

*AN EVALUATION OF PERSISTENCE OF TREATMENT EFFECTS DURING LONG-TERM  
TREATMENT OF DESTRUCTIVE BEHAVIOR*

DAVID P. WACKER<sup>1</sup>, JAY W. HARDING<sup>1</sup>, WENDY K. BERG<sup>1</sup>, JOHN F. LEE<sup>1</sup>, KELLY M. SCHIELTZ<sup>1</sup>,  
YANIZ C. PADILLA<sup>1</sup>, JOHN A. NEVIN<sup>2</sup>, AND TIMOTHY A. SHAHAN<sup>3</sup>

<sup>1</sup>THE UNIVERSITY OF IOWA

<sup>2</sup>THE UNIVERSITY OF NEW HAMPSHIRE

<sup>3</sup>UTAH STATE UNIVERSITY

Eight young children who displayed destructive behavior maintained, at least in part, by negative reinforcement received long-term functional communication training (FCT). During FCT, the children completed a portion of a task and then touched a communication card attached to a microswitch to obtain brief breaks. Prior to and intermittently throughout FCT, extinction probes were conducted within a withdrawal design in which task completion, manding, and destructive behavior were placed on extinction to evaluate the relative persistence of appropriate and destructive behavior over the course of treatment. FCT continued until appropriate behavior persisted and destructive behavior failed to recur at baseline levels during extinction probes. The completion of FCT was followed by four challenges to the persistence of treatment effects conducted within mixed- or multiple-schedule designs: (a) extended extinction sessions (from 5 to 15 min), (b) introduction of a novel task, (c) removal of the microswitch and communication card, and (d) a mixed schedule of reinforcement in which both appropriate and destructive behavior produced reinforcement. The results showed that although FCT often resulted in quick reductions in destructive behavior and increases in appropriate behavior, destructive behavior often recurred during the extinction probes conducted during the initial treatment. When the effects of treatment persisted during the extinction probes, the remaining challenges to treatment effects resulted in only mild to moderate disruptions in behavior. These results are consistent with the quantitative predictions of behavioral momentum theory and may provide an alternative definition of maintenance as constituting behavioral persistence.

*Key words:* functional communication training, behavioral persistence, behavioral momentum, destructive behavior, young children

Functional communication training (FCT) is currently among the most common reinforcement-based treatments for destructive

behavior, with over 60 citations listed in PsychInfo (Tiger, Hanley, & Bruzek, 2008). Epidemiological studies reported by Kurtz et al. (2003), Wacker et al. (1998), and Wacker et al. (2005) have shown that FCT can be conducted by parents in outpatient and home settings and that the results can be maintained and generalized across stimulus conditions. Most previous studies have defined and evaluated maintenance as steady-state responding under treatment conditions (e.g., Stokes & Baer, 1977). Thus, relative to FCT, maintenance is shown to occur when appropriate behavior remains high and stable and destructive behavior remains low and stable over the long-term course of FCT treatment.

For example, Berg, Wacker, Harding, Ganzer, and Barretto (2007), Derby et al. (1997), Durand and Carr (1991), Durand and Carr (1992), Wacker et al. (1998), and Wacker et al. (2005) all reported that long-term maintenance of FCT occurred frequently and reductions in destructive behavior were correlated with manding (Durand & Carr, 1991; Wacker et al., 2005) or other prosocial behaviors

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David P. Wacker is at Department of Pediatrics, The University of Iowa Children's Hospital, Iowa City; Jay W. Harding, Wendy K. Berg, John F. Lee, Kelly M. Schieltz, and Yaniz C. Padilla are at Center for Disabilities and Development, The University of Iowa Children's Hospital, Iowa City; John A. Nevin is at Department of Psychology, The University of New Hampshire, Durham, NH; and Timothy A. Shahan is at Department of Psychology, Utah State University, Logan, UT 84322.

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Address correspondence to David P. Wacker, Ph.D., Center for Disabilities and Development, 100 Hawkins Dr Room 251, Iowa City, IA 52242 (e-mail: david-wacker@uiowa.edu).

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(Derby *et al.*, 1997). However, most long-term evaluations of maintenance have provided only correlational analyses and not experimental analyses of the long-term effects of treatment. For example, Derby *et al.* (1997) and Wacker *et al.* (1998) showed that maintenance occurred and was correlated with increases in manding and other adaptive behavior under treatment conditions. Experimental analyses of maintenance (i.e., the conditions under which destructive and adaptive behavior occurred following long-term treatment) were not conducted.

An alternative approach to evaluating the long-term effects of treatment based on the theory of behavioral momentum (Nevin, 1992) is to evaluate behavioral persistence (Dube, Ahearn, Lionello-DeNolf, & McIlvane, 2009) during challenges to treatment (e.g., extinction). An analysis of challenges to treatment would evaluate the effects of treatment over time to determine if appropriate behavior persisted (Dube, McIlvane, Mazzitelli, & McNamara, 2003) or if destructive behavior recurred (Lattal & St. Peter Pipkin, 2009; Lieving & Lattal, 2003; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). Behavioral persistence might be established if treatment effects persisted during the treatment challenges (Nevin & Wacker, *in press*).

In this study, we conducted two analyses of behavioral persistence that constituted challenges to treatment. First, throughout treatment, we conducted intermittent extinction probes during which appropriate communication, destructive behavior, and compliance to task requests all resulted in extinction. These probes were used to evaluate the persistence of destructive and appropriate behavior when the effects of treatment were challenged at different points in treatment via brief periods of extinction. Our goal was to determine if long-term FCT treatment decreased the persistence of destructive behavior and increased the persistence of appropriate behavior later but not earlier in treatment. We defined treatment as having been successful when appropriate behavior persisted and destructive behavior did not recur during the extinction probes.

Second, at the completion of successful treatment, we further challenged the effects of treatment by extending the length of the extinction period from 5 to 15 min, altering the antecedent stimulus conditions (by chang-

ing the tasks and removing the microswitch), and implementing a concurrent schedule (FR 1 FR 1) of reinforcement for destructive and appropriate behavior. These challenges were conducted posttreatment specifically to identify potential conditions (e.g., increased time in the relevant motivating operation, stimulus control, changes in reinforcement schedules) that may be related to the persistence of treatment effects.

Each of these challenges was selected because they represent conditions in applied settings that often vary from the original treatment plan. Duration of demands increases (extinction challenge), different tasks are introduced, augmentative communication devices are not deployed, and care providers reinforce destructive behavior, at least intermittently. Thus, this study evaluated the long-term effects of FCT in the treatment of escape-maintained destructive behavior. We present single-case analyses for 2 participants (Tina and José) as exemplars of the analyses completed for all children. We then provide summary data for all 8 children and quantitative analyses for 7 of the children.

## METHOD

### *Participants and Settings*

Eight young children participated in this investigation as part of a federally funded research project<sup>1</sup>. Criteria for enrollment in the current study were (a) 6 years of age or less, (b) diagnosed developmental disability, (c) occurrence of destructive behavior during the negative reinforcement condition of a functional analysis, and (d) informed consent. All participants were asked to enroll for a period of 2 years.

Tina and José were the 2 participants for whom single-case analyses are presented in the results. (The functional analyses for both participants were previously published in Schieltz, Wacker, Harding, Berg, Lee, & Padilla Dalmau, 2010; Tina's functional analysis and FCT results were also previously published in Wacker, Berg, Harding, & Cooper-Brown, 2009). Tina was 3 years 11 months

<sup>1</sup>Wacker, D. P., Berg, W. K., & Harding, J. W. (2004). *Maintenance effects of functional communication training*. Washington, DC: Department of Health and Human Services, National Institute of Child Health and Human Development.

Table 1  
Participant Description.

Participant	Age	Diagnoses	Destructive Behavior	Language Skills	Target Work Task
Tina	3.11	Autism, Developmental Delay	Aggression, Property destruction	Single words	Stacking blocks
José	4.4	Fragile X, Moderate Intellectual Disability	Aggression, Property destruction, Self-injury	Single words, manual signs	Pointing to pictures
Cam	2.11	Developmental Delay	Aggression, Self-injury	Single words, manual signs	Picking up toys
Kevin	2.3	Developmental Delay	Aggression, Self-injury	Single words, manual signs	Stacking blocks
Juan	3.11	Autism, Developmental Delay	Aggression, Self-injury	Short spoken sentences	Putting puzzle together
Andy	2.6	Developmental Delay	Aggression, Property destruction	Single words, manual signs	Stacking blocks
Bud	3.6	Autism, Mild Intellectual Disability	Self-injury, Aggression	Single words	Pointing to pictures
Rose	3.4	Mild Intellectual Disability	Self-injury, Aggression, Property destruction	Single words	Picking up blocks

old and was diagnosed with autism and developmental delay. Destructive behavior included aggression (hitting, kicking) and property destruction (throwing objects). Communication consisted of a limited vocabulary of single words. José was 4 years 4 months old and was diagnosed with fragile X syndrome and moderate intellectual disability. Destructive behavior included aggression (biting, hitting), self-injury (finger biting), and property destruction (throwing toys). Communication consisted of a few single words and manual signs (e.g., “Done”). Subject descriptions for all 8 participants are presented in Table 1.

All assessment and treatment procedures were conducted in the living room or participant’s bedroom (Andy only) of the children’s homes. The children’s mothers served as therapists with coaching from the investigators during all procedures. All sessions were videotaped for subsequent data collection and analysis.

### Materials

Given the children’s limited vocal communication and manual signing skills, the investigators provided the parents with a BIGMack® microswitch and a 10.2 cm × 10.2 cm communication card created with Boardmaker® as an augmentative communication device during FCT. The card displayed the word “play” and a drawing of a child surrounded by toys.

The card was taped to the touch plate of the microswitch. The parents programmed the microswitch to say, “Play, please,” when the card on the microswitch was touched. The card attached to the microswitch was used as a visual discriminative stimulus that reinforcement was available for appropriate manding.

