The elevated rates of the FCR in the presence of the S^{Δ} could therefore suggest that the reduced levels of destructive behavior during challenge sessions following mult FCT are due to variables other than the presence of the discriminative stimuli (e.g., schedule thinning).

One way to equate reinforcement rates and separate the effects of the S^{Δ} following mult FCT from the effects of differential rates of reinforcement would be first to implement mult FCT in one stimulus context (e.g., blue) and then to implement trad FCT in two separate but equivalent stimulus contexts (e.g., green and yellow; with equal rates of reinforcement in each). Then, after mult FCT training, the S^{Δ} from mult FCT could be introduced during one extinction challenge following trad FCT (e.g., yellow) but not in the other (e.g., green). If resurgence occurred during the extinction challenge without the S^{Δ} but not in the extinction challenge with the S^{Δ}, then we could conclude more definitively that the stimulus control of the S^{Δ}, rather than differential rates of reinforcemen, produced the lowered levels of responding during treatment.

Despite these limitations, the current findings, combined with those of Betz et al. (2013), suggest that mult FCT may be used to mitigate resurgence of destructive behavior when the FCR contacts relatively extended periods of extinction. It is not entirely clear at this point whether the effectiveness of mult FCT under these conditions is due primarily to stimulus control (i.e., the presence of the S^{Δ}), to the reduction in reinforcement rates during mult FCT resulting from schedule thinning, or to the combination of these variables. Nevertheless, the current results are consistent with the predictions of behavioral momentum theory, and they suggest that that the incorporation of a multiple schedule in the context of FCT may increase the robustness of the treatment by preventing or mitigating resurgence of destructive behavior during exposure to extinction.

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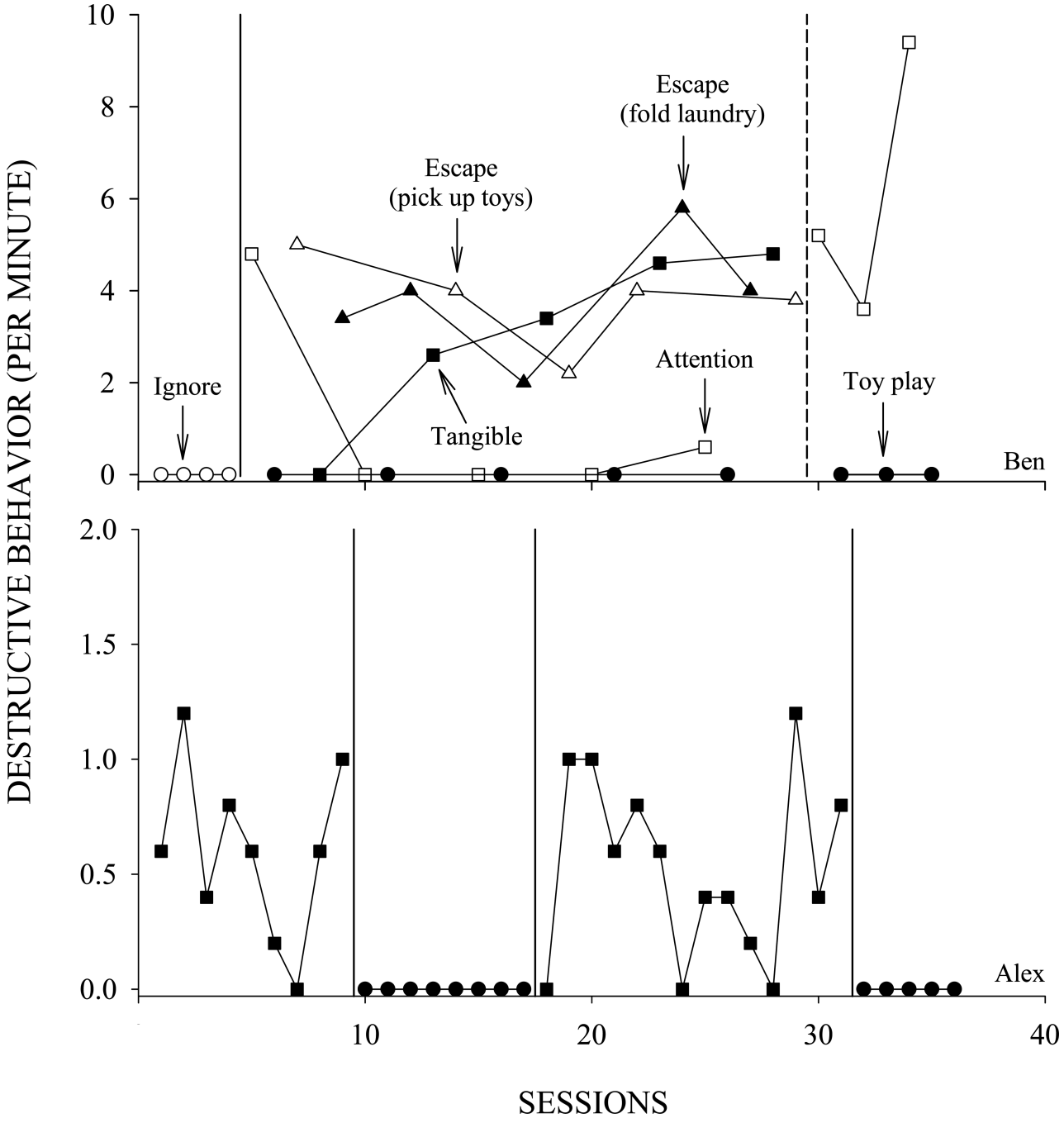

