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A COMPARISON OF DENSE-TO-LEAN AND FIXED LEAN SCHEDULES OF ALTERNATIVE REINFORCEMENT AND EXTINCTION

LOUIS P. HAGOPIAN, LISA M. TOOLE, ETHAN S. LONG, LYNN G. BOWMAN, AND GREGORY A. LIEVING

KENNEDY KRIEGER INSTITUTE AND
JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

Behavior-reduction interventions typically employ dense schedules of alternative reinforcement in conjunction with operant extinction for problem behavior. After problem behavior is reduced in the initial treatment stages, schedule thinning is routinely conducted to make the intervention more practical in natural environments. In the current investigation, two methods for thinning alternative reinforcement schedules were compared for 3 clients who exhibited severe problem behavior. In the dense-to-lean (DTL) condition, reinforcement was delivered on relatively dense schedules (using noncontingent reinforcement for 1 participant and functional communication training for 2 participants), followed by systematic schedule thinning to progressively leaner schedules. During the fixed lean (FL) condition, reinforcement was delivered on lean schedules (equivalent to the terminal schedule of the DTL condition). The FL condition produced a quicker attainment of individual treatment goals for 2 of the 3 participants. The results are discussed in terms of the potential utility of using relatively lean schedules at treatment outset.

DESCRIPTORS: extinction, schedule thinning, functional communication training, noncontingent reinforcement, response-prevention hypothesis

Behavior-reduction interventions designed on the basis of functional analysis outcomes usually involve eliminating reinforcement for problem behavior (i.e., extinction) while providing access to that same reinforcer on some alternative reinforcement schedule. For example, functional communication training (FCT) involves providing the maintaining reinforcer contingent on specific communicative behaviors, whereas noncontingent reinforcement (NCR) involves the delivery of the maintaining reinforcer on a time-based schedule, independent of responding (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Typically, treatment is initiated under dense schedules of reinforcement. Ideally, those schedules are subsequently thinned to make the treatment easier to implement and maintain in the natural environment.

A number of methodological variations in how the initial reinforcement schedules used in behavior-reduction interventions such as FCT and NCR are selected and later thinned have been described in the literature (e.g., Hanley, Iwata, & Thompson, 2001; Kahng, Iwata, DeLeon, & Wallace, 2000). These procedures usually involve thinning the reinforcement schedule progressively across multiple sessions until some terminal schedule that is judged to be practical for care providers to implement is reached. In the case of NCR, schedule thinning involves gradually decreasing the amount of time the client has access to the reinforcer, while progressively longer periods of time that the reinforcer is not available are concurrently introduced (Vollmer et al., 1993). Some researchers have thinned NCR schedules based

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Address correspondence to Louis P. Hagopian, Neurobehavioral Unit, Kennedy Krieger Institute, 707 N. Broadway, Baltimore, Maryland 21205 (e-mail: Hagopian@kennedykrieger.org).

on latency to responding and interresponse times (IRT) during previous sessions (e.g., Kahng et al.; Lalli, Casey, & Kates, 1997). With FCT, schedule thinning has involved progressively altering the period in which the client's requests will and will not be reinforced using a multiple-schedule arrangement (e.g., Hanley et al.), introducing gradually longer delays to reinforcement for communication (Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998), or progressively increasing some response requirement as in demand fading (Lalli, Casey, & Kates, 1995). In contrast to NCR, in which schedule thinning is routinely implemented, the majority of published studies on FCT have not included schedule thinning for communication.

Unfortunately, increases in problem behavior are commonly observed in the course of schedule thinning in the context of FCT (Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hagopian et al., 1998; Hanley et al., 2001) and NCR (Hagopian, Fisher, & Legacy, 1994; Lalli et al., 1997; Vollmer et al., 1993; Vollmer, Marcus, & Ringdahl, 1995; Vollmer, Ringdahl, Roane, & Marcus, 1997). In many cases, increases in responding are transient, and the terminal schedule eventually can be attained while low levels of problem behavior are maintained. However, increases in problem behavior during schedule thinning can persist in some cases and require the addition of other treatment components. To address increases in problem behavior during schedule thinning for communication when implementing FCT, researchers have supplemented FCT with alternative activities during delays (Fisher et al.), discriminative stimuli to signal reinforcement and extinction for communication in a multiple-schedule arrangement (Hanley et al.), and punishment for problem behavior (Hagopian et al., 1998). In the case of NCR, Vollmer et al. (1997) shifted from a fixed-time (FT) schedule to a momentary differential reinforcement procedure based on analysis of within-session response patterns that suggested adventitious reinforcement of problem behavior during schedule thinning. These studies demonstrate that there are ways to overcome increases in problem behavior associated with schedule thinning during FCT and NCR; however, the addition of other treatment components may make those interventions more labor intensive.

Given the importance of establishing schedules of reinforcement that are practical to implement in the natural environment, it is surprising that little research has formally examined schedule thinning during FCT and NCR (Kahng et al., 2000; Lalli et al., 1997). Lalli and colleagues based the initial FT schedule on the mean latency to the first response during baseline sessions, and thereafter implemented schedule thinning by increasing the FT intervals by 30, 60, or 90 s. Although increases in responding during schedule thinning were observed in all cases, all schedule-thinning variations produced an effective outcome (attainment of the terminal schedule with low levels of problem behavior). Kahng et al. described a schedule-thinning procedure for NCR that involved arranging the schedule based on the mean IRT for the previous three sessions. Relative to a more traditional schedule-thinning procedure that involved increasing the FT intervals progressively, the adjusting IRT procedure resulted in quicker attainment of the terminal schedule while low levels of problem behavior were maintained across all participants. Hanley et al. (2001) compared three procedures for thinning reinforcement for communication during FCT. In one condition, delay to reinforcement involved a fixed-ratio (FR) 1 schedule with increasing delays. The second condition involved a graduated fixed-interval schedule, and the third condition consisted of a graduated multiple schedule. The multiple FR extinc-

tion schedule was shown to be superior in maintaining low levels of problem behavior and moderate levels of communication while decreasing the FR component duration.