### Response Definitions and Interobserver Agreement

A 6-s partial-interval recording system was used to measure child behavior. *Self-injury* was defined as any behavior that produced or could produce tissue damage on the child. *Aggression* was defined as any behavior that produced or could produce tissue damage on another person. *Property destruction* was defined as any behavior that damaged or could damage items in the home. For the purpose of this investigation, intervals in which aggression, self-injury, and property destruction occurred were combined and labeled as *destructive behavior*. *Independent target manding* was defined as saying the word “Play,” emitting the manual sign for “Play,” or touching a “Play” communication card that was attached to the touch plate of a microswitch that played the recorded message, “Play, please,” without a specific prompt instructing the child what to say or do. *Prompted target manding* was defined as the child emitting the mand within two 6-s intervals of a specific prompt (e.g., “Say, play”; “Touch the switch”). *Other independent*

*manding* was defined as a word or manual sign that indicated the child wanted a break from the assigned task (e.g., saying, "All done."). *Other prompted manding* was defined as the child's emitting an alternative request for a break within two 6-s intervals of a specific prompt from the parent (e.g., "Tell me, 'All done'"). An event-recording system was used to measure child task completion. *Independent task completion* was defined as the child's completion of required work activities (e.g., stacking blocks) without physical guidance.

Trained data collectors independently scored the occurrence of child behavior using a 6-s partial-interval recording system. Interobserver agreement on the occurrence of behavior was calculated based on exact interval-by-interval comparisons in which the number of agreements was divided by the number of agreements plus disagreements and multiplied by 100%. Interobserver agreement for child behaviors was assessed for 30% of each session and averaged 96% (range = 93% to 98%) across children. Data collectors scored the occurrence of task completion using a trial-recording procedure in which the child's response to an adult task request was recorded during each trial as (a) independent task completion, (b) task not completed, or (c) task completed with physical assistance. Interobserver agreement was calculated based on trial-by-trial comparisons in which the number of agreements was divided by the number of agreements plus disagreements and multiplied by 100%. Interobserver agreement for task completion was assessed for 30% of each session and was 100%.

### *Experimental Design*

The investigation was conducted in four phases. During Phase 1, a functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) was conducted within a multiple schedule design to identify the maintaining conditions for destructive behavior. During Phase 2, extinction probes of a target task and three additional age-appropriate tasks were conducted within a multiple schedule design to evaluate the occurrence of destructive and appropriate behavior under extinction conditions. During Phase 3, FCT and extinction probes of the target behaviors were conducted within a withdrawal design. Phase 3 continued until the child (a) independently completed

the amount of work presented during the initial extinction condition and (b) displayed substantially reduced levels of destructive behavior during two to three consecutive extinction sessions. During Phase 4, treatment challenge conditions were conducted to evaluate each child's behavior during increased periods of extinction, changes in tasks, removal of the microswitch, and changes in reinforcement contingencies. The extent to which parents were satisfied with the FCT program at the conclusion of the study was assessed via a treatment acceptability questionnaire (*Treatment Acceptability Rating Form—Revised [TARF-R]*; Reimers & Wacker, 1988).

### *Procedures*

*Phase 1: Functional analysis.* Functional analyses were conducted by parents and were completed over an average period of 4 weeks (range = 3 to 8 weeks). An average of 13 sessions (range = 10 to 15 sessions) were conducted for each child's analysis with an average of three sessions conducted during each visit. During the functional analysis, four assessment conditions were conducted to identify the maintaining variables for destructive behavior. During the negative reinforcement condition, the parent used a least-to-most restrictive prompt hierarchy to guide the child in completing a task (e.g., stacking blocks). The target task involved a nonpreferred toy identified during a free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998). For example, if the child's least favorite toy was blocks, then age-appropriate block activities (e.g., stacking, picking up) were used as the target work task. The target work task for Kevin, Tina, and Andy was stacking blocks. Cam's task was picking up toys, Juan's task was putting a puzzle together, Bud's and José's task was pointing to pictures in a book, and Rose's task was picking up blocks. If the child engaged in destructive behavior following task instructions, then the task was removed for 20 s. During the first positive reinforcement condition, the parent diverted her attention from the child (e.g., read a magazine). If the child engaged in destructive behavior, the parent provided attention in the form of reprimands (e.g., "Stop doing that") and redirection for 20 s. During the second positive reinforcement condition, the child was initially allowed to

play with a preferred toy that was identified during the previously conducted preference assessment. After a brief period of play, the preferred toy was removed and the child was given a less preferred toy. If the child engaged in destructive behavior, the preferred toy was returned for 20 s. During the free-play condition, the child had continuous access to toys and parent attention. Sessions were counterbalanced and lasted 5 min.

Coaching, as described by Harding, Wacker, Berg, Lee, and Dolezal (2009), was provided by an investigator who videotaped the sessions. Prior to conducting each session, the investigator explained the purpose of the condition and how the parent should respond to the child's behavior. During sessions, the investigator cued the parent when it was time to deliver reinforcement and when the reinforcement period had elapsed. In the case of the negative reinforcement condition, the investigator demonstrated how to deliver task requests in a three-step prompt sequence.

*Phase 2: Initial extinction.* The first extinction condition was conducted to evaluate the occurrence of destructive behavior during demands in the absence of reinforcement (i.e., programmed breaks from demands). The communication card/microswitch was not present during this condition, and manding and destructive behavior were ignored or blocked in a neutral fashion. During the first extinction condition, the parent presented the same task that was used during the child's functional analysis negative reinforcement condition. Task demands were presented in a series of 30-s trials during 5-min sessions. The parent presented the task to the child (e.g., "Put the red block on the blue block") and modeled the appropriate response but did not provide additional physical assistance. If the child completed the task, the parent provided verbal praise. If 30 s elapsed, the parent presented a new task. If the child refused to engage in the task, the parent repeated the instructions and kept the task in front of the child. During extinction, the children were asked to complete an average of eight tasks (e.g., stack eight blocks) per session (range = 5 to 11 tasks per session).

In addition to the target task that was used during the functional analysis and the initial extinction condition, a 5-min extinction demand condition was conducted with three

additional tasks for each child. The purpose of this assessment was to identify at least one other task that occasioned destructive behavior and resulted in low levels of independent task completion. The three additional tasks were selected from the children's toys and included items such as books, blocks, and puzzles. Children were asked to complete age-appropriate tasks such as pointing to pictures, picking up blocks, and completing puzzles using the same procedures that were conducted with the initial extinction condition task. The task that resulted in the highest level of destructive behavior and lowest level of task completion was selected as the novel task that was used during the treatment challenges. Novel tasks selected for the treatment challenges included picking up toys and blocks (Kevin, Tina, Juan, Andy), stacking blocks (Cam, Bud), putting together a puzzle (Rose), and placing balls in an electronic toy (José).

*Phase 3: Functional communication training (FCT).* Initially, from one to three FCT sessions were conducted during weekly visits for all 8 children. Following an average of 9 months (range = 5 to 15 months) of weekly visits, FCT sessions were conducted on a monthly basis for 5 children (Cam, Kevin, Juan, Andy, Bud). Overall, FCT sessions were conducted for an average of 14 months (range = 9 to 17 months) across children. The average number of FCT sessions conducted across children was 41 (range = 19 to 69).

During FCT, the child was first taught to comply with the task request and then to request a break to play. Thus, FCT was composed of a two-step chain in which compliance produced the word card attached to the microswitch and touching the card/switch produced a brief (1- to 2-min) break. Each FCT training session began with the parent's providing attention to the child while the child played with preferred toys for 20 to 30 s. After this brief period of play, the parent showed the child a word card that said, "Work," and told the child, "Time to work. When we're done, you can play." Andy, Tina, José, and Bud were directed to sit at a desk during their work tasks, whereas Cam, Juan, Kevin, and Rose completed their work tasks on the floor. The parent provided specific verbal directions and modeled how to complete each task. If the child completed the task, he or she received praise. If the child refused to attempt

the task, the parent provided hand-over-hand physical guidance. The parent then presented another task for the child to complete without assistance. The child was required to complete each task independently prior to receiving both praise and the word card attached to the microswitch to obtain negative reinforcement. As training continued, the work requirement for each training session was increased progressively within a demand fading program (Lalli, Casey, & Kates, 1995) to the initial extinction condition levels (eight tasks). During initial FCT sessions, each child was required to complete two work tasks (FCT [2]) during the course of two trials (i.e., one task per trial). Over time, work requirements were increased to completing four work tasks (FCT [4]) per session (i.e., two tasks per trial), and then eight work tasks (FCT [8]) per session (i.e., four work tasks per trial). For one child (Juan), task demands were increased to 12 tasks (FCT [12]) per session (i.e., six work tasks per trial) after 4 months.

After the child completed the required work task independently, the parent presented the microswitch and a piece of the work task to the child and said, "More work or play?" or "Tell me if you want to play." Over time, a more general prompt was typically delivered such as, "What do you want to do?" If the child emitted the target mand or other functionally equivalent mand in an appropriate fashion, he or she received praise (e.g., "Thank you for telling me!") and a 1- to 2-min break to play with toys with the parent. After 1 to 2 min, the child was again directed to the work task. If the child did not emit an appropriate mand but was not engaging in destructive behavior, the parent provided a more specific prompt, such as "Say, 'play,'" or "Touch the switch if you want to play," or gave hand-over-hand assistance in touching the switch.

During FCT sessions, destructive behavior during work activities was blocked in a neutral fashion (i.e., did not result in escape). If the child engaged in destructive behavior during break activities, the break was ended and the child was required to return to work. Mild disruptive behavior such as crying or whining was ignored. Parents were asked to practice FCT for 10 to 15 min per day at a time that was convenient and free of interruptions. The investigators provided parents with written instructions on conducting the program,

procedural demonstrations, and prescriptive feedback during FCT sessions. No observations of the parents conducting the treatment at home were obtained and thus their treatment integrity is not known.

*Repeated extinction.* Extinction in the absence of FCT was repeated two to four times during the course of intervention at mean intervals of approximately two months (8 children), six months (8 children), ten months (5 children), and sixteen months (2 children) from the beginning of FCT. Extinction conditions lasted two to four sessions (mean number of sessions = 3). Extinction conditions were repeated (a) to demonstrate the experimental control of the treatment procedures and (b) to evaluate the persistence of destructive behavior and appropriate behavior when compliance and manding no longer produced breaks from the task. We conducted multiple replications of extinction over the long-term course of FCT to determine if destructive behavior continued to occur or if the effects of treatment persisted despite being challenged via brief periods of extinction. Reductions in destructive behavior and increases in appropriate behavior (task completion) relative to the initial extinction baseline were the criteria established for initiating the remaining behavioral challenges.

