

*REINFORCEMENT SCHEDULE THINNING
FOLLOWING TREATMENT WITH
FUNCTIONAL COMMUNICATION TRAINING*

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We evaluated four methods for increasing the practicality of functional communication training (FCT) by decreasing the frequency of reinforcement for alternative behavior. Three participants whose problem behaviors were maintained by positive reinforcement were treated successfully with FCT in which reinforcement for alternative behavior was initially delivered on fixed-ratio (FR) 1 schedules. One participant was then exposed to increasing delays to reinforcement under FR 1, a graduated fixed-interval (FI) schedule, and a graduated multiple-schedule arrangement in which signaled periods of reinforcement and extinction were alternated. Results showed that (a) increasing delays resulted in extinction of the alternative behavior, (b) the FI schedule produced undesirably high rates of the alternative behavior, and (c) the multiple schedule resulted in moderate and stable levels of the alternative behavior as the duration of the extinction component was increased. The other 2 participants were exposed to graduated mixed-schedule (unsignaled alternation between reinforcement and extinction components) and multiple-schedule (signaled alternation between reinforcement and extinction components) arrangements in which the durations of the reinforcement and extinction components were modified. Results obtained for these 2 participants indicated that the use of discriminative stimuli in the multiple schedule facilitated reinforcement schedule thinning. Upon completion of treatment, problem behavior remained low (or at zero), whereas alternative behavior was maintained as well as differentiated during a multiple-schedule arrangement consisting of a 4-min extinction period followed by a 1-min reinforcement period.

DESCRIPTORS: functional analysis, functional communication training, differential reinforcement of alternative behavior, reinforcement schedules, delay to reinforcement

The development of interventions based on the results of functional analyses (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) has become a hallmark of current research on the assessment and treatment of problem behavior. Once the function of a problem behavior is identified, an intervention is designed that typically consists of reinforcement (e.g., either noncontingent, Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993, or contingent on an alternative response, Carr & Durand, 1985) and extinction, in which stimuli delivered or withheld

are the same as those found to be responsible for maintenance of problem behavior. When positive treatment effects are observed, the initially dense schedule of reinforcement is sometimes thinned to some predetermined and presumably practical goal.

Several methods have been developed for thinning noncontingent schedules of reinforcement. For example, Vollmer et al. (1993) presented a method for thinning noncontingent reinforcement (NCR) in the form of attention from a continuous schedule (i.e., fixed-time [FT] 10 s) to a relatively thin schedule (FT 5 min). This type of NCR schedule thinning was used successfully in several subsequent investigations (e.g., Hagogopian, Fisher, & Legacy, 1994; Marcus & Vollmer, 1996). A slightly different procedure was described by Lalli, Casey, and Kates (1997). They set the initial NCR schedule

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based on the mean latency to the first problem behavior observed during baseline and subsequently increased the FT intervals by either 30, 60, or 90 s. As an alternative to fixed-increment procedures for thinning NCR schedules, Kahng, Iwata, DeLeon, and Wallace (2000) used an adjusting-interresponse-time (IRT) procedure, in which the NCR schedule was initially set and then later thinned based on the mean IRT from preceding sessions. The authors observed that the adjusting-IRT procedure was somewhat more efficient in reaching a terminal schedule than was the fixed-increment procedure.

The procedures described above for thinning NCR schedules each may have particular advantages (e.g., efficiency, ease of implementation); however, the procedures are similar in that they are all time based (i.e., the delivery of reinforcers under all three arrangements is based purely on the passage of time). Differential-reinforcement-of-other-behavior (DRO) schedules can be thinned in a similar manner, in that the duration of time during which the target behavior must be absent is gradually increased (e.g., from 5 s to 15 min, Repp & Deitz, 1974). By contrast, schedule-thinning procedures used for NCR or DRO are not applicable to differential-reinforcement-of-alternative-behavior (DRA) schedules, such as those arranged in functional communication training (FCT) (e.g., Carr & Durand, 1985), because DRA schedule thinning requires that some appropriate responses will be reinforced and others will not. Thus, schedule-thinning procedures that may be appropriate for time-based interventions (NCR and DRO) may compromise the integrity of interventions involving a reinforcement contingency for a particular response.