Whereas these studies have examined procedural variations in the progressive thinning of FCT and NCR schedules, Hagopian et al. (1994) compared the effects of dense versus lean schedules of NCR for the treatment of attention-maintained problem behavior. In all cases, the dense NCR schedule resulted in a greater and more immediate reduction in problem behavior than did the lean NCR schedule. The authors then continued treatment with the dense schedule only, and over time, progressively thinned the NCR schedule systematically to be equivalent to the lean schedule applied initially (while low levels of problem behavior were maintained). The results indicated that NCR with extinction using lean schedules did not initially produce sufficient reductions in problem behavior, but that problem behavior could be maintained at low levels under lean schedules after progressive schedule thinning.

The Hagopian et al. (1994) study demonstrated a clear advantage of dense schedules of NCR over lean schedules, at least in the initial phases of treatment. As the authors noted, however, the lean NCR condition was not implemented for an extended period (M = 8 sessions; range, 4 to 10 20-min sessions across participants). It is unknown whether problem behavior may have been reduced further if the lean schedule condition had been conducted over a longer period. It is possible that the identified treatment goal (a 90% or 95% reduction in problem behavior under the lean schedule arrangement) could have been achieved more quickly under the lean NCR condition than under the dense NCR condition.

The purpose of the current investigation was to compare the effects of dense-to-lean (DTL) versus fixed lean (FL) schedules of alternative reinforcement (using NCR or FCT) applied concurrently with extinction for the treatment of problem behavior. The primary goal was to determine which condition would result in faster attainment of the clinical goal. We hypothesized that during the transitions from baseline to treatment (during the initial implementation of treatment and replication following reversal to baseline), immediate and dramatic reductions in problem behavior would be observed under the dense schedules present in the DTL condition relative to the FL condition. In the FL condition, we expected responding to change little from baseline, or possibly increase initially. This hypothesis was based on the known effects of dense versus lean schedules of NCR (Hagopian et al., 1994) and dense schedules of contingent reinforcement for communication during FCT (e.g., Hanley et al., 2001). We also hypothesized that brief increases in problem behavior would be observed during schedule thinning in the DTL condition. This hypothesis was based on the frequently reported effects of schedule thinning during FCT (e.g., Hagopian et al., 1998) and NCR (e.g., Lalli et al., 1997).

GENERAL METHOD

Participants and Setting

The participants in the current investigation were 3 individuals with developmental disabilities who had been admitted to an inpatient behavioral unit for the assessment and treatment of severe behavior problems. Brent was a 10-year-old boy who had been diagnosed with moderate mental retardation and Fragile X syndrome. He was ambulatory and was able to communicate via a limited expressive vocabulary. Jason was a 12-year-old boy who had been diagnosed with severe mental retardation, obsessive-compulsive disorder, and epilepsy. He was ambulatory and communicated via pictures. Sally was a 10-year-old girl who had been diagnosed

with profound mental retardation, hydrocephalus, epilepsy, seizure disorder, and autism. She was ambulatory and communicated via the use of gestures and pointing to objects. It should be noted that none of the participants displayed problem behavior of such severity that extinction was contraindicated because of safety concerns.

Data Collection and Interobserver Agreement

Frequency data were collected on target responses during the functional analyses and treatment evaluations for all participants. These data are expressed as target responses per minute. Brent's target responses included aggression (defined as hitting, kicking, pulling hair, and throwing objects within 0.5 m of another person), self-injurious behavior (SIB) (defined as hitting himself in the head with his hands or fists and hand biting), and disruption (defined as throwing objects and property destruction). Jason's target responses included aggression (defined as hitting, kicking, scratching, hair pulling) and disruption (defined as throwing, breaking, ripping, or tearing objects). Sally's target responses included SIB (defined as banging her head, throwing her head back forcefully while extending her neck, and hitting her head with her hands and fists) and aggression (defined as hitting, kicking, head butting, and hair pulling).

Trained observers recorded the frequency of target responses on laptop computers. A second independent observer collected data during 48%, 38%, and 45% of sessions during Phase 1 (functional analysis) for Brent, Jason, and Sally, respectively. Percentage of exact agreement was calculated by dividing the number of exact agreements by the number of exact agreements plus disagreements and multiplying by 100%. An exact agreement was defined as both observers recording the same frequency of a target behavior during the 10-s interval. Average exact agreement coefficients for targeted responses in Phase 1 for Brent, Jason, and Sally were 99.7%, 98.5%, and 99.5%, respectively. Interobserver agreement was assessed in 45%, 49%, and 60% of sessions in Phase 2 (treatment analysis) for Brent, Jason, and Sally, respectively. Average exact agreement coefficients for targeted behaviors during Phase 2 for Brent, Jason, and Sally were 98%, 91%, and 96%, respectively.

Experimental Design

Functional analyses for each participant were conducted using a multielement design (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). For Brent and Jason, subsequent pairwise analyses of test conditions and control conditions were conducted (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). Treatment analyses were conducted for Sally and Jason, wherein the DTL and FL conditions were examined separately across similar baselines (i.e., two separate baselines were conducted). Experimental control of each intervention was demonstrated using an ABAB design. For Brent, the DTL and FL conditions were compared using a multielement design embedded within an ABAB design. Thus, transitions from baseline to treatment (and treatment to baseline) could not be examined separately for the DTL and the FL conditions for Brent.