*Phase 4: Treatment challenges.* The treatment challenge conditions were conducted following a substantial decrease in destructive behavior and an improvement in task completion during two to three sequential extinction condition sessions. For some children, this improvement occurred after a relatively short time (e.g., 4 months), whereas others took considerably longer to meet these criteria (e.g., up to 16 months). For children who met the criteria early in treatment, we continued to conduct FCT probes, extinction conditions, and additional treatment challenge conditions until their participation in the study was concluded.

The purpose of the treatment challenges was to evaluate the occurrence of destructive behavior and appropriate behavior when distinct components of the FCT program were manipulated. Treatment challenges were conducted over the course of two to three weekly visits. For 6 of the 8 children, an extended extinction (EE) test was conducted first and the order of the other challenge

conditions was counterbalanced across children. For the remaining 2 children, the order of all challenge conditions was counterbalanced.

The *EE* challenge was presented to evaluate whether increasing the amount of work time under extinction conditions resulted in increased levels of destructive behavior and decreased levels of appropriate behavior. During a preceding extinction condition in Phase 3, the investigators determined that each child had emitted steady-state responding relative to both destructive behavior and task completion. In this challenge, the extinction condition was conducted for 15 min instead of for 5 min with a correlated increase in the amount of work to be completed (e.g., 24 task requests instead of 8 task requests). All other procedures were the same as during the initial extinction condition.

The *novel task* challenge required the child to complete a second task that had been assessed during the initial extinction condition and was shown to be associated with destructive behavior but was not included as a training task during FCT. The purpose of this challenge was to evaluate whether changes in child behavior occurred with the introduction of a task that had not acquired a treatment history with the FCT program. The children were presented with initial extinction condition task levels (e.g., eight tasks) rather than the reduced task requirements that were implemented at the beginning of FCT. All other procedures of the FCT program (e.g., sequence of task prompts, manding, reinforcement schedule) remained the same as during Phase 3.

During the *no-switch* challenge, the microswitch with attached word card was not present during FCT sessions. The purpose of this challenge was to evaluate if other mands (e.g., vocal or manual sign) and compliance persisted and if destructive behavior recurred in the absence of the microswitch with the attached word card. Parents continued to deliver a general mand prompt (e.g., "What do you want to do?") following independent task completion. Reinforcement was delivered if the child emitted the vocal mand "play" or other functionally equivalent mand such as vocally requesting a specific item ("want book") or pointing to a specific toy. All other FCT procedures remained the same.

In the *competing reinforcement schedule* challenge, the same reinforcement contingencies were made available for either manding or engaging in destructive behavior (FR 1 FR 1 schedule) following the presentation of the work task. Thus, in this condition, both manding and destructive behavior resulted in the same 1- to 2-min break with parent attention and preferred toys. All other FCT procedures remained the same.

## RESULTS

### *Case Examples*

*Tina.* The results of Tina's functional analysis are shown in the top panel of Figure 1. Destructive behavior averaged 25.33% (range = 12% to 32%) during the demand condition, 25% (range = 14% to 36%) during the tangible condition, 4% (range = 0% to 8%) during the attention condition, and 2.66% (0% to 4%) during the free-play condition. Thus, destructive behavior appeared to be maintained by both negative and tangible reinforcement.

The results of Tina's extinction and FCT analyses are shown in Figure 2. The top panel shows the percentage of intervals of destructive behavior. During the three target task initial extinction sessions, destructive behavior averaged 28.66% (range = 12% to 42%) and showed an increasing trend. These results showed that destructive behavior continued to occur under brief periods of extinction. A probe of a novel task (picking up blocks) showed destructive behavior at 32%. During the initial FCT (2) condition, destructive behavior decreased to 0%. A return to extinction was conducted during Sessions 20 and 21, and destructive behavior averaged 16% (range = 12% to 20%). A return to FCT (2) showed a decrease in destructive behavior, and Tina's task demands were increased to four task requests per session during Session 26. During FCT (4), destructive behavior decreased to 0%. A third extinction probe was conducted during Sessions 37 and 38, and destructive behavior averaged 21% (range = 10% to 32%), again showing that destructive behavior recurred during brief periods of extinction. A return to FCT (4) showed a decrease in destructive behavior. Task demands were increased to eight task requests per session (FCT [8]) during Session 42, in

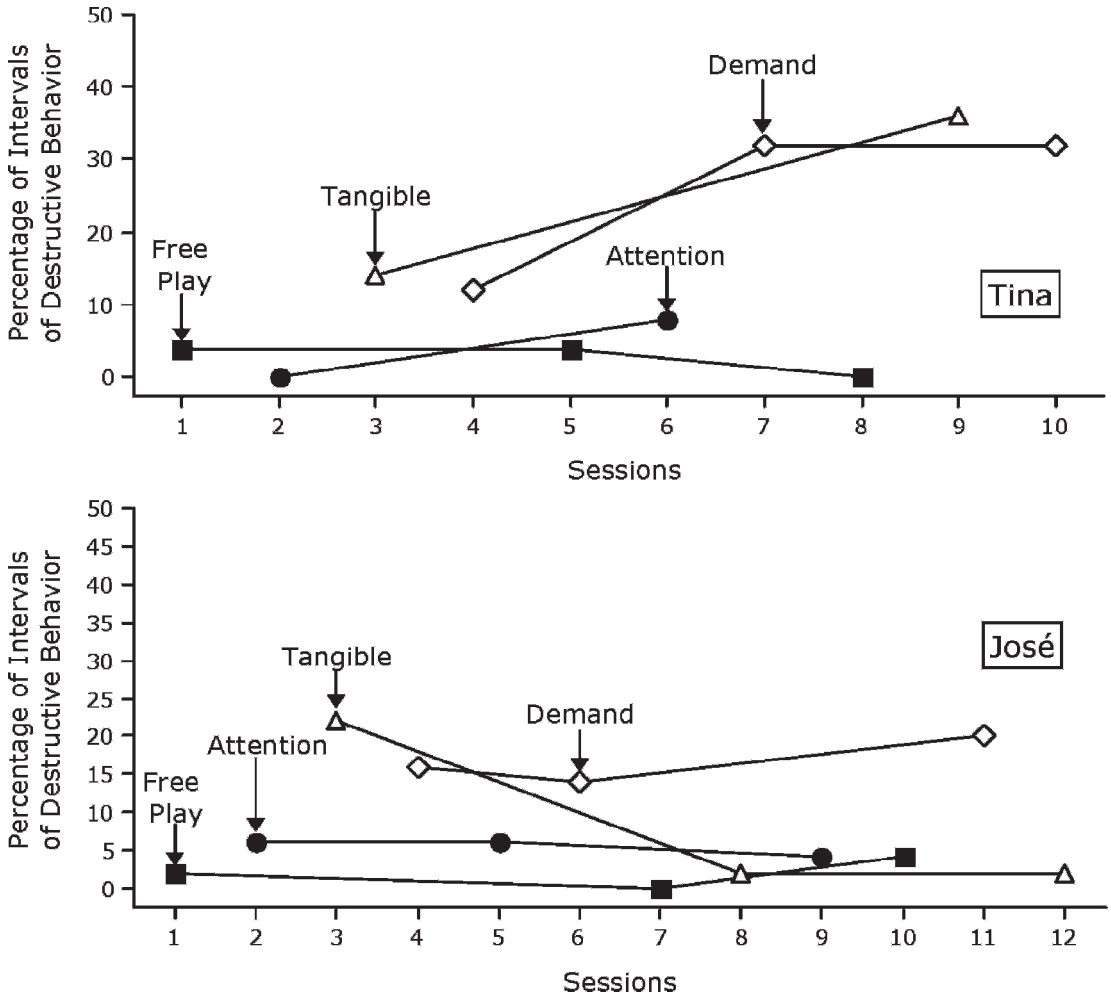


Fig. 1. Percentage of intervals of destructive behavior during functional analysis for Tina (top panel) and José (bottom panel). Tina's and José's functional analysis results were published in Schieltz, K. M. et al. (2010). Tina's functional analysis results were also published as a bar graph in Wacker et al. (2009).

which destructive behavior remained at 0%. A fourth extinction probe was conducted during Sessions 48 through 51 and showed a decrease in destructive behavior to 0%. The final FCT (8) sessions were conducted during three monthly probes, and destructive behavior was at 0% across all three sessions.