Few methods for thinning schedules of reinforcement within FCT treatment packages have been formally evaluated. In a large-scale analysis of FCT outcomes, Hagopian, Fisher, Sullivan, Acquistio, and LeBlanc (1998) de-

scribed a thinning procedure that involved gradually increasing the interval of time (delay) between a communication response and the delivery of positive reinforcement. This procedure resulted in a 90% reduction in problem behavior at the terminal schedule in only 5 of 12 applications. Punishment, in addition to the FCT intervention, was necessary for maintaining 90% reductions in problem behavior at the terminal schedule in all applications.

Fisher, Thompson, Hagopian, Bowman, and Krug (2000) noted that the delay procedure may weaken the contingency between communicative responding and reinforcement as the delay interval is increased. This contingency-weakening effect inherent to delay procedures (Lattal, 1984) may result in extinction of the newly acquired communicative response as well as recovery of the historical problem behavior. Following successful reduction of attention-maintained problem behavior through FCT, Fisher *et al.* increased the delay to reinforcement following occurrences of alternative (communicative) responses. In the absence of the delay and during initial brief delays, alternative responses were maintained at just above four per minute. However, as the delay was gradually increased to 30 s, the rate of the alternative behavior dropped to near zero. In addition, problem behavior occurred somewhat more frequently than did alternative behavior under the 30-s reinforcement delay in two of the final four sessions. Although FCT with a 30-s delay was a successful intervention in that problem behavior was greatly reduced from its baseline rate, potential hazards of the contingency-weakening effects of the delay procedure also were apparent in the data.

A slightly different procedure for FCT schedule thinning that may be more likely to maintain alternative responding is to present reinforcement on an initially dense fixed-interval (FI) schedule of reinforcement

and to subsequently thin the FI schedule. FI schedules involve the delivery of a reinforcer for a response after a specified amount of time has elapsed since the last reinforced response (Ferster & Skinner, 1957) and have been demonstrated to support various human behaviors as schedules were thinned (Orlando & Bijou, 1960; Schroeder, 1972; Weiner, 1969), presumably because the contingency between responding and reinforcement was maintained.

One limitation of FI schedules is that responding may be maintained at high levels during the intervals in which reinforcement is unavailable. In fact, in an early study on the operant performance under FI schedules of children with developmental disabilities, Orlando and Bijou (1960) observed either scalloping (an increase in response rate near the end of the interval) or stable and high rates of responding (similar to those observed under fixed-ratio [FR] schedules). Thus, in the context of FCT interventions, FI arrangements may lead to undesirably high rates of alternative behavior in the absence of reinforcement as the FI schedule is thinned. This response pattern could be disruptive to others in a home or classroom as well as annoying to the person responsible for delivering reinforcement, especially as the interval is about to expire.

Undesirably high levels of responding between opportunities for reinforcement might be decreased through the use of distinctive stimuli correlated with the availability and unavailability of reinforcement (Bijou & Orlando, 1961; Long, 1962). For example, Fisher, Kuhn, and Thompson (1998) established discriminative control over two alternative responses during FCT with 2 participants. Training involved pairing specific stimuli (a drawing of the participant interacting with an adult or a drawing of the participant playing with toys) with particular forms of positive reinforcement (attention or access to toys) for different alternative re-

sponses (the manual sign for “hugs” or the manual sign for “games”). The two drawings and their associated contingencies were alternated every 30 s and were successful in producing highly discriminated responding (following training, participants emitted only the response that would be reinforced at that moment).