Phase 1: Functional Analysis

Procedure

One or more functional analyses were conducted for each participant based on procedures described by Iwata et al. (1982/1994). Functional analyses consisted of an alone or an ignore condition (specific to each participant), attention, demand, tangible, and toy play conditions. In addition, analyses included a "do" requests condition for Brent (similar to that described by Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998) and a modified tangible condition for Jason. During pairwise analyses for Brent

and Jason, test conditions were compared to control conditions via sequential presentations (Iwata et al., 1994). The purpose of conducting the pairwise analysis was to further evaluate potential variables that maintained problem behavior while minimizing the potential for carryover effects or ambiguity of relevant contingencies that sometimes occur when test conditions are rapidly alternated.

For each of the participants, the problem behavior described above was targeted in the functional analysis. During the alone condition, the participant was alone in the session room. During the ignore condition, a therapist was present during the session but did not interact with the participant. In both conditions, materials and social interaction were not available. The purpose of these conditions was to evaluate problem behavior in the absence of social consequences (i.e., to determine if problem behavior was maintained by automatic reinforcement). In the attention condition, access to brief attention in the form of a verbal reprimand was delivered contingent on the occurrence of a target behavior. The purpose of the attention condition was to determine whether problem behavior was maintained by access to positive reinforcement in the form of adult attention. In the demand condition, academic or vocational tasks were presented using a three-step guided-compliance prompting sequence. Contingent on the occurrence of a target behavior, a 30-s escape was provided. Compliance with the instructional task resulted in praise. The purpose of the demand condition was to evaluate the role of escape from instructional demands in the maintenance of problem behavior. In the tangible condition, the occurrence of target behavior resulted in 30-s access to preselected preferred items that were held constant across sessions. In the modified tangible condition for Jason, problem behavior resulted in 1-min access to several activities and preferred stimuli available in the session room. The purpose of the tangible and modified tangible conditions was to determine whether problem behavior was maintained by access to preferred items or activities. In the "do" requests condition for Brent, the therapist issued a demand every 30 s that interrupted the activity that he was engaged in at the time (playing with toys, interacting with the therapist, etc.). Problem behavior resulted in termination of the "do" request, permitting him to engage in the previously interrupted activity (or other activity of his choosing) for 30 s. The purpose of this condition was to determine whether problem behavior was maintained by termination of "do" requests that interrupted engagement in preferred activities. During toy-play conditions, each participant had access to adult attention and preferred items and activities were present. No instructional demands were presented. This condition served as a control against which the other conditions could be compared.

Results

Brent's functional analysis data are presented in the top panel of Figure 1. During the initial functional analysis using a multielement design (Iwata et al., 1982/1994), responding was low and undifferentiated in all conditions. We suspected this was a function of interference secondary to the rapid alternation of conditions; therefore, we initiated a pairwise analysis (Iwata et al., 1994). These results suggested that Brent's problem behavior was multiply maintained by access to tangible items, access to adult attention, termination of "do" requests that interrupted preferred activities, and escape from demands. The functional analysis (Figure 1, middle) suggested that Jason's problem behavior was sensitive to positive reinforcement in the form of access to preferred items and activities. The functional analysis (Figure 1, bottom) suggested that Sally's prob-