The middle panel of Figure 2 shows the percentage of intervals of Tina's independent target manding and other manding. Tina displayed 0% of target manding during the target work task and novel task extinction sessions. Other manding was also at 0% during the initial extinction condition and remained at 0% across all subsequent baseline and FCT

sessions. During the initial FCT (2), target manding increased and remained stable. A return to extinction was conducted during Sessions 20 and 21. Target manding was at 6% during the first extinction session. However, this manding occurred because of an error in condition implementation; the microswitch was not removed from the room and Tina touched the microswitch several times. The microswitch was not present during the second session, and target manding decreased to 0%. A return to FCT (2) and a subsequent increase to FCT (4) showed relatively stable target manding with the exception of Session 31. A third extinction probe was conducted during



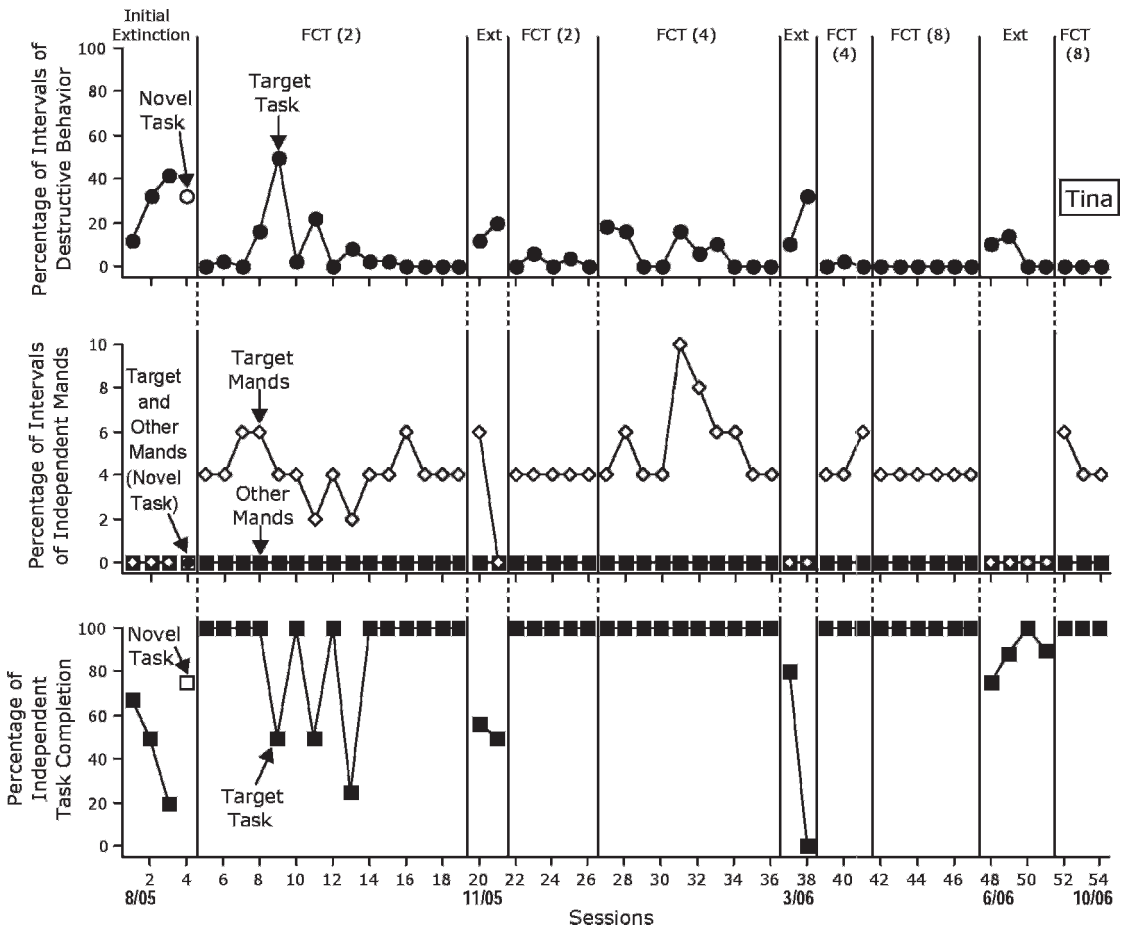


Fig. 2. Percentage of intervals of destructive behavior (top panel), percentage of intervals of independent target manding and other manding (middle panel), and percentage of independent task completion (bottom panel) during FCT for Tina. FCT = functional communication training. Ext = extinction. Tina's FCT results were also published as a bar graph in Wacker et al. (2009).

Sessions 37 and 38, and target manding decreased to 0%. A return to FCT (4) and an increase in task demands to FCT (8) showed stable levels of target manding. A fourth extinction probe was conducted during Sessions 48 through 51, and target manding again decreased to 0%. Target manding was stable during the final three FCT (8) monthly probes. Overall, manding failed to persist through the extinction probes.

The bottom panel of Figure 2 shows the percentage of Tina's independent task completion. During the initial extinction condition, task completion averaged 45.66% (range = 20% to 67%) and showed a decreasing trend during the target work task. Thus, task completion failed to persist during brief

periods of extinction. Task completion during the novel work task was 75%. During the initial FCT (2), task completion increased to 100% with the exception of Sessions 9, 11, and 13, which were correlated with increases in destructive behavior. During the first return to extinction, task completion decreased to 50%. The return to FCT (2) and subsequent increase to FCT (4) showed that task completion remained stable at 100%. Task completion decreased to 0% ( $M = 39%$ , range = 0% to 78%) during the third extinction probe, again showing a lack of persistence during brief periods of extinction. A return to FCT (4) and subsequent increase to FCT (8) again showed task completion at 100%. During the fourth extinction probe, task completion

showed a relatively modest decrease ( $M = 85.75\%$ , range = 75% to 100%). Thus, task completion persisted during extinction. Task completion then increased to 100% during the final three FCT (8) monthly probes.

When the persistence of treatment effects (decreased destructive behavior and increased task completion) was obtained, the treatment challenges were conducted. The results of Tina's treatment challenges conducted after 11 months of treatment are displayed in Figure 3. The top panel shows the percentage of intervals of destructive behavior during the EE, no-switch, competing reinforcement, and novel task challenge conditions. Destructive behavior averaged 1.99% (range = 0.66 to 3.33%) during the EE challenge, 0.8% during the no-switch challenge, 2% during the competing reinforcement challenge probe, and 2% during the novel task challenge probe (as compared to 32% during the initial extinction condition). Therefore, the persistence of treatment effects was evident for destructive behavior.

The middle panel shows the percentage of intervals of Tina's independent target manding and other manding. During the EE challenge, target manding averaged 0% and other manding was at 2.33%. Target manding averaged 1.2% (range = 0% to 4%) and other manding averaged 6% (4% to 12%) during the no-switch condition. During both the competing reinforcement and novel task challenges, target manding was at 4% and other manding was at 0%. These levels of manding showed that persistence occurred as the percent occurrence across conditions was similar to what was observed during FCT.

The bottom panel shows the percentage of Tina's independent task completion. During the EE challenge, task completion averaged 92% (range = 90% to 94%). Task completion was at 100% during the no-switch challenge. During the competing reinforcement and novel task challenges, task completion was at 66% and 100%, respectively. These results show modest (competing reinforcement challenge) to high levels of persistence. Overall, the persistence of appropriate behavior and reduced levels of destructive behavior during the treatment challenges indicate that long-term FCT produced durable effects.

*José.* The results of José's functional analysis are shown in the bottom panel of Figure 1.

Destructive behavior averaged 16.66% (range = 14% to 20%) during the demand condition, 8.66% (range = 2% to 22%) during the tangible condition, 5.33% (range = 4% to 6%) during the attention condition, and 2% (range = 0% to 4%) during the free-play condition. Although José displayed relatively high mean levels of destructive behavior during the tangible condition, most of his destructive behavior occurred during the first tangible condition session (22%), and destructive behavior decreased to 2% during each of the subsequent sessions. Thus, José's destructive behavior appeared to be maintained by negative reinforcement.

The results of José's extinction and FCT conditions are shown in Figure 4. The top panel shows the percentage of intervals of destructive behavior. During the three target task extinction sessions, destructive behavior averaged 32% (range = 26% to 42%). During the novel task extinction probe, destructive behavior was 46%. During the initial FCT (2) condition, destructive behavior decreased to 0%. A return to extinction was conducted during Sessions 21 through 23 and showed 0% destructive behavior. A return to FCT (2) showed continued zero to near-zero percentages of destructive behavior. José's task demands were increased to eight task requests per session (FCT [8]) during Session 28. Destructive behavior remained at 0% during FCT (8) with the exception of Session 29. A third extinction probe was conducted during Sessions 36 through 38, and destructive behavior remained at 0%. During the final return to FCT (8), destructive behavior remained at low levels. Sessions 42 through 46 were conducted at approximately one-month to three-month intervals.

The middle panel of Figure 4 shows the percentage of intervals of independent target manding and other manding. José displayed 0% other manding across all FCT and extinction sessions. José displayed 0% target manding during the target work task and novel work task during the initial extinction sessions. During the initial FCT (2) condition, target manding increased immediately and remained stable at 4% to 6% across sessions. A return to extinction was conducted during Sessions 21 through 23, and target manding decreased to 0% during these three sessions. During the return to FCT (2) and subsequent increase to