Figure 1.
Functional analysis results for Ben (top) and Alex (bottom).

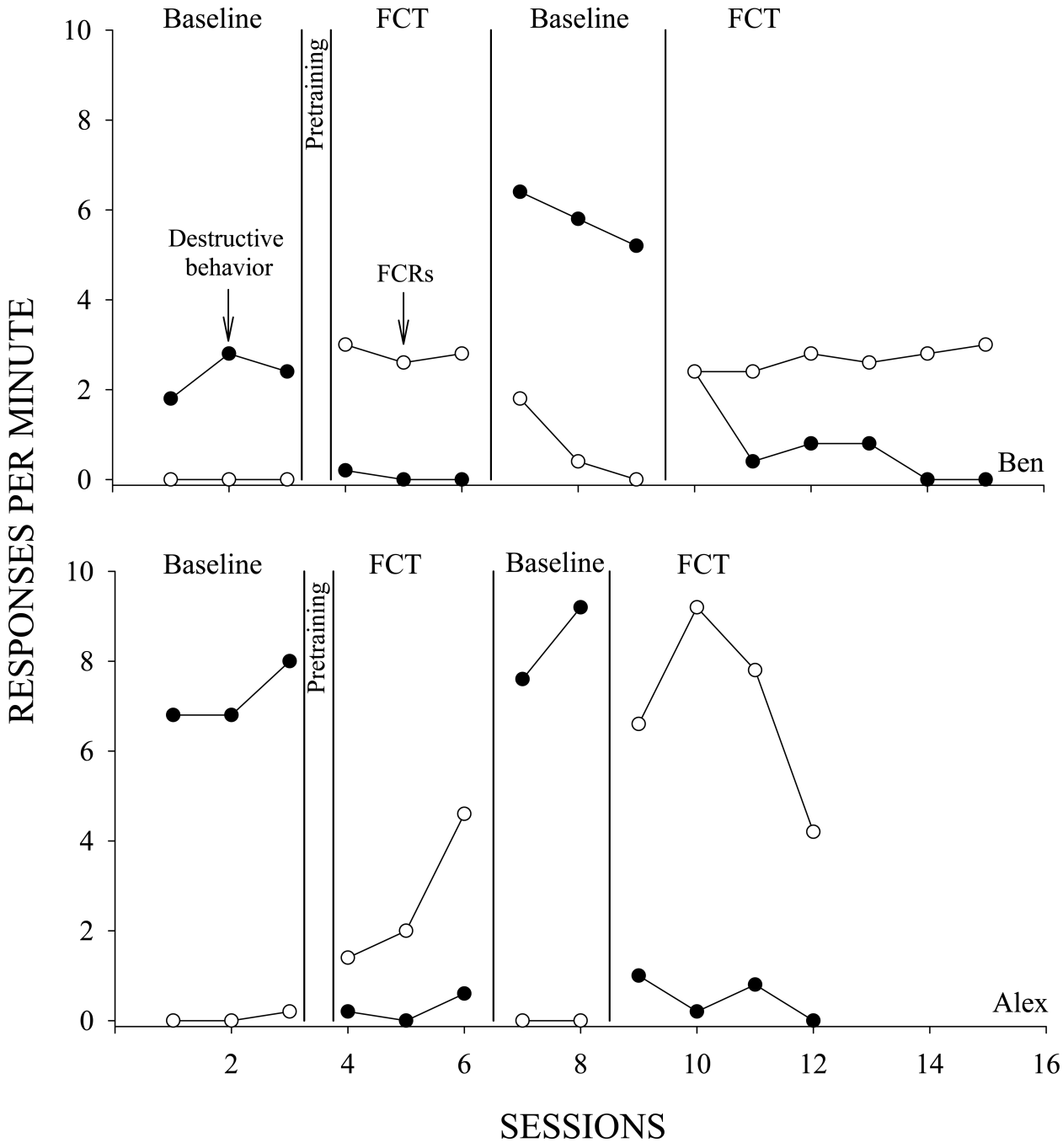