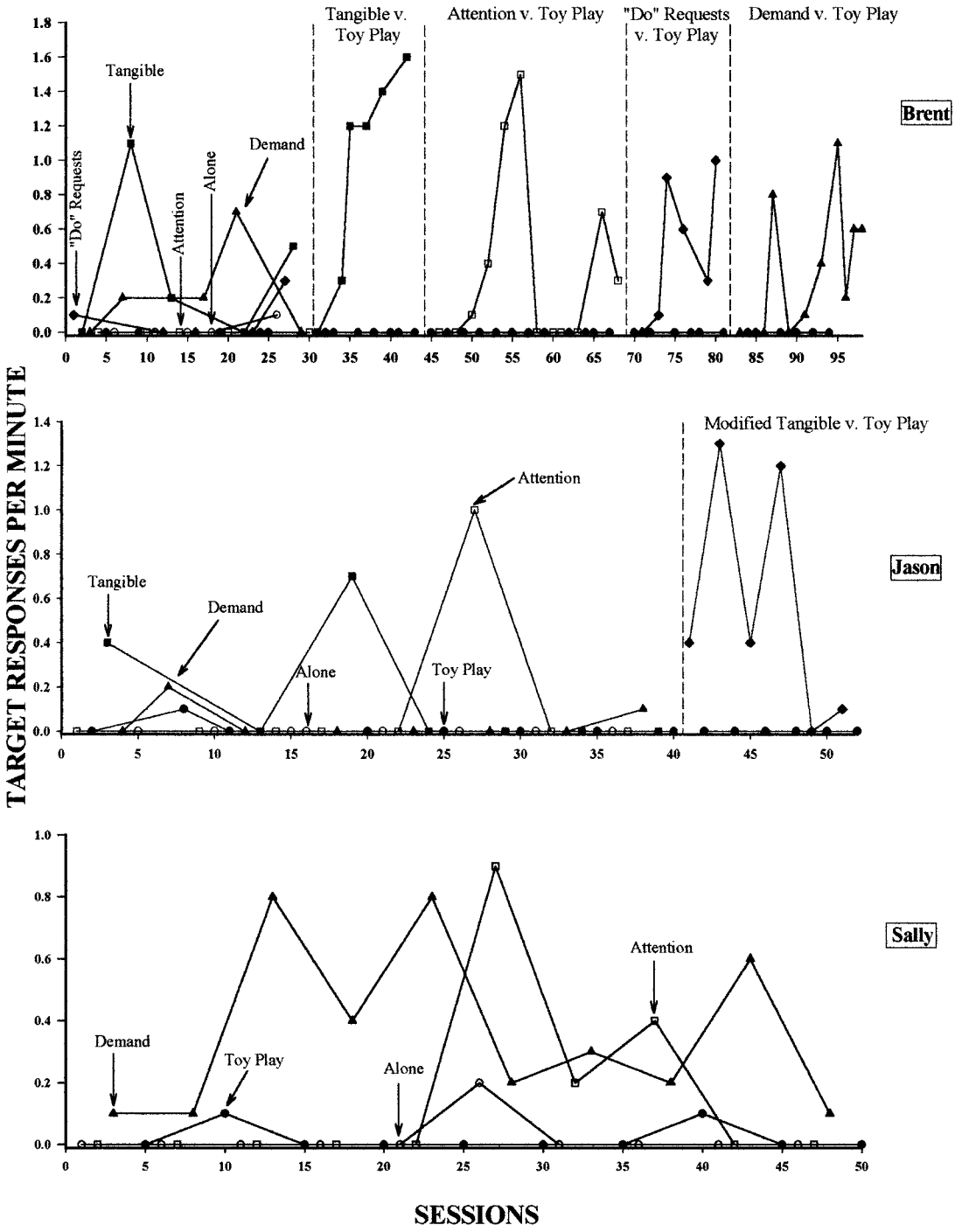

Figure 1. Target responses per minute during functional analyses for Brent (top panel), Jason (middle panel), and Sally (bottom panel).

lem behavior was sensitive to negative reinforcement in the form of escape from demands. It should also be noted that Sally's problem behavior served multiple functions, in that her target behavior was also elevated in the tangible condition. Data from the tangible condition (M = 2.7 responses per minute) are not included in Figure 1 because depicting the data from those sessions would alter the y axis to the degree that all other data points would appear to be at zero (moreover, the tangible function was treated separately and is not relevant to the current investigation).

Phase 2: Treatment Analysis

Procedure

Baseline. Brent's baseline was identical to the "do" requests condition in the functional analysis. That is, the therapist issued a request every 30 s that interrupted the activity that he was engaged in at the time. Problem behavior resulted in termination of the request, permitting him to engage in the previously interrupted activity. For Jason, problem behavior resulted in 1-min access to a video game (the video game was used in this condition because that was the stimulus he typically selected in the modified tangible condition of the functional analysis). Prior to the start of sessions, Jason was allowed to play with the video game for 2 min. At the start of each session, the game was turned off. Two separate baselines were conducted with Jason (one for each treatment condition). During Sally's baseline, instructional demands were delivered every 30 s using a three-step prompting sequence (identical to the demand condition). Compliance to the verbal or modeled prompt resulted in praise, whereas problem behavior resulted in a 30-s escape from demands. If Sally failed to comply after the verbal and modeled prompt, the therapist physically guided her to complete the demand. For Sally, two demand baselines were established (one for each treatment condition). The demand baselines were conducted in two separate rooms, with a different therapist assigned to each baseline to minimize interference across the two conditions. The demands were identical to those in the demand condition of the functional analysis, and different but similar demands were used in each baseline. For example, folding a towel was a demand issued in the DTL condition baseline, whereas folding a shirt was a demand used in the FL condition baseline.

Individual treatment goals. For each participant, individualized treatment goals for reductions in rate of problem behavior and for the terminal reinforcement schedule were developed prior to treatment. These goals were based on a combination of factors including baseline rates of responding and the severity of the targeted problem behavior. The goals for reductions in rate of targeted behaviors were an 80% reduction or more relative to baseline for Brent and Sally (0.3 and 0.5 responses per minute or less, respectively) and a 90% reduction or greater for Jason (0.2 responses per minute or less) for two consecutive sessions under the terminal reinforcement schedule. The goal for schedule thinning for Brent was 1 min of FR 1 and 9 min of extinction. The terminal schedule for Sally was 1 min of access to a break card and 9 min of work. For Jason, the terminal schedule was 1 min of access to the video game every 4 min.

DTL versus FL schedules of reinforcement with extinction. The general procedure for all participants involved comparing a DTL schedule condition to an FL schedule condition. The DTL condition involved the use of dense schedules of reinforcement at the outset of treatment, followed by progressive schedule thinning to the terminal reinforcement schedule. The FL condition involved the use of a fixed schedule of reinforcement throughout treatment that was equivalent to

the terminal reinforcement schedule in the DTL condition. Both conditions included extinction for problem behavior combined with FCT for Brent and Sally and NCR for Jason.

For Brent, FCT with extinction was used to treat problem behavior maintained by termination of "do" requests that interrupted engagement in preferred activities. For the schedule comparison, therapists wore a blue gown for the DTL condition and a red gown for the FL condition to minimize interference across conditions (the gowns were also worn during baseline). In both the DTL and the FL conditions, problem behavior was placed on extinction, while mands produced uninterrupted access to the requested activity or toy for 30 s (i.e., requests were not issued during this time). A multiple FR 1 extinction schedule, based on the procedures described by Hanley et al. (2001), was employed to facilitate thinning reinforcement for mands in the DTL condition. That is, schedule thinning in the DTL condition was accomplished by progressively decreasing the duration of the FR 1 component (while concurrently increasing the duration of the extinction component). During the FR 1 component (signaled by a stimulus card placed on a table in the room), mands for access to activities or toys resulted in uninterrupted access to the requested activity or toy for 30 s. During the extinction component (signaled with a stimulus card placed on a table in the room), mands were not reinforced and requests continued to be issued by the therapist.