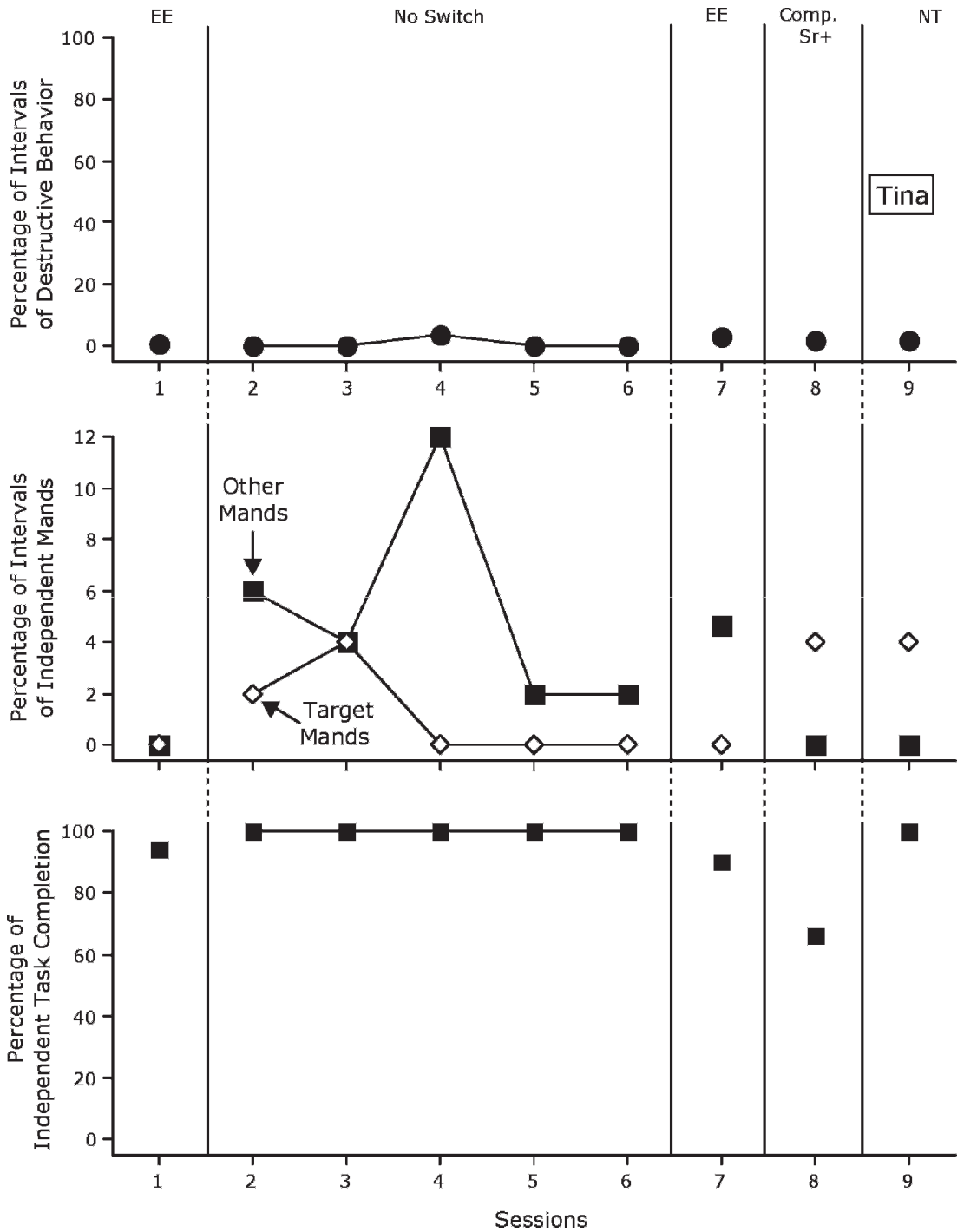


Fig. 3. Percentage of intervals of destructive behavior (top panel), percentage of intervals of independent target manding and other manding (middle panel), and percentage of independent task completion (bottom panel) during treatment challenge conditions for Tina. EE = extended extinction; Comp. Sr+ = Competing reinforcement; NT = novel task.

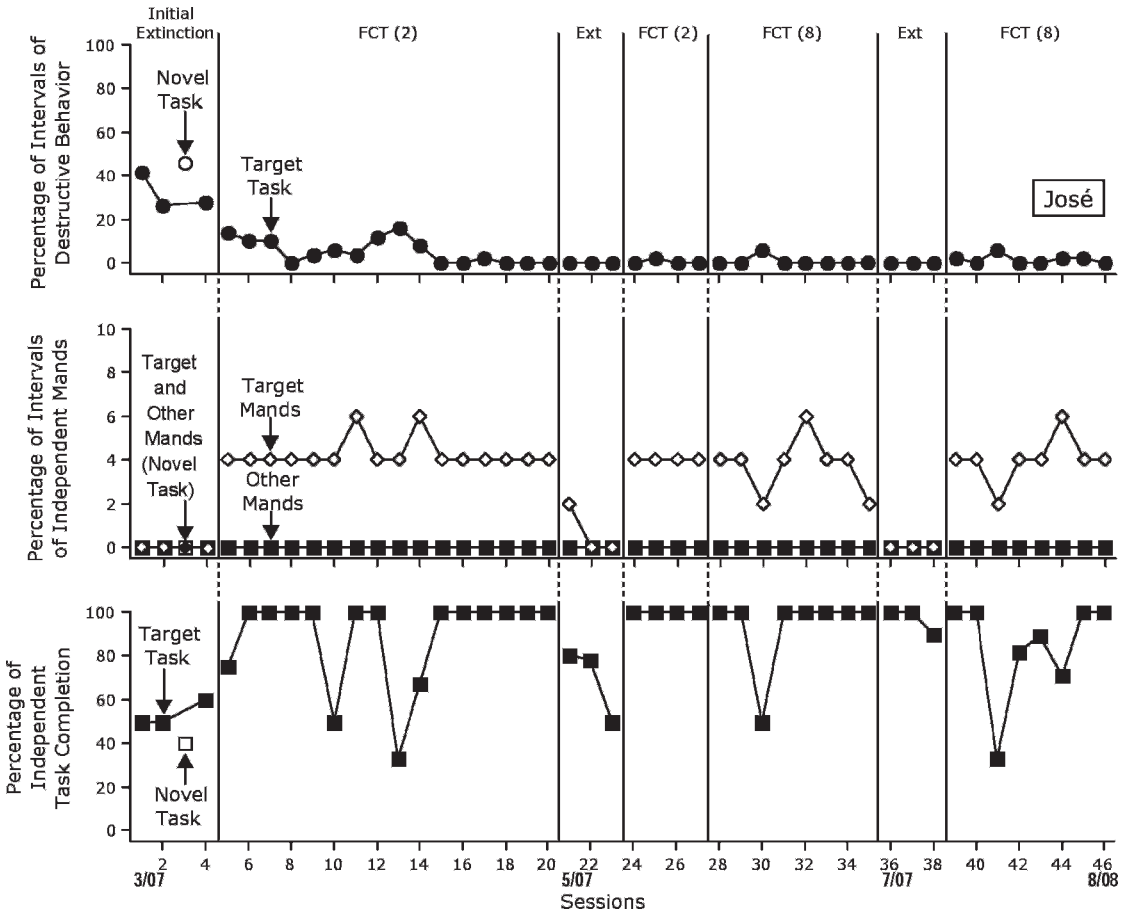


Fig. 4. Percentage of intervals of destructive behavior (top panel), percentage of intervals of independent target manding and other manding (middle panel), and percentage of independent task completion (bottom panel) during FCT for José. FCT = functional communication training. Ext = extinction.

FCT (8), target manding again increased and was relatively stable at 2% to 6% across sessions. During the third extinction probe, target manding again decreased to 0%. During the final return to FCT (8), target manding remained relatively stable at 2% to 6% across sessions.

The bottom panel of Figure 4 shows the percentage of José’s independent task completion. During the initial extinction probe, task completion averaged 53.33% (range = 50% to 60%). During the initial FCT (2) condition, task completion increased and was at 100% with the exception of Sessions 5, 10, 13, and 14. During the first return to extinction, task completion showed a decreasing trend and averaged 69.33% (range = 50% to 80%). Thus, task completion did not persist

during brief periods of extinction. During the return to FCT (2) and subsequent increase to FCT (8), task completion remained at 100% with the exception of Session 30 (50%). During the third extinction probe, task completion was 90% or higher across all three sessions, showing that it now persisted during extinction. During the final return to FCT (8), José displayed some variability in task completion, but all sessions were higher than during the initial extinction condition with the exception of Session 41 (33%).

The results of José’s treatment challenges are displayed in Figure 5. The top panel shows the percentage of intervals of destructive behavior during the EE, novel task, competing reinforcement, and no-switch conditions. During the first treatment challenge (left panel),

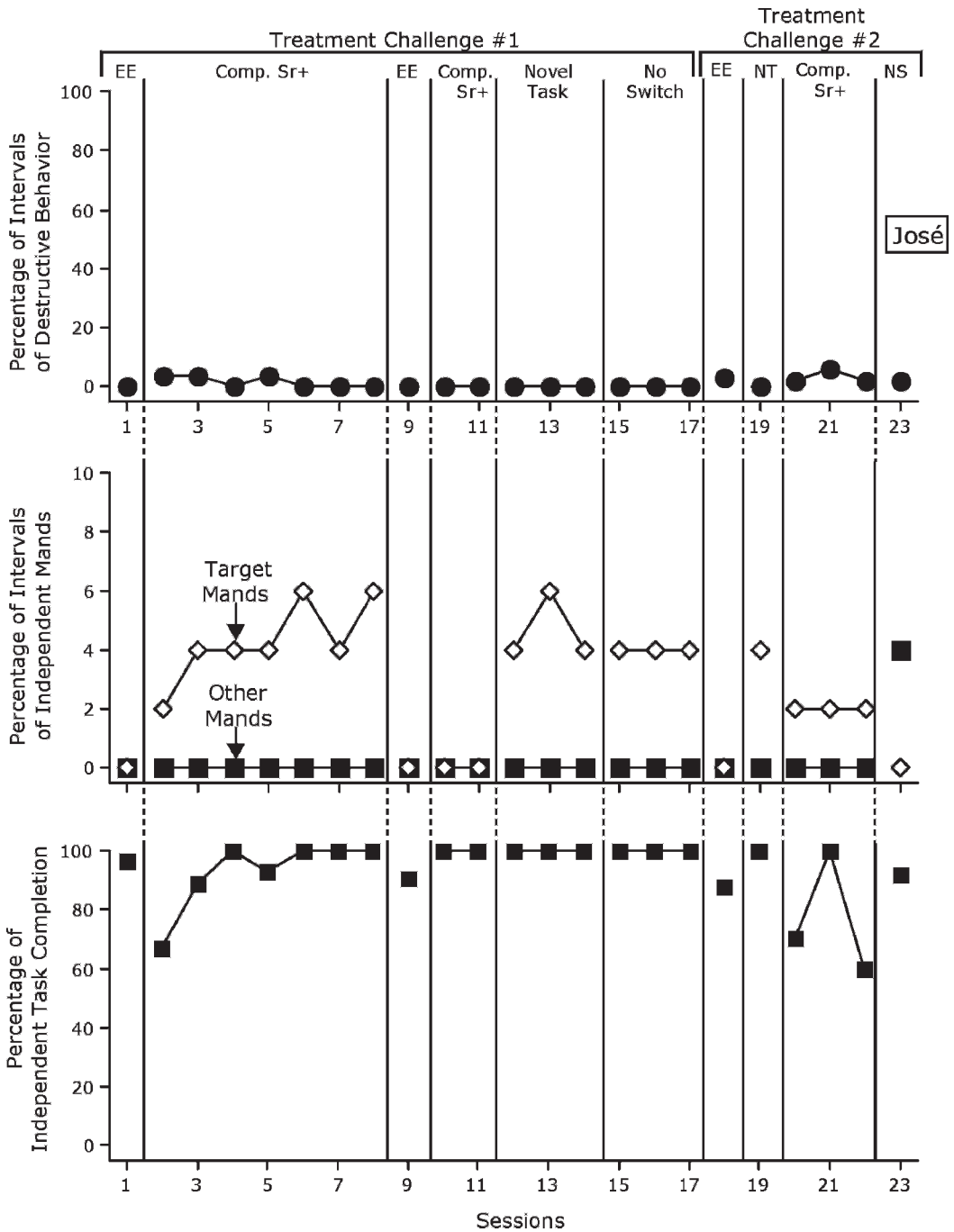


Fig. 5. Percentage of intervals of destructive behavior (top panel), percentage of intervals of independent target manding and other manding (middle panel), and percentage of independent task completion (bottom panel) during treatment challenge conditions for José. EE = extended extinction; Comp. Sr+ = Competing reinforcement; NS = no switch.

destructive behavior was at 0% during the EE challenge. Destructive behavior averaged 1.33% (range = 0% to 4%) during the competing reinforcement challenge, and 0% during the novel task challenge and the no-switch challenge.