Figure 2.
FCT evaluation results for Ben (top) and Alex (bottom).

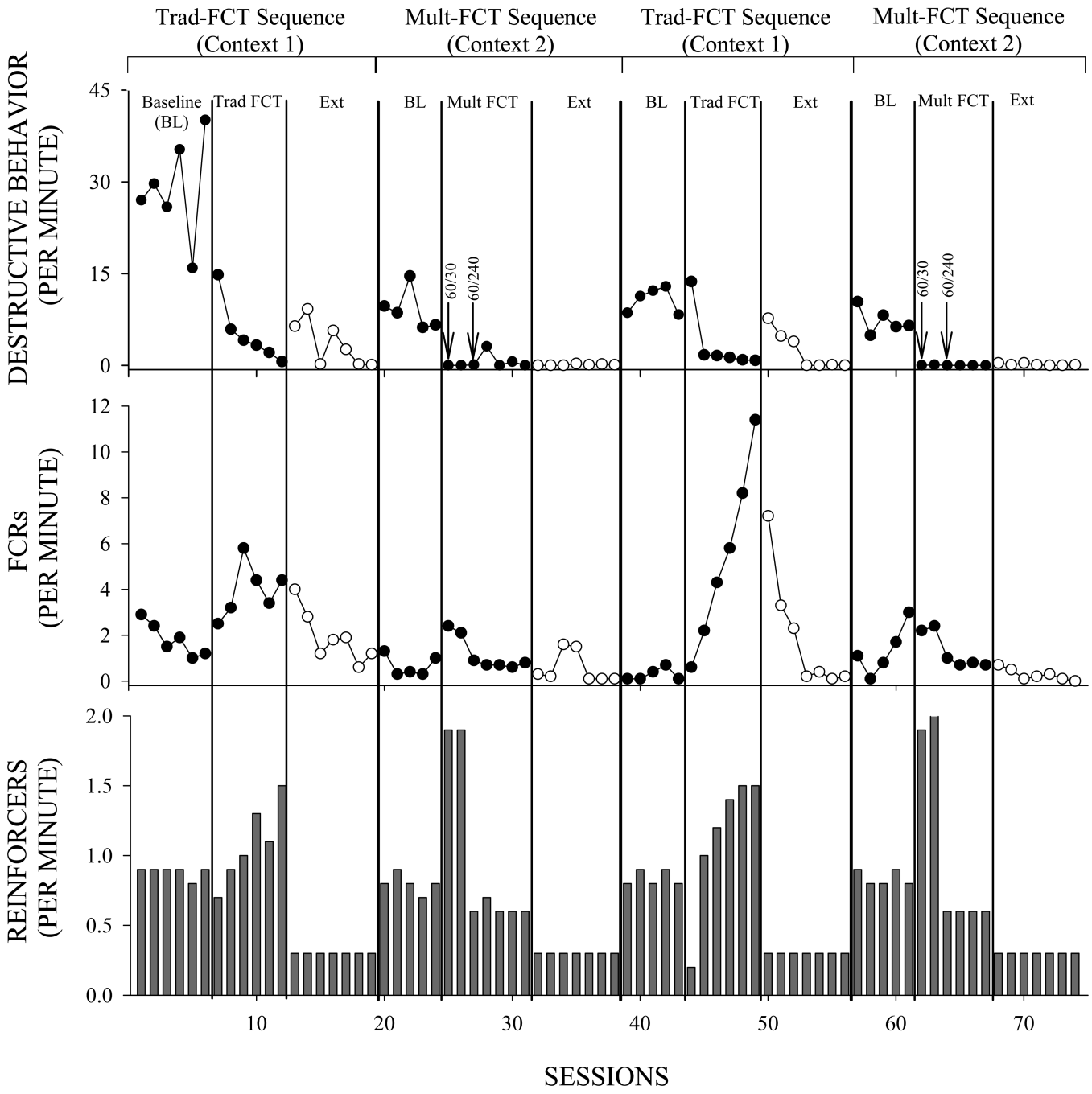

Figure 3.