The arrangement used by Fisher et al. (1998) was a multiple schedule (Herrick, Myers, & Korotkin, 1959), which represents an attractive alternative to reinforcement delays and FI arrangements during FCT schedule thinning. That is, reinforcement for alternative responding could be decreased during FCT by correlating distinctive stimuli with reinforcement and extinction within a multiple-schedule arrangement and then increasing the relative duration of the extinction component. Because reinforcement is delivered immediately following an alternative response in the reinforcement component, the response-reinforcer relation is maintained. In addition, the schedule-correlated stimuli may generate more efficient responding when reinforcement is available as well as less responding when reinforcement is unavailable.

We evaluated several strategies for thinning DRA schedules in the present study. DRA interventions consisting of FCT and extinction for problem behavior were implemented with 3 participants based on the results of functional analyses. Subsequently (Study 1), the effects of reducing reinforcement for appropriate behavior were observed under three conditions with 1 participant: (a) an FR 1 with increasing delays, (b) a graduated FI schedule, and (c) a graduated multiple schedule. In Study 2, the effects of altering the durations of the reinforcement and extinction components under (a) a mixed schedule (no stimuli correlated with the reinforcement and extinction components) and (b) a multiple schedule (distinctive stimuli correlated with the reinforcement and extinction components) were ob-

served on the problem and alternative behaviors of 2 participants.

GENERAL METHOD

Participants and Setting

Three individuals who lived in a state residential facility for persons with developmentally disabilities participated. They had been referred for assessment and treatment of various forms of self-injurious behavior (SIB) or aggression. Karen was a 29-year-old woman who had been diagnosed with profound mental retardation. She was ambulatory, communicated via gestures, and could follow one-step instructions. She engaged in SIB consisting of face, head, and body hitting and hand biting. Staff reported that her SIB occurred intermittently throughout the day but was more likely when she was denied access to food (i.e., trips to restaurants, cafeterias, or stores in which food was visible were reported to occasion SIB).

Jake was a 34-year-old man who had been diagnosed with profound mental retardation. Jake was ambulatory, communicated through either gestures or signs (but rarely did so spontaneously), and followed two-step instructions. He engaged in SIB in the form of hand and arm biting and occasionally engaged in aggression (biting, pinching, and limb twisting). Jake's SIB resulted in severely callused hands and forearms and, at times, produced open wounds and bruising. Staff reported no identifiable antecedents to these problem behaviors, which often occurred in "bursts." Due to Jake's size (he was 6 ft tall and weighed approximately 190 lb) and the intensity of his outbursts, staff reported that they often provided preferred materials (food, radio, puzzles) to "calm him down."

Julie was a 31-year-old woman who had been diagnosed with profound mental retardation, Angelmann's syndrome, cerebral palsy, and a seizure disorder. Julie was not ambulatory (she spent most of her day in a

wheelchair), communicated via gestures, and could follow one-step instructions. She engaged in SIB (banging hands, wrists, and arms against hard surfaces) and aggression (slapping, punching, pinching, scratching, and kicking others). Staff reported that these behaviors occurred at high rates throughout the day in the absence of any identifiable antecedents. Staff also noted that Julie often was aggressive towards peers and that the typical response was for a staff member to tell Julie to stop and to sit within an arm's reach when peers were nearby.

All sessions were conducted in therapy rooms at the day-treatment program located on the grounds of the residential facility. Session rooms contained tables, chairs, and other materials as needed (see below). Sessions lasted for 10 to 12 min and were conducted three to six times daily, 4 to 5 days per week.

Response Measurement and Reliability

Data were collected on participants' SIB, aggression, and alternative responses, and on therapists' delivery of reinforcement. Karen's SIB was defined as hitting her face, head, or torso with any part of her hand and as forceful contact between her teeth and hand (hand biting rarely occurred). Jake's SIB was defined as closure of his teeth on any part of his hand, arm, or sides of fingers. Jake's aggression was defined as twisting another's skin or limbs, forcefully striking others with hands, or closing his teeth on another's skin. Julie's SIB was defined as forceful contact between her hand, wrist, or arm and a hard surface (e.g., table, wheelchair); her aggression was defined as hitting, kicking, punching, or scratching others.