The middle (left) panel of Figure 5 shows the percentage of intervals of José's independent target manding and other manding. During the EE challenge, José displayed 0% target manding. During the competing reinforcement challenge, target manding averaged 3% (range = 0% to 6%). During the novel task challenge, target manding averaged 4.66% (range = 4% to 6%). During the no-switch challenge, target manding averaged 4%. Jose displayed 0% other manding during the first challenge conditions.

The bottom (left) panel of Figure 5 shows José's percentage of independent task completion. During the EE challenge, task completion averaged 93.66% (range = 90.66 to 96.66%). Task completion during the competing reinforcement challenge averaged 94.33% (range = 67% to 100%). Task completion averaged 100% during both the novel task and no-switch challenges.

The top (right) panel of Figure 5 shows José's percentage of destructive behavior during the second treatment challenges conducted 5 months after the first treatment challenges. Destructive behavior was at 3.33% during the EE challenge and 0% during the novel task challenge. Destructive behavior averaged 3.33% (range = 2% to 6%) during the competing reinforcement challenge and was at 2% during the no-switch challenge. The middle (right) panel shows the percentage of independent manding. José displayed 0% target or other manding during the EE challenge. During the novel task challenge, target manding was at 4% and other manding was 0%. During the competing reinforcement challenge, target manding averaged 2% and other manding was 0%. During the no-switch challenge, target manding was 0% and other manding was 4%. The bottom (right) panel shows the percentage of independent task completion. Task completion was at 88% during the EE challenge and 100% during the novel task challenge. Task completion averaged 76.66% (range = 60% to 100%) during the competing reinforcement challenge and was at 92% during the no-switch challenge.

Table 2

Mean Percentage of Intervals of Destructive Behavior during Functional Analysis Conditions.

Child	Demand	Attention	Tangible	Free Play
Tina	25.33	4	25	2.66
José	16.66	5.33	8.66	2
Cam	10.66	.66	4.66	3
Kevin	23.33	1.33	11.33	0
Juan	4.66	0	2.66	0
Andy	26.66	5.50	5	3
Bud	2.5	2	18	0
Rose	14	7.33	10.66	1.5

Overall, Tina and José showed substantial decreases in destructive behavior and increases in task completion in comparison to initial extinction condition levels across all challenge conditions. More modest increases occurred for manding. One explanation for these findings is that treatment abolished the reinforcing effects of escaping the tasks. These results suggest that FCT resulted in long-term effects across the target behaviors. For Tina, persistence of treatment effects occurred only after long-term treatment for both destructive behavior and task completion. For José, more rapid effects occurred for destructive behavior than for task completion. These two patterns of effects were representative of those obtained for all 8 participants. It is unclear why these two patterns of responding occurred. As mentioned previously, integrity data were not collected when the investigators were not present, and so it is possible that these different patterns were related to the degree of treatment integrity during intervention conducted by the parents. The patterns also may be correlated with the reinforcement history of each participant.

### Summary of Results

The results of the functional analyses for all children are summarized in Table 2. All children showed a higher mean percentage of destructive behavior during the negative reinforcement (demand) test condition than during the free-play (control) condition. For 7 of the 8 children, the highest mean percentage of destructive behavior occurred during the negative reinforcement condition. Thus, all children appeared to display destructive behavior that was maintained at least in part by negative reinforcement. These results

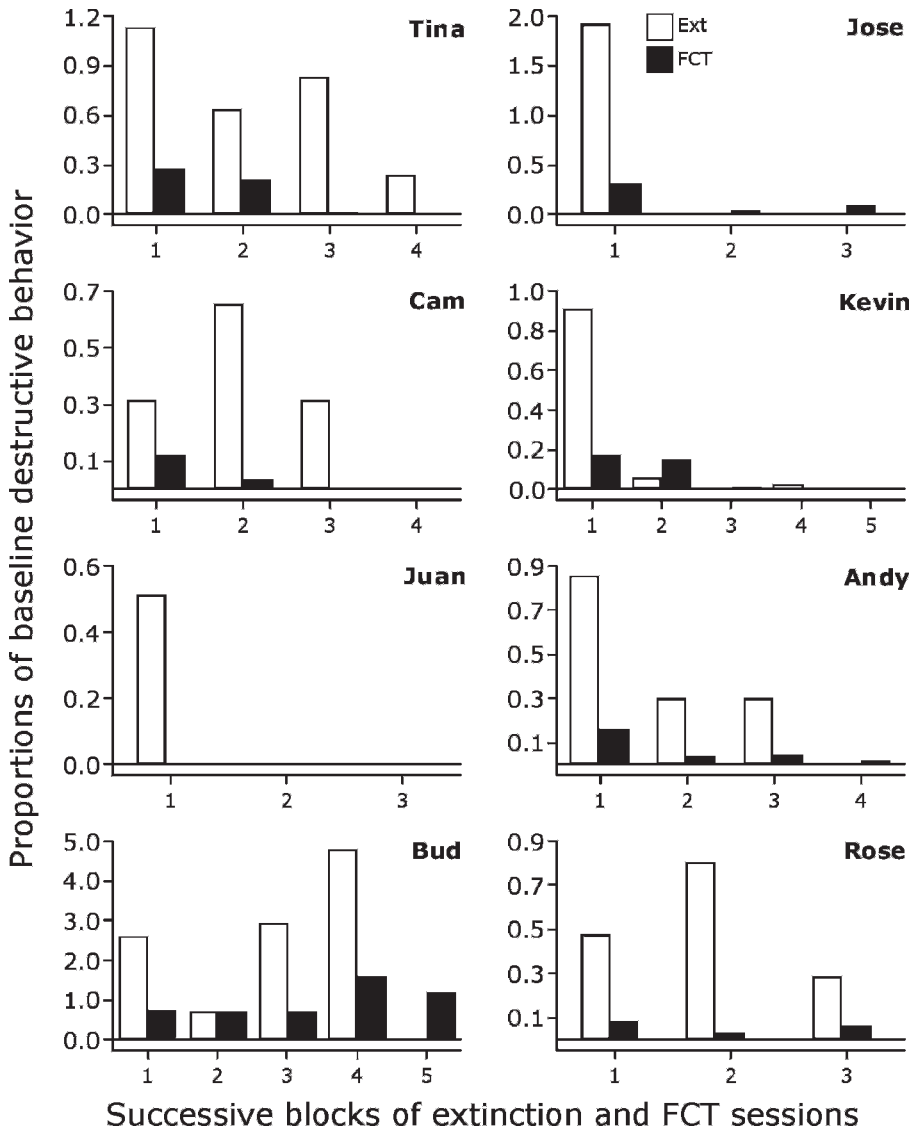


Fig. 6. Individual data for destructive behavior of all children, expressed as proportions of the functional analysis baseline, during successive blocks of FCT sessions (black bars) and extinction sessions (white bars). Note that y-axis scales vary across children.

were substantiated using the criteria proposed by Hagopian et al. (1997).

The percentages of destructive behavior during extinction and FCT sessions are summarized for all 8 participants in Figure 6. Each panel presents the average percentage for each successive block of extinction or FCT sessions expressed as a proportion of the percentage of destructive behavior during the functional analysis demand sessions. During the initial extinction condition, proportions of

baseline ranged from 2.60 (Bud) to 0.31 (Cam). Averaged over all 8 children, the value was 1.09; thus, on average, destructive behavior persisted unchanged during the initial extinction condition.

Figure 6 also shows that proportions of baseline were lower during the final extinction test for all participants, reaching zero for Tina and Rose; however, the trend was irregular across successive tests for some children. Finally, Figure 6 shows that the proportions

Table 3  
 Percentage of Intervals of Destructive Behavior during Treatment Challenge Conditions.

Child	Treatment #1				Treatment #2				Treatment #3				Treatment #4			
	EE	NT	CR	NS	EE	NT	CR	NS	EE	NT	CR	NS	EE	NT	CR	NS
Tina	1.99	2	2	.80												
José	0	0	1.33	0	3.33	0	3.33	2								
Cam	.66	0	0	0	0	0	0	2	0	0	0	0				
Kevin	0	0	0	0												
Juan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Andy	1.33	2	0	2	2	0	0	0								
Bud	0	0	4	4												
Rose	2.66	0	0	0												

EE = Extended extinction condition, NT = Novel task condition, CR = Competing reinforcement condition, NS = No switch condition

of baseline (functional analysis) destructive behavior were usually higher during extinction sessions than during the preceding or following FCT sessions, exemplifying resurgence. Exceptions were Kevin, Block 2; Bud, Block 5; and José, whose destructive behavior did not recur during extinction after the initial exposure to FCT. By inspection, the data for Bud differ substantially from those for the other 7 children in both their levels and their variability (note the y-axis scale). Averaged over the course of treatment, Bud's proportions of baseline during FCT and extinction were 18.2 and 8.4 standard deviation units, respectively, from the means of the other 7 children. Although Bud did not emit destructive behavior during his fifth extinction session, we have omitted his data from further quantitative treatment and modeling.