Responses per minute of destructive behavior (top), FCRs (middle), and reinforcers (bottom) across trad FCT and mult FCT sequences for Ben. The range of the *y* axes differs across panels.

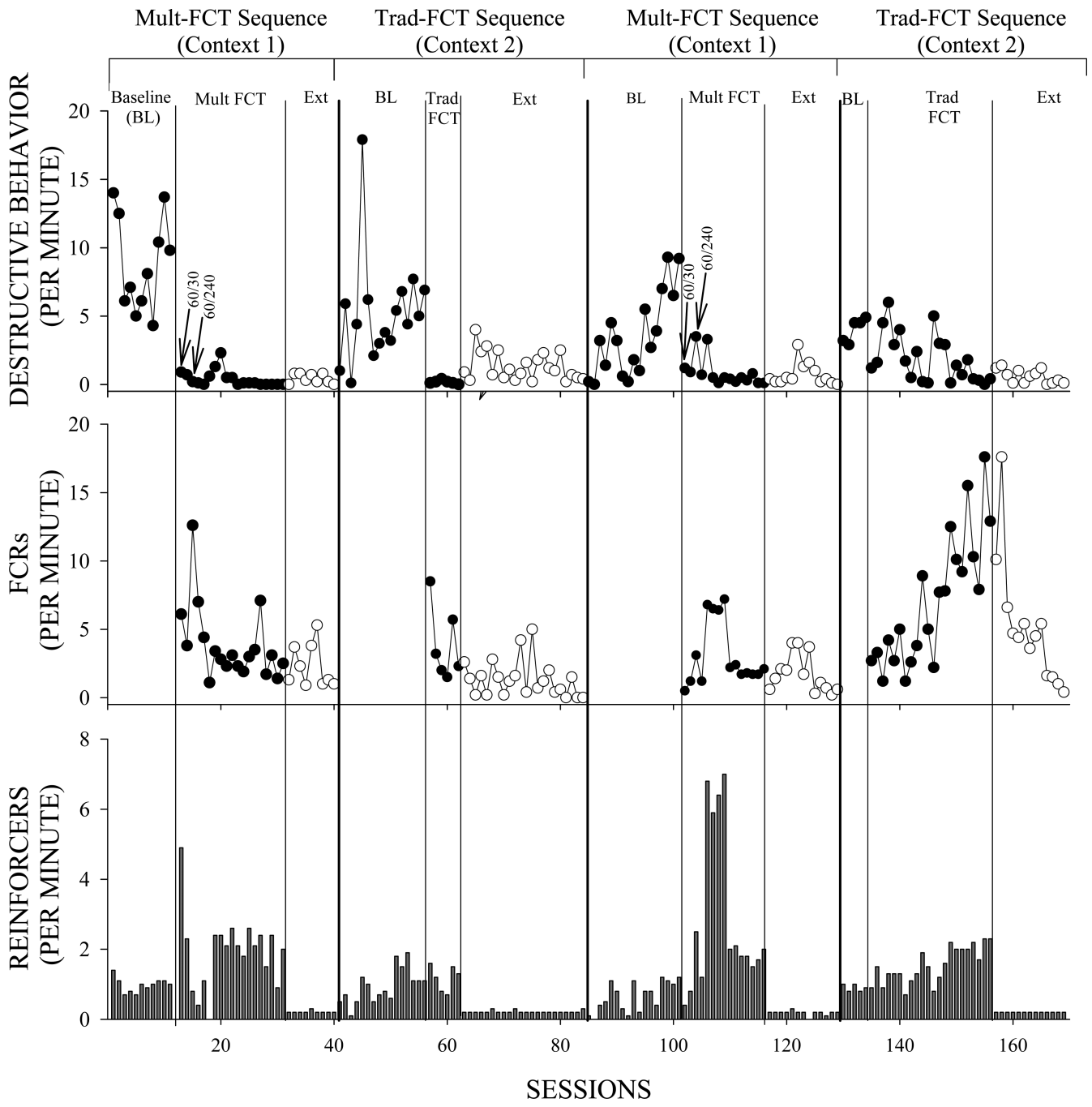

Figure 4.