Alternative responses were selected based on recommendations by speech and language specialists who worked regularly with the participants. Voice-output microswitches were selected for Karen and Julie. Alternative responses were scored each time the participant's hand depressed the microswitch such

that the programmed sound (“more, please” for Karen; “talk to me, please” for Julie) was emitted. The manual sign “more” was selected as Jake’s alternative response, which was defined as repeatedly touching the fingertips of both hands together (another response was not scored until there was at least a 1-s period between fingertip touches).

Alternative responses were scored as either prompted (by a therapist) or unprompted (independent) and as occurring under either reinforcement or extinction components during the mixed- and multiple-schedule conditions (see below). Data were collected by trained observers on handheld computers (Assistant Model A102) during continuous 10-s intervals and were summarized as number of responses per minute. Interobserver agreement was assessed by having a second observer collect data simultaneously but independently during 48% of the sessions across all participants. Agreement data were collected during at least 30% of the sessions in each condition for each participant. Observers’ records were compared on an interval-by-interval basis, and agreement percentages were calculated by dividing the smaller number of responses recorded in each interval by the larger number of responses; these fractions then were averaged and multiplied by 100%. Mean interobserver agreement for all behaviors across the 3 participants was 96.9% (range, 80.4% to 100%).

STUDY 1:
EVALUATION OF
INCREASED DELAYS,
FI SCHEDULES, AND
MULTIPLE SCHEDULES
PROCEDURE

A functional analysis, evaluation of a DRA procedure, and an assessment of three types of schedule-thinning procedures were conducted with Karen. The conditions of the functional analysis were arranged in a multielement design, and the effects of the

treatment and schedule-thinning procedures were evaluated in a reversal design.

*Functional Analysis and Initial
DRA Evaluation*

An analysis based on procedures described by Iwata et al. (1982/1994) was conducted to determine if Karen’s SIB was sensitive to edible reinforcement. The functional analysis was arranged in a pairwise manner, in which only two (test and control) conditions were compared (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). In one condition, the putative reinforcer was delivered contingent on problem behavior (contingent reinforcement, CR); in a second condition, the same reinforcer was available noncontingently (noncontingent reinforcement, NCR). As noted above, Karen’s SIB predominantly occurred during situations in which access to foods or snacks was delayed or denied. Nonfat popcorn was chosen as the reinforcer for her evaluation because it was a typical snack in her home. During the CR condition, instances of SIB produced 10-s access to a plate of popcorn. During the NCR condition, the plate of popcorn was continuously available. A therapist was present during the NCR condition but did not deliver any consequences following SIB. The CR condition of the functional analysis served as the baseline for evaluating the effects of the DRA contingency.

During the DRA condition, the microswitch was placed on the table, and an FR 1 schedule of reinforcement was arranged such that each occurrence of the alternative response (pressing a microswitch that emitted the sound “more, please”) resulted in 10-s access to popcorn, whereas SIB no longer produced access to reinforcement (i.e., extinction). At the beginning of the initial session, Karen was physically guided to emit the alternative response, and reinforcement was delivered for the prompted response. Physical prompts were gradually replaced by

gestural prompts, which were then faded using a delay procedure during the initial session of each DRA (FR 1) condition (1 s was added to the delay following emission of each prompted response until the response occurred independently). A return to the CR condition, in which reinforcement was delivered contingent upon occurrences of SIB, was conducted (the microswitch was not available in this condition) and was followed by a return to the DRA condition. The DRA condition then was used as a baseline for evaluating the effects of the three schedule-thinning procedures on SIB and alternative responding.

FR 1 Delay

During this condition, gradually increasing delays were inserted between the emission of an alternative response (pressing the microswitch) and delivery of the reinforcer (10-s access to popcorn). Responses during the delay were not reinforced, and the delays were not signaled (i.e., the therapist did not deliver any instructions to the participant or indicate in any other way that reinforcement was unavailable). The initial delay was 1 s; this delay was increased following two consecutive sessions in which SIB remained at or below 85% of the baseline mean (see Figure 1 for the graduated delays). Occurrences of SIB produced no programmed consequences.