#### *Persistence During Treatment Challenges*

The percentage of intervals of destructive behavior during all treatment challenge conditions for each child is displayed in Table 3. The first series of challenges was conducted for all children in the investigation. Treatment challenges were repeated twice for 4 children (Cam, Juan, Andy, José), three times for 2 children (Cam, Juan), and a fourth time for 1 child (Juan). The first treatment challenge was conducted between 5 months and 18 months ( $M = 10.25$  months) after FCT was implemented. During the first series of challenges, destructive behavior averaged 0.83% (range = 0% to 2.66%) of intervals during the EE challenge, 0.5% (range = 0% to 2%) during the novel task challenge, 0.91% (range = 0% to 4%) during the competing reinforcement

challenge, and 0.85% (range = 0% to 4%) during the no-switch challenge. The second treatment challenge was conducted between 2 months and 7 months ( $M = 3.25$  months) after the first challenge. During the second series of challenges ( $n = 4$ ), destructive behavior averaged 1.33% (range = 0% to 3.33%) of intervals during the EE challenge, 0% during the novel task challenge, .83% (0% to 3.33%) during the competing reinforcement challenge, and 1.00% (0% to 2%) during the no-switch challenge. The third challenge was conducted between 2 months and 3 months ( $M = 2.50$  months) after the second challenge. The fourth challenge was conducted 4 months after the third challenge for 1 child. During the third ( $n = 2$ ) and fourth ( $n = 1$ ) series of challenges, destructive behavior was 0% across all challenge conditions.

In summary, the overall results of the challenges demonstrated that all children displayed reduced levels of destructive behavior during each of the challenge conditions in comparison to the mean levels of destructive behavior ( $M = 15.45\%$ ) displayed during the initial extinction condition. This reduction was evident across individual children and collectively as a group. Furthermore, this reduction in destructive behavior from the initial extinction levels continued to be displayed during repetitions of the challenge conditions over an extended period of time.

A summary of the results of all of the children's initial extinction probes, final three FCT probes, final extinction probes, and final challenge condition outcomes are displayed in Figure 7. The top panel shows the mean percentage of intervals of destructive behavior



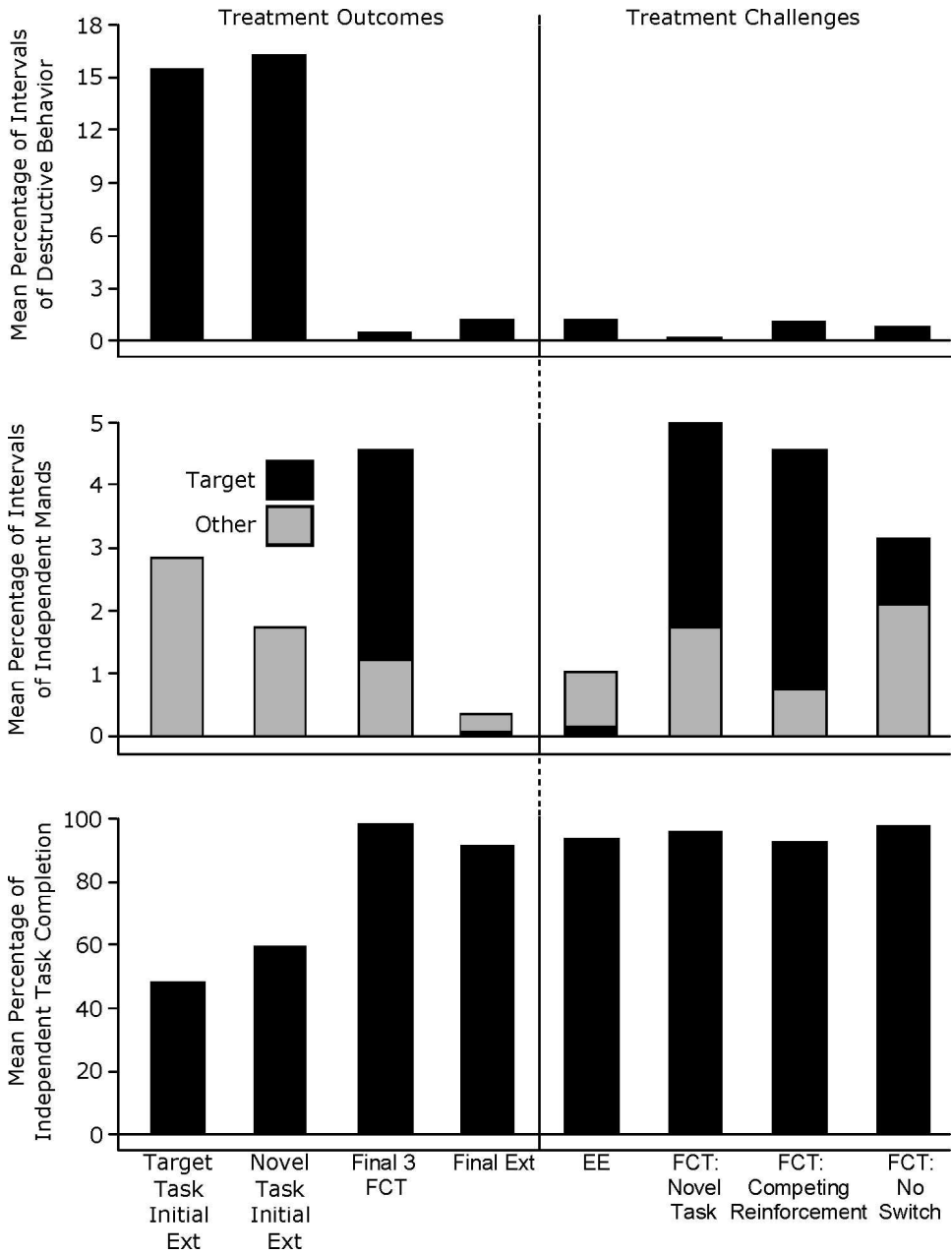


Fig. 7. Percentage of intervals of destructive behavior (top panel), percentage of intervals of independent target manding and other manding (middle panel), and percentage of independent task completion (bottom panel) during initial extinction, final three treatment probes, and treatment challenge conditions for all participants. FCT = functional communication training; EE = extended extinction; Ext = extinction.

across conditions. Destructive behavior averaged 15.45% (range = 2.4% to 32%) across participants during the initial (target task) extinction condition. Destructive behavior averaged 16.25% (range = 0% to 46%) during

the initial novel task extinction condition. The average percentage of destructive behavior during the final three FCT sessions for each participant was 0.58% (range = 0% to 2.66%). During the final extinction condition for each

participant, destructive behavior averaged 1.25% (range = 0% to 6%).

During the EE challenge, destructive behavior averaged 1.24% (range = 0% to 3.33%). Destructive behavior averaged 0.25% (range = 0% to 2%) during the novel task challenge (compared to an average of 16.25% during the initial novel task extinction condition), 1.16% (range = 0% to 4%) during the competing reinforcement challenge, and 0.85% (range = 0% to 4%) during the no-switch challenge. These combined results showed that destructive behavior rarely recurred when treatment was challenged.

The middle panel of Figure 7 shows the mean percentage of intervals of target manding ("play") and other manding ("No," "all done") across conditions. Target manding was 0% and other manding averaged 2.85% (range = 0% to 22%) during the initial target task extinction sessions across participants. Target manding occurred in 0% of the intervals and other manding occurred in 1.75% of the intervals for the novel task. The average percentage of target manding during the final three FCT sessions was 4.57% (range = 2.66% to 6%) and other manding averaged 1.24% (range = 0% to 6%). During the final extinction condition, target manding averaged 0.08% (range = 0% to .66%) and other manding averaged 0.37% (range = 0% to 2%).

During the EE challenge, target manding averaged 0.16% (range = 0% to .66%) and other manding averaged 1.04% (range = 0% to 4%). During the novel task challenge, target manding averaged 5% (range = 4% to 8%) and other manding averaged 1.75% (range = 0% to 8%) compared to an average of 0% for target manding and 1.75% for other manding during the initial novel extinction condition. During the competing reinforcement challenge, target manding averaged 4.58% (range = 2% to 8%) and other manding averaged 0.75% (range = 0% to 6%). During the no-switch challenge, target manding averaged 3.15% (range = 0% to 8%) and other manding averaged 2.12% (range = 0% to 6%). These results show that modest levels of persistence occurred for manding for most children.

The bottom panel of Figure 7 shows the mean percentage of independent task completion across conditions. Independent target task completion averaged 48.67% (range =

4.66% to 100%) during the initial extinction sessions across participants. During the final three FCT sessions, task completion averaged 98.29% (range = 90.33% to 100%). During the final extinction condition, task completion averaged 91.67% (range = 75% to 100%).

During the EE challenge, task completion averaged 94.12% (range = 71% to 100%). Task completion averaged 96.37% (range = 71% to 100%) during the novel task challenge (compared to an average of 59.87% during the initial novel task condition), 92.83% (range = 66% to 100%) during the competing reinforcement challenge, and 97.62% (range = 89% to 100%) during the no-switch challenge. These results showed that persistence occurred for task completion.

Overall, the persistence of treatment effects across target behaviors suggested that FCT produced good long-term effects for this group of children. The persistence of appropriate behavior and decrease in destructive behavior remained relatively stable across the challenges, suggesting that durable treatment effects might occur in the future.

#### *Quantitative Analysis of Extinction and Resurgence of Destructive Behavior*

According to behavioral momentum theory, the basic equation for the persistence of reinforced behavior during challenge or disruption is

$$\log\left(\frac{B_x}{B_o}\right) = \frac{-x}{r^{0.5}} \quad (1)$$

where  $B_o$  represents baseline responding,  $B_x$  represents responding during disruption,  $x$  represents the value of a current disruptor, and  $r$  represents the rate of reinforcement obtained within the discriminative-stimulus context. The sign of  $x$  is negative to indicate that disruptors decrease response rate. Equation 1 states that decreases in behavior relative to baseline are larger with higher values of  $x$ , but such decreases are counteracted by higher values of  $r$ . The rate of reinforcement (i.e.,  $r$ ) is raised to the power 0.5 on the basis of estimates from basic research summarized by Nevin (2002). In other words, the greater the rate of reinforcement in the stimulus context during baseline, the smaller the impact of a given disruptor. This prediction has been confirmed repeatedly (for review and quanti-

tative development see Nevin, 1992; Nevin & Grace, 2000). To bring Equation 2 to bear on simple proportions rather than log proportions of baseline, Equation 1 must be exponentiated:

$$\frac{B_x}{B_0} = e^{(-x/r^{0.5})} \quad (2)$$

where  $e$  is the base of natural logarithms.