During the DTL condition, the FR 1 and extinction component durations varied according to a predetermined schedule. Schedule thinning entailed 10 steps, with the first step consisting of 10 min of the FR 1 component (and 0 min of the extinction component), with each progressive step involving a reduction in the time the FR 1 component was operative by 1 min (and a corresponding increase in the duration of extinction). The criterion for advancing to the next step in schedule thinning was that problem behavior had to be at or below 0.3 responses per minute (an 80% or greater reduction relative to baseline) for two consecutive sessions. The terminal schedule in the DTL condition was 1 min of FR 1 and 9 min of extinction. The terminal schedule of the DTL condition was used throughout treatment in the FL condition (i.e., 1 min of FR 1 and 9 min of extinction).

For Jason, NCR with extinction was implemented to treat his problem behavior maintained by access to tangible items. DTL and FL conditions were conducted in two separate rooms, with a different therapist assigned to each condition to minimize interference. In both treatment conditions, problem behavior was on extinction. During the DTL condition, schedule thinning was based on the procedures described by Vollmer et al. (1993). Schedule thinning entailed seven steps, with the first step consisting of 1 min of access to the video game on an FT 15-s schedule. That is, every 15 s he received access to the video game for 1 min. Each progressive step involved a reduction in reinforcer-access time by 1 min. Before advancing to the next step in the thinning process, problem behavior had to be at or below 0.2 responses per minute (a 90% reduction or greater relative to baseline) for two consecutive sessions. The terminal schedule in the DTL condition was 1 min of access to the reinforcer every 4 min (FT 240). The terminal schedule of the DTL condition was used throughout treatment in the FL condition (FT 240).

For Sally, FCT with extinction was used for the treatment of escape-maintained problem behavior. Prior to beginning the schedule comparison, a backward chaining procedure was used to teach Sally to request a 30-s break during demands. The FCT response consisted of handing a break card to

the therapist. Training continued until Sally could independently emit that response for at least 80% of trials across two consecutive 10-trial sessions. Across both treatment conditions, demands were issued in the same manner as during baseline. Problem behavior was placed on extinction in both conditions. During the FL condition, the FCT card was available (placed on the table where demands were presented) for only 1 min of the 10-min session. Thus, at 9 min into the session, the break card was made available, and she was given a 30-s break from demands contingent on handing the card to the therapist. During the DTL condition, the break card was made available (placed on the table where demands were presented) on a predetermined schedule. Schedule thinning consisted of nine steps, with the first step being continuous availability of the FCT card and each progressive step involving a reduction in the time the FCT card was available by 1 min. Before advancing to the next step in the schedule-thinning process, target behavior had to be at or below 0.5 responses per minute (an 80% reduction or greater from baseline levels) for two consecutive sessions. If problem behavior occurred above 0.5 responses per minute for two consecutive sessions, the previous step was imposed. This thinning procedure was similar to that described by Fisher et al. (1993). The terminal schedule in the DTL condition was 9 min of work and 1 min of access to the break card. The terminal schedule of the DTL condition was used throughout treatment in the FL condition.

Results

Brent. The results of Brent's treatment comparison are displayed in Figure 2. It should be noted that the same data are graphed in the baseline phases in both the top and bottom panels of Figure 2. The data are graphed on separate panels to facilitate comparison between the two conditions (which were conducted using a multielement design). In the first phase when the dense schedule of FCT was implemented, immediate reductions in problem behavior were observed; however, there was some variability across sessions (top panel). Twelve of the 14 sessions were below the baseline average, and problem behavior did not occur in seven of the sessions. In the FL condition, however, problem behavior persisted at levels comparable to baseline (bottom panel). Experimental control was demonstrated, in that initial effects observed in the dense reinforcement condition were replicated following the second baseline condition and in that levels of problem behavior differed between the FL and DTL conditions. As hypothesized, the DTL condition (under the dense schedule) produced more immediate reductions in problem behaviors than did the FL condition.

For Brent, schedule thinning in the DTL condition proceeded slowly. Eight sessions were conducted before the criterion for advancing to the second step was met. However, increases in responding were observed when attempts were made to thin the schedule, particularly during Sessions 63 and 68. The DTL condition was terminated after 4 of the 10 steps of schedule thinning were completed (i.e., 7 min of FR 1 and 3 min of extinction). The DTL condition was terminated at that time because the treatment goal had been achieved in the FL condition. The treatment goal (a 90% or greater reduction in problem behavior for two consecutive sessions under the terminal schedule) was reached in the FL condition at Session 64 (in the 16th treatment session) following the second baseline. In contrast, schedule thinning had not progressed beyond the first step (9 min of FR 1 and 1 min of extinction) in the DTL condition after 16 treatment sessions. It should be noted that stable and low rates of responding were