Fixed Interval

Following a return to the FR 1 condition without delays, reinforcers (10-s access to popcorn) were delivered for alternative responses according to an FI schedule. For instance, under the FI 25-s schedule, the first response that occurred after 25 s elapsed from either the start of the session or from a previous reinforcer delivery produced a reinforcer. Responses that occurred prior to the end of the interval were not reinforced. The initial FI value was 1 s; this interval was

increased following two consecutive sessions in which SIB remained at or below 85% of the baseline mean (see Figure 1 for the graduated intervals). Occurrences of SIB produced no programmed consequences.

Multiple Schedule: FR 1 Extinction

Following a return to the FR 1 condition without delays, the effects of a multiple schedule were evaluated with Karen. The multiple schedule consisted of two distinct components: an FR 1 component in which each alternative response produced reinforcement (10-s access to popcorn) and an extinction component in which alternative responses produced no reinforcement. During both components, SIB resulted in no programmed consequences. A distinct stimulus was present during each component: A round (20 cm) white laminated card was present on the table during the FR 1 component, and a rectangular (20 cm by 30 cm) red laminated card was present during the extinction component. Initially, the component durations were set at 45 s and 15 s for FR 1 and extinction, respectively. When the session began, the white card was present for 45 s, and each alternative response resulted in 10-s access to popcorn. The white card was then replaced with the red card for the next 15 s, during which reinforcement was withheld for all behavior. Basically, the therapist responded to instances of the alternative response only when the white card was present and ignored all responding in the presence of the red card. Alternative responses that occurred in the presence of the white and red cards were scored separately. Schedule thinning was accomplished by gradually altering the durations of the components following two consecutive sessions in which SIB remained at or below 85% of the baseline mean (see Figure 1 for graduated component durations).