During extinction, the disruptor  $x$  has three components. First, when extinction begins, the operant response–reinforcer contingency is suspended. Second, reinforcers—construed as stimuli that accompany responding during baseline—are omitted, thus altering the stimulus context. Third, time passes, and the effects of these disruptors are assumed to increase with the passage of time (see Nevin, McLean, & Grace, 2001, for rationale). Thus, we replace  $x$  in Equation 2 with the term  $-t(c+dr)$ , where  $t$  represents time in extinction,  $c$  represents the disruptive effect of suspending the contingency, and  $d$  represents the discriminability or salience of omitting  $r$  reinforcers per unit time.

Shahan and Sweeney (2011) extended behavioral momentum theory to account for resurgence of extinguished behavior after discontinuing reinforcement for alternative behavior. They assumed that reinforcers for alternative behavior serve simultaneously to disrupt target behavior and to increase the future strength of target behavior because such reinforcers occur within the same stimulus context; both assumptions are supported by a number of studies reviewed in their article. With the addition of these factors, Equation 2 becomes:

$$\frac{B_t}{B_0} = e^{\left(\frac{-t(c+dr+pr_{alt})}{(r+r_{alt})^{0.5}}\right)} \quad (3)$$

where  $B_t$  is responding at time  $t$  and  $r_{alt}$  represents the rate of reinforcement for alternative behavior. In the denominator, the inclusion of  $r_{alt}$  reflects the contribution of alternative reinforcement to the overall level of reinforcement in the context in which target behavior occurs. In the numerator,  $pr_{alt}$  reflects the added disruptive effect of alternative reinforcement on the target behavior, scaled by the parameter  $p$ . Equation 3 predicts

resurgence when alternative reinforcement is removed from the situation because of the reduction in disruption associated with the removal of  $pr_{alt}$  from the numerator (see Shahan & Sweeney, 2011, for discussion).

We fitted Equation 3 to the data of all children except Bud, for reasons noted above. For each child, the value of  $t$  for each successive block of FCT sessions was the number of sessions per block divided by 2 (because responding was averaged over the block) summed over successive blocks, plus the number of extinction sessions preceding each block of FCT sessions. The value of  $t$  for each successive extinction condition was the sum of all preceding FCT and extinction sessions plus 3 for the current test; the value of  $p$  was set at 0 during extinction because no alternative reinforcers were presented. The values of  $r$  and  $r_{alt}$  were taken from tabulations of raw data for each child. The values of parameters  $c$ ,  $d$ , and  $p$  (during FCT) were estimated from the individual data of the 7 children for each block of FCT and extinction sessions—a total of 52 separate observations—by nonlinear estimation using Microsoft Excel Solver. The estimated values were  $c = 0.3$ ,  $d = 0.01$ , and  $p = 0.016$ , accounting for 43% of the data variance. The quality of the fit to data averaged across the 7 children is shown in Figure 8. We conclude that Equation 3 gives a satisfactory account of the effects of extended FCT training on the decrease in resurgence of destructive behavior over successive extinction sessions and on the progressive elimination of destructive behavior during FCT sessions.

#### *Treatment Acceptability*

At the end of the study, all 8 parents who participated in the investigation completed the *TARF-R* (Reimers & Wacker, 1988). This survey asked respondents to answer questions regarding treatment acceptability, effectiveness, and negative side effects (complete results are available from the first author by request). With respect to the question, “How acceptable do you find the treatment to be regarding your concerns about your child?” parents could rate the treatment on a Likert scale of (1) *Not at all acceptable* to (7) *Very acceptable*. The average rating on treatment acceptability was 6.62 (range = 5 to 7). With regard to “How effective is this treatment likely to be for your child?” parents could rate

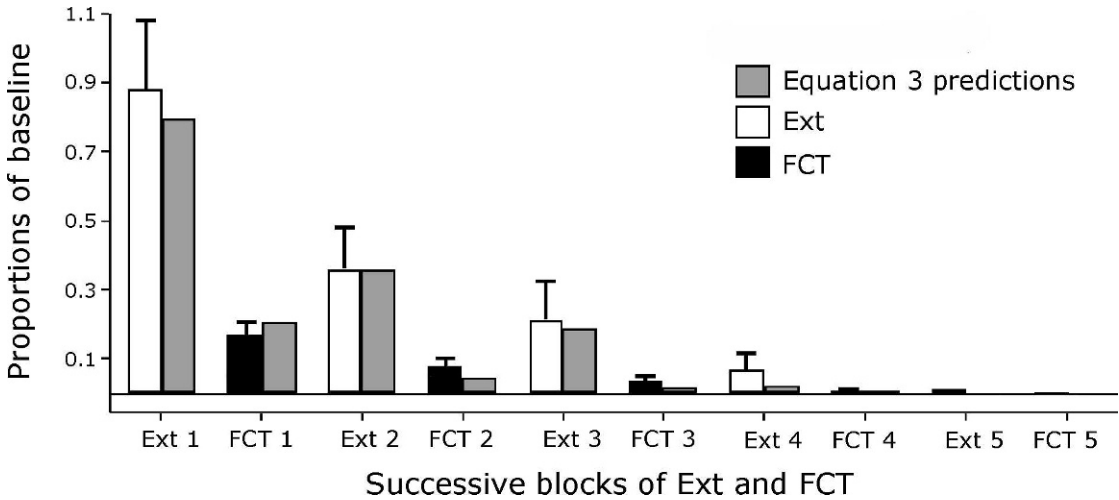


Fig. 8. Proportions of baseline destructive behavior averaged over 7 children during successive blocks of FCT sessions (black bars) and during successive extinction sessions (white bars). Error bars represent standard errors. The predictions of Equation 3 appear as grey bars; see text for explanation of equation fitting and parameter values.

the treatment from (1) *Not at all effective* to (7) *Very effective*. The average rating on treatment effectiveness was 6.62 (range = 5 to 7). Overall, parents viewed the intervention as being an acceptable treatment approach and effective for their child.

## DISCUSSION

As discussed by Nevin and Wacker (in press), maintenance in applied studies is most often defined as steady-state responding under stable treatment conditions (e.g., Stokes & Baer, 1977). Relative to FCT, several researchers (e.g., Derby et al., 1997) showed that long-term reductions in destructive behavior and improvements in adaptive behavior were possible with continued application of the FCT treatment package. These studies thus documented the direct effects of treatment and specifically showed that these direct effects can be continued over time. These were important findings for the development of FCT treatments because they showed that FCT could be effectively applied across a variety of settings, behaviors, and subgroups (e.g. Tiger et al., 2008).

Studies showing the long-term direct effects of FCT provide a necessary but not sufficient analysis of maintenance. In applied situations, the antecedent and consequent stimuli present during treatment change over time. In order to achieve durable treatment effects, we

need to analyze how treatment conditions facilitate or inhibit persistence during challenges to treatment.

One way to document persistence is to conduct analyses of generalized treatment effects (e.g., Berg et al., 2007; Durand & Carr, 1991). For example, Berg et al. showed that long-term FCT treatment could promote generalized treatment effects across settings, care providers, and tasks. These studies have substantial applied value and can also be used to identify limitations in treatment.

A second method, based on behavioral momentum (Nevin, 1992; Nevin & Grace, 2000), is to analyze resistance to change within functional contexts. Of the challenges to treatment reported in the basic literature, the most common has been extinction (Mace et al., 2009), and thus we first conducted brief extinction probes to test behavioral persistence in Phase 3. The results of this analysis showed that treatment effects often persisted only after an extended period of time in treatment. Treatment was considered to be successful only after persistence had been achieved, meaning that treatment had to be continued for much longer than in most previous demonstrations of the effectiveness of FCT. Thus, one applied implication of analyses of persistence is that the continuation of treatment can be based on empirical demonstrations of resistance to change rather than only on steady-state respond-

ing under the prevailing conditions of treatment. This may lead to variations in how treatment is conducted (Mace et al., 2010) or in how we define treatment as being successful. In the current study, success was defined only after appropriate behavior persisted and destructive behavior failed to recur during brief periods of extinction.

Decreases in destructive behavior over the course of extended treatment were well described by Equation 3, which was derived from behavioral momentum theory and augmented by a term for the effects of reinforcement for alternative behavior on destructive behavior. The same equation, with the same parameters, also described the resurgence of destructive behavior when alternative reinforcement was removed and the progressive decrease of resurgence over the course of treatment. Thus, behavioral momentum theory may provide a unifying quantitative model for the persistence of treatment effects.

The current results, and those of Mace et al. (2010), suggest that differential reinforcement of alternative behavior (DRA) treatments may need to be implemented for long periods before they promote desirable resistance to change (Nevin & Wacker, in press). Perhaps alterations to those treatments would produce greater resistance more quickly. Mace et al. (2010) proposed that alternative responses, such as mands, might best be trained in contexts in which there is no reinforcement for destructive behavior to avoid adding reinforcement to the context correlated with reinforcement of problem behavior, thereby avoiding an increase in behavioral mass due to the introduction of DRA.

Following treatment, treatment challenges were conducted not only to determine the overall effectiveness of the treatment but also to analyze variables that may be functionally related to the persistence of the effects achieved during treatment. Changes in durations of extinction, tasks, and reinforcement schedules are all common challenges that occur in applied settings. Changes in responding during some challenges but not during others might lead to extensions and refinements of the treatments.

For example, the no-switch challenge did not disrupt appropriate behavior or result in the return of baseline levels of destructive behavior for Tina. These results suggested that

the use of the switch with attached communication card could be faded for Tina. For both Tina and José, the competing reinforcement challenge appeared to disrupt task completion, suggesting that a fading program might be needed. On an individual basis, the challenge analyses provided an empirical determination of how the treatments might be altered to better produce maintenance. On both an individual and a group basis, these analyses permit inspection of the operant mechanisms that underlie persistence, and as suggested by Nevin and Wacker (in press), may provide an explicit technology of maintenance based on the theory of behavioral momentum.

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