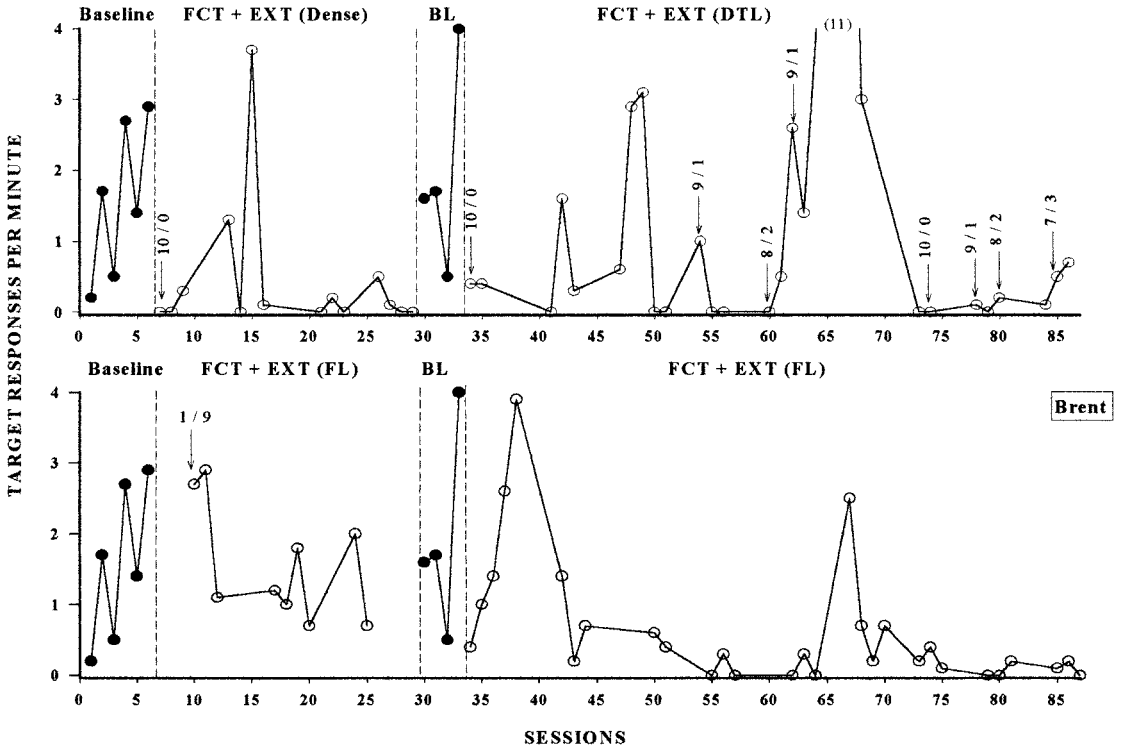

Figure 2. Treatment analysis results for Brent during baseline (BL) and functional communication plus extinction (FCT + EXT). Top panel depicts problem behavior during the DTL condition; bottom panel depicts problem behavior during the FL condition. Arrows and values indicate schedule-thinning steps.

not observed in the FL condition until Session 75.

Jason. The results of Jason's treatment comparison are displayed in Figure 3. With the initial implementation of the DTL condition, an immediate and total suppression in responding was observed (top panel). With the implementation of the FL condition, an increase in responding occurred during the first session, followed by no responding in the next three sessions (bottom panel). With a return to baseline in the DTL condition, responding recovered to baseline levels immediately. By contrast, responding more slowly recovered to baseline levels in the FL condition. With a return to treatment following baseline, the initial treatment effects were partially replicated across both conditions. In the DTL condition, problem behavior did not occur in five of six sessions implemented prior to the onset of schedule thinning (high levels of problem behavior occurred in the third session).

Schedule thinning proceeded quickly in the DTL condition, in that Jason's problem behavior occurred during only 2 of 15 sessions. The treatment goal (a 90% or greater reduction for two consecutive sessions under the terminal schedule) was achieved after 15 sessions following the return to baseline (at Session 26). Responding in the FL condition was initially higher and more variable following the return to baseline, but eventually decreased to zero in most sessions. The treatment goal was achieved in the FL condition after seven sessions following the return to baseline (at Session 19). After seven sessions in the DTL condition, schedule thinning had progressed only to the second step (FT 20). Although the treatment goal was

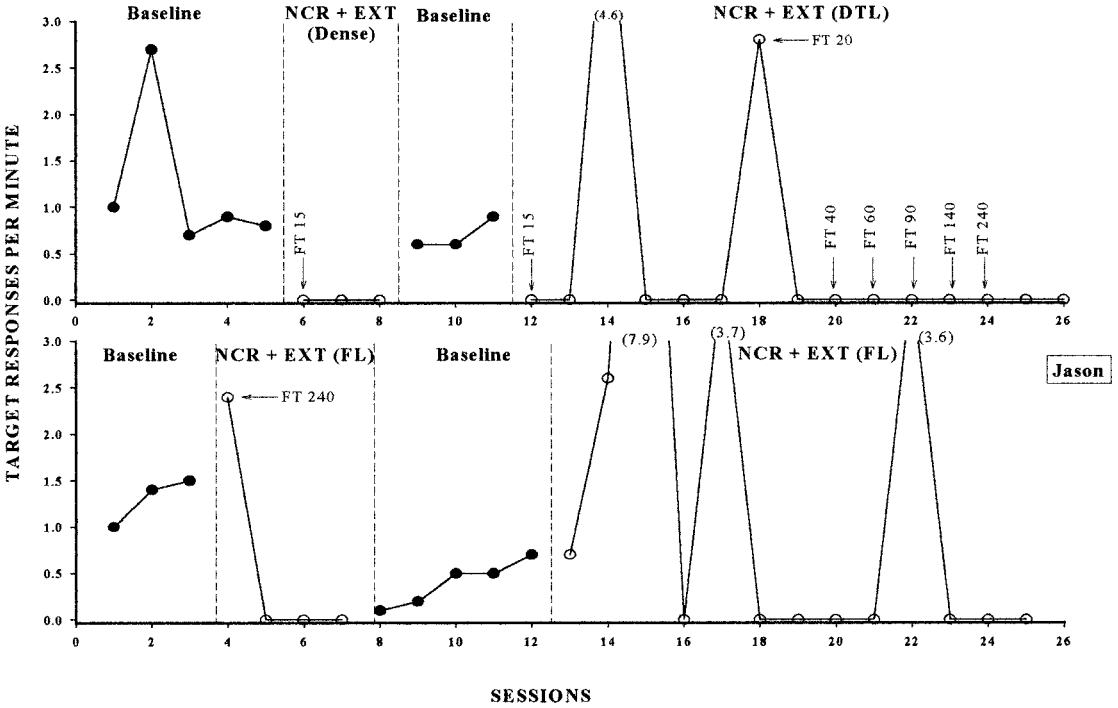

Figure 3. Treatment analysis results for Jason during baseline (BL) and noncontingent reinforcement plus extinction (NCR + EXT). Top panel depicts problem behavior during the DTL condition; bottom panel depicts problem behavior during the FL condition. Arrows and values indicate schedule-thinning steps.

achieved sooner in the FL condition than in the DTL condition, differences across these conditions were minimal.