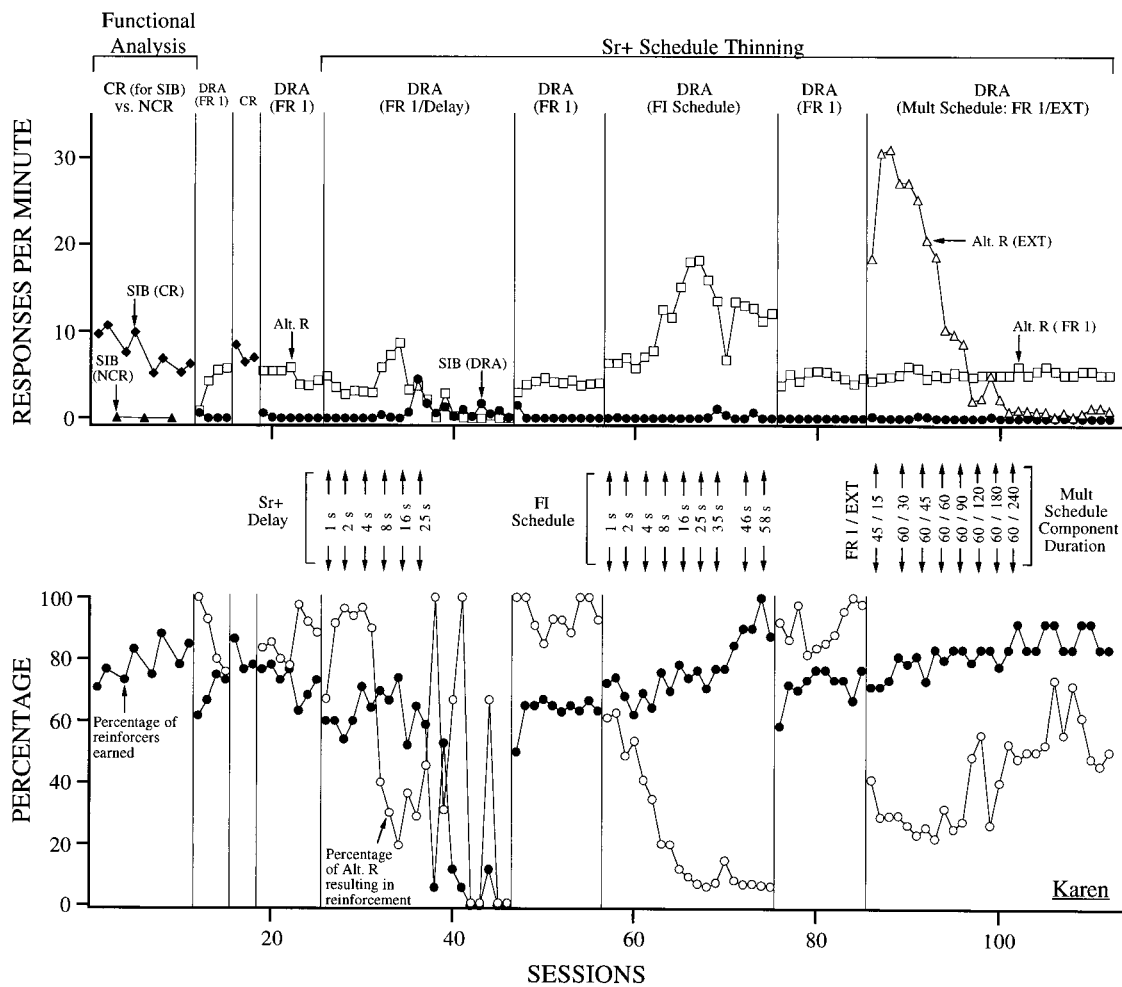


Figure 1. Number of self-injurious and alternative responses per minute (top panel), and the percentage of reinforcers earned and the percentage of alternative responses resulting in reinforcement (bottom panel) during Karen's functional analysis, treatment assessment, and evaluation of schedule-thinning procedures.

RESULTS AND DISCUSSION

The top panel of Figure 1 shows Karen's rate of SIB and alternative responses during the functional analysis, initial DRA evaluation, and assessment of the three schedule-thinning procedures.

Functional Analysis and Initial DRA Evaluation

High rates of SIB were observed ($M = 7.7$ responses per minute) when reinforcement was delivered contingent on occurrences of SIB (CR condition). By contrast, little or no SIB occurred when Karen was

given continuous access to the same reinforcer (NCR condition). These data showed that Karen's SIB was sensitive to food as reinforcement and were consistent with anecdotal reports and observed instances of problem behavior in her home. However, this assessment does not rule out the possibility that problem behavior was also maintained by other sources of reinforcement that are typically examined in more thorough functional analyses (e.g., Iwata et al., 1982/1994).

The DRA (FR 1) intervention resulted in an immediate decrease in Karen's rate of SIB

($M = 0.2$) and a gradual increase in her rate of alternative responding ($M = 4.2$; only unprompted alternative responses are shown in the figures for all participants). A return to contingent reinforcement for SIB resulted in an immediate increase in SIB ($M = 7.3$) to levels observed in the initial CR condition. A return to the DRA condition again resulted in an immediate and sustained decrease in SIB ($M = 0.1$) and maintenance of the alternative response ($M = 4.9$). These data indicated that the DRA intervention in which SIB was placed on extinction and an alternative response was reinforced on an FR 1 schedule was successful in eliminating SIB and strengthening the alternative response. However, the DRA component resulted in unacceptably high rates of the alternative response (e.g., a response about every 12 s). This outcome seemed impractical (necessitating almost continuous therapist involvement) and particularly prone to failures of treatment integrity. Therefore, several strategies for thinning the schedule of reinforcement and making the intervention more practical to implement were evaluated. The goal of these strategies was to produce an arrangement under which (a) problem behavior either did not occur or occurred at rates much lower than those observed in baseline and (b) the newly acquired alternative response was maintained but did not occur at excessively high rates.