Responses per minute of destructive behavior (top), FCRs (middle), and reinforcers (bottom) across mult FCT and trad FCT sequences for Alex. The range of the *y* axes differs across panels.

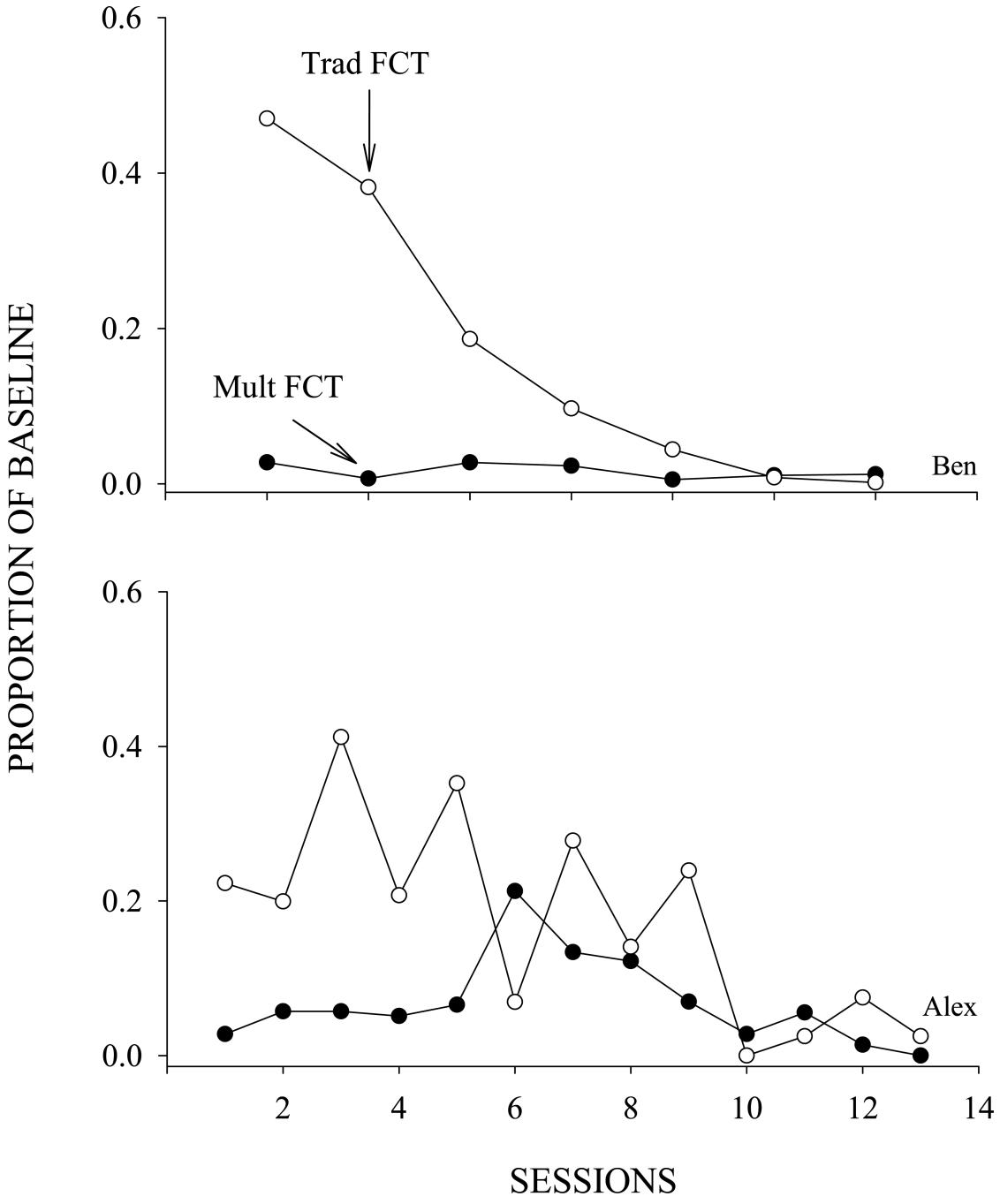

Figure 5.
Proportion of baseline responding averaged across extinction challenge phases for Ben (top) and Alex (bottom).