Sally. Sally's FCT treatment analyses are depicted in Figure 4. With the implementation of the DTL condition, there was immediate suppression of problem behavior (top panel). The FL condition produced an immediate increase in responding, but responding decreased gradually to baseline levels (bottom panel). With the return to baseline, responding recovered more gradually in the FL condition than in the DTL condition. A reversal to the DTL and FL conditions replicated the initial effects. Once again, responding was suppressed immediately in the DTL condition, whereas problem behavior increased in the FL condition for the first several sessions.

Schedule thinning advanced to the next step in the DTL condition at Session 20 (when problem behavior was below the 80% reduction criterion). Sally's responding increased, and the criteria to return to the previous step were met. After returning to the first step, 12 more sessions were required before the criterion to advance to the next step was met. Thereafter, problem behavior continued to be variable across sessions in the DTL condition, resulting in completion of only 4 of the 10 schedule-thinning steps (3 min of work and 7 min of access to the break card). Although problem behavior in the FL condition decreased over the course of treatment, the treatment goal was not achieved in either condition. In both conditions, a DRA for compliance with demands was added to the treatment, resulting in increases in compliance across both conditions (data on compliance are not shown). In the DTL condition, schedule thinning progressed to Step 6 of 10; however, increases in problem behavior necessitated a return to the previous step. The treatment goal (an

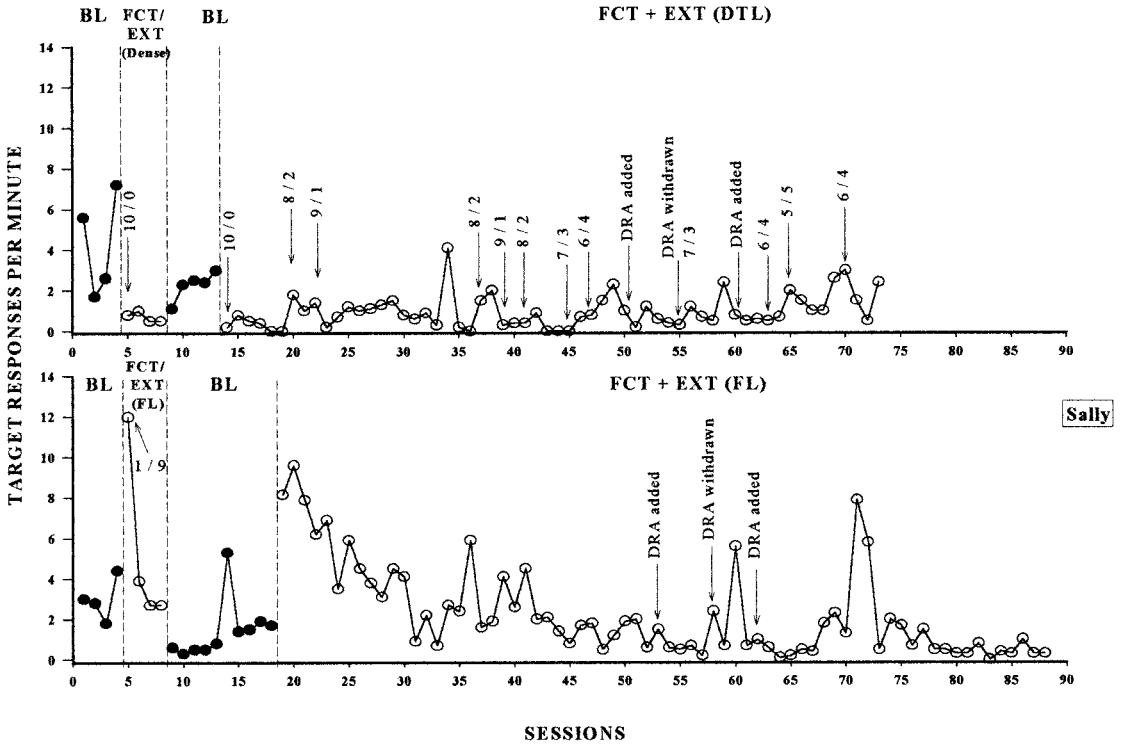

Figure 4. Treatment analysis results for Sally during baseline (BL) and functional communication training plus extinction (FCT + EXT). Top panel depicts problem behavior during DTL condition; bottom panel depicts problem behavior during the FL condition. Arrows and values indicate schedule-thinning steps.

80% reduction for two consecutive sessions in problem behavior) was achieved after 48 sessions following the return to baseline in the FL condition (at Session 66). Shortly after the treatment goal was achieved in the FL condition, the DTL condition was terminated. At that time, schedule thinning had progressed through 5 of the 10 steps (i.e., she had 6-min access to the break card and was required to work at least 4 min).

DISCUSSION

For two of the three cases, the clinical goal was attained more rapidly in the FL condition than in the DTL condition and, for the third case, the difference between conditions was marginal. It was hypothesized that relative to the FL condition, the DTL condition would result in more dramatic reductions in problem behavior following baseline and brief instances of recovery during schedule thinning in the DTL condition. These hypotheses generally were supported.

For Sally and Jason, immediate and somewhat dramatic reductions in problem behavior were observed both times the dense schedule of reinforcement was implemented (in the DTL condition) following baseline. By contrast, the FL schedule resulted in temporary increases in responding following baseline. However, responding gradually decreased in the FL condition over the course of the analysis. In addition, during the baselines that followed the initial implementations of the dense schedules of reinforcement (with Sally and Jason), we observed a rapid recovery of responding relative to the FL condition reversals to baseline that resulted in slower recovery.