FR 1 Delay

This arrangement, in which delays were programmed between occurrences of the alternative response and the delivery of reinforcement, resulted in a temporary increase in the rate of the alternative response as the delay was increased to 8 s. However, as the delay to reinforcement was increased further (to 16 s and then to 25 s), alternative responding decreased sharply and appeared to be extinguished (no alternative responses occurred in four of the last five sessions). As

the alternative response appeared to be weakening under the increasing delays, SIB also reemerged at low but variable rates. This pattern of alternative and problem behavior was similar to that observed by Fisher *et al.* (2000) under similar conditions of reinforcement delay.

Supplemental calculations were included to evaluate additional effects of the schedule-thinning procedures (bottom panel of Figure 1). The percentage of reinforcers earned was calculated by dividing the actual number of reinforcers earned within a session by the total number of reinforcers that were available (or that could have been earned) within a session and multiplying by 100%. For example, in a 10-min session in which an FR 1 schedule without a delay is arranged, 60 reinforcers (one every 10 s) are available. If the participant emitted five alternative responses per minute and earned 50 of the 60 reinforcers, then the percentage of reinforcers earned would be 83%. Karen earned most of the available reinforcers during baseline (CR; $M = 79\%$) and DRA FR 1 without delay ($M = 72\%$) conditions. However, as the delay between the alternative response and reinforcement increased during the FR 1 delay condition, the percentage of reinforcers earned began to decrease and eventually reached zero.

An additional measure, the percentage of alternative responses that resulted in reinforcement, was calculated by dividing the number of reinforcers earned by the number of alternative responses within each session and multiplying by 100%. During the DRA FR 1 (without delay) condition, the mean percentage of alternative responses that resulted in reinforcement was 87% (it was not 100% under these conditions because some responding occurred while Karen had access to the reinforcer). As the delay between alternative responding and reinforcement increased, the percentage of alternative responses that resulted in reinforcement be-

came more variable. It appeared that, although more alternative responses were being emitted under the FR 1 delay condition, at times, few of these responses resulted in reinforcement. Taken together, these data suggest that the FR 1 delay condition resulted in a weakening of the contingency between alternative responding and reinforcement that was sufficient to extinguish the newly acquired alternative response and evoke problem behavior.

Fixed Interval

As the delay interval increased under the FR 1 delay procedure, the likelihood that an alternative response would be followed by reinforcement decreased. This contingency-weakening effect of the FR 1 delay procedure might be circumvented by programming the delays following reinforcement and by providing subsequent reinforcement immediately following the first response that occurs after a specified time interval expires. This subtle change in procedures results in an FI schedule of reinforcement. A return to the FR 1 condition without delay was conducted prior to the evaluation of FI schedules and resulted in (a) SIB returning to zero, (b) increased alternative responding that became stable ($M = 4.1$ responses per minute), (c) the majority of available reinforcers being earned ($M = 63\%$), and (d) a high percentage of alternative responses resulting in reinforcement ($M = 94\%$). The initiation of the FI schedule of reinforcement for alternative responding resulted in a small and immediate increase followed by a sharp increase in the rates of alternative responding that eventually became stable (mean for the last five sessions of the condition was 12.5 responses per minute). Even though the percentage of alternative responses that produced reinforcement was low (mean percentage for the last five sessions of the condition was 7%), Karen earned most of the available reinforcers (mean percentage

for the last five sessions of the condition was 91%). These data are interesting in that, under the FR 1 delay condition, the percentage of alternative responses that produced reinforcement was higher than that observed under the FI condition ($M = 65\%$ and 23%, respectively), and fewer of the available reinforcers were earned under the FR 1 delay condition than under the FI condition ($M = 40\%$ and 77%, respectively). This discrepancy seems most likely related to the subtle contingency-weakening (FR 1 delay) and contingency-strengthening (FI) effects of these two procedures for thinning reinforcement schedules within DRA interventions.

In many ways, the FI schedule resulted in the desired pattern of behaviors because SIB remained near zero ($M = 0.1$ responses per minute), alternative responding was maintained, and the overall availability of reinforcement was decreased. However, the FI arrangement engendered a different but still problematic situation in that the alternative response occurred at extremely high rates (over three times that observed during the FR 1 condition). This response pattern could be disruptive in the home or workshop (or classroom) as well as disturbing to the person responsible for delivering reinforcement, especially as the interval is about to expire.

Multiple Schedule: FR 1 Extinction

High rates of alternative responding that occur during the FI schedule (i.e., those that do not result in reinforcement) may be reduced by enhancing discrimination between the availability and unavailability of reinforcement through the pairing of distinctive (discriminative) stimuli with the two conditions. This type of arrangement, in which stimuli are correlated with alternating periods of reinforcement and extinction, results in a multiple schedule.

Prior to introducing the multiple-schedule

condition, a return to the FR 1 condition was conducted and produced patterns similar to those observed previously (i.e., zero SIB, moderate and stable rates of alternative responding). As the multiple-schedule component durations were changed, alternative responding during the FR 1 and extinction components was measured separately and revealed different patterns of responding during the two components. A stable rate of alternative responding consistent with, although slightly higher than, that observed in previous FR 1 conditions was observed throughout the FR 1 component of the multiple-schedule condition ($M = 5.2$). As can be seen from the data in the bottom panel of Figure 1, Karen earned larger percentages of reinforcement ($M = 83\%$) under the multiple schedule arrangement than under the previous FR 1 condition ($M = 72\%$). Alternative responding during the extinction component initially increased to extremely high rates (mean for the first five sessions was 26.7 responses per minute); however, as the component durations were altered across successive sessions (and more alternative responses contacted relevant contingencies in the presence of different stimuli), the rate of alternative responses decreased to near zero during the extinction component (mean for the last five sessions was 0.9 responses per minute). Reduced rates of SIB under the extinction component and the efficient alternative responding observed during the FR 1 component resulted in most of the alternative responses producing reinforcement ($M = 55\%$).

In the final multiple-schedule arrangement, 1-min periods of reinforcement for alternative responding alternated with 4-min periods of extinction. Under these conditions, SIB remained at zero, and most alternative responses were emitted when reinforcement was available (few were emitted when reinforcement was unavailable). It appears that the multiple-schedule arrange-

ment was effective in (a) maintaining low rates of SIB while (b) maintaining a strong contingency between alternative responding and reinforcement, (c) maintaining low levels of alternative responding when reinforcement was not available, and (d) decreasing the overall availability of reinforcement (and necessary supervision) from continuous to one fifth of the time.

STUDY 2: EVALUATION OF SCHEDULE-CORRELATED STIMULI

PROCEDURE

Functional analyses, evaluations of DRA procedures, and assessments of schedule-correlated stimuli were conducted with Jake and Julie. The functional analyses were arranged in multielement designs, the effects of the treatment were assessed in reversal designs, and the effects of schedule-correlated stimuli were assessed in multielement and reversal designs. Two therapists alternated within sessions for both participants, except during the multielement evaluations of schedule-correlated stimuli, when one therapist conducted the multiple-schedule sessions and a second therapist conducted the mixed-schedule sessions.

Functional Analyses and DRA Evaluations

A functional analysis (Iwata *et al.*, 1994) similar to that described for Karen was conducted to determine if Jake's SIB (his aggression was measured but not included in the contingency class) was maintained by edible and material reinforcement and if Julie's SIB and aggression were maintained by attention. In one condition, the putative reinforcer was delivered contingent on problem behavior (CR); in the other condition, the same reinforcer was available noncontingently (NCR). As noted previously, Jake's

SIB usually resulted in access to preferred items. On several occasions, snacks or activities such as listening to his radio were provided following episodes of SIB. Therefore, M&Ms® and a radio were chosen as reinforcers during his assessment and treatment. Reports from staff and results from structured observations suggested that Julie's problem behaviors often occurred when staff members were not directly interacting with Julie and that her problem behavior often resulted in strong reactions (e.g., verbal reprimands) from peers and staff. Therefore, attention (statements of concern, comments on her play behavior, and brief physical contact) was included as reinforcement throughout Julie's evaluations. During Jake's sessions, no materials other than the session furniture and reinforcers were included