For Sally and Jason, we were able to achieve our clinical goal more quickly using

the FL schedule as opposed to initiating treatment under dense schedules and then progressively thinning the schedule. It is possible, however, that the clinical goal would have been achieved eventually in the DTL condition while avoiding high-rate sessions such as those observed during the FL condition. In addition, the treatment goal may have been achieved more quickly in the DTL condition had there been fewer steps between the initial and terminal schedules. We elected to thin the schedule based on commonly used procedures (e.g., Fisher et al., 1993; Vollmer et al., 1993), but it is possible that the clinical goal would have been attained more quickly in the DTL condition had other schedule-thinning procedures been employed (e.g., those based on IRTs described by Kahng et al., 2000).

From an applied standpoint, these findings raise questions about whether schedule thinning in the context of FCT or NCR should involve progressive thinning across sessions versus initiating treatment under the terminal schedule. For individuals who display severe problem behavior that can produce injury to self or others at high rates, escalations or bursts of problem behavior that can occur when treatment is initiated under lean schedules may not be acceptable. In such cases, thinning the schedule gradually may be more appropriate, although potentially more time consuming. On the other hand, for two of the three cases reported in this study, a successful outcome was not achieved in the DTL condition. It is not known whether the treatment goal could have been achieved under the DTL condition without additional treatment components that might have rendered the intervention more labor intensive or restrictive (e.g., Fisher et al., 2000; Hagopian et al., 1998). The potential effects of a prolonged schedule-thinning process are not known, but could conceivably include nontherapeutic effects, such as adventitious reinforcement of problem behavior (Ringdahl, Vollmer, Borrero, & Connell, 2001; Vollmer et al., 1997).

One potential limitation of the current study is that it did not examine the interaction between the method of thinning alternative reinforcement (DTL vs. FL) and type of reinforcement schedule (NCR vs. FCT). Such an analysis is not possible with the data in the current study because it did not include a sufficient number of cases. Rather, the purpose of the current study was to compare two methods of thinning reinforcement across two commonly used interventions. Nevertheless, the results should be interpreted with respect to differences between FCT and NCR.

The design of the current study does not allow us to determine the processes that underlie the observed differences across the FL and DTL conditions. As noted, the findings obtained in the current study may have been due to the particular methods used to thin the reinforcement schedules in the DTL condition. Clearly, additional research is needed to replicate these findings before any generalizations can be made. Future investigators also should consider examining why initiating treatment under lean schedules may result in a better outcome than progressively thinning to lean schedules in light of the establishing-operation-altering effects of dense reinforcement schedules. It is possible that dense reinforcement schedules may suppress problem behavior to levels such that the extinction contingency is contacted minimally or not at all.

In the case of NCR, as the schedule of reinforcement is thinned (and the establishing operation for problem behavior is strengthened), problem behavior is more likely to occur and therefore is more likely to contact extinction. In the case of FCT, as the schedule for communication is thinned, responding shifts from communication to problem behavior, again increasing the like-

lihood that extinction is contacted. Perhaps the use of moderately dense schedules of reinforcement that would engender a level of responding that is tolerable but results in sufficient contact with extinction should be examined in future research.

Leitenberg and colleagues have examined a similar phenomenon in a series of laboratory studies on the effects of alternative reinforcement on extinction (Leitenberg, Rawson, & Bath, 1970; Rawson & Leitenberg, 1973; Rawson, Leitenberg, Mulick, & Lefebvre, 1977). Leitenberg et al. demonstrated that when a response cannot be emitted (or simply does not occur) during concurrent reinforcement extinction procedures, the process of extinction does not take place. In an experimental preparation analogous to the clinical application of FCT, rats were trained to respond on a single lever for food reinforcement. In the second condition, these responses were placed on extinction while (for some rats) responses on a second lever produced reinforcement. In the final phase of that experiment, reinforcement of alternative behavior was removed. Recovery of the original response occurred in those rats that were provided with a reinforced alternative, but no recovery was evident in those subjects whose behavior was under extinction only. Thus, the provision of alternative reinforcement that produced a shift in responding from one lever to an alternative lever appeared to interfere with extinction of the original response.

If it is necessary for problem behaviors to be emitted and followed by nonreinforcement for the process of extinction to occur, then behavior-reduction interventions using dense reinforcement schedules that produce immediate and dramatic reductions in problem behavior may delay the extinction process. Conversely, less dense reinforcement schedules (those that do not reduce problem behavior to near zero) may increase the probability that problem behavior will contact extinction earlier in treatment. As noted above, however, the design of the current study does not permit us to determine if the observed differences across conditions are related to extinction. Nevertheless, these findings point to the need for additional research designed to examine more directly how alternative reinforcement schedules commonly used in behavior-reduction interventions can affect extinction.

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STUDY QUESTIONS

1. Briefly describe some procedures that have been used to thin reinforcement schedules during functional communication training (FCT).

2. Why was Brent exposed to a pairwise functional analysis, and what did the results of this analysis show?

3. Describe the baseline context used for each participant.

4. What was the difference between the dense-to-lean (DTL) and fixed lean (FL) procedures?

5. What was the difference between the DTL schedule-thinning procedures used for Brent and Sally?

6. In general, what were the initial and overall effects of the DTL versus the FL procedures?

7. Based on the results of the current study, what are some potential benefits and limitations of DTL and FL procedures?

8. The authors discussed the possibility that behavior is more likely to contact extinction as a given reinforcement schedule is thinned. Why might FL schedules be superior to DTL schedules in this respect?

Questions prepared by Natalie Rolider and Carrie Dempsey, University of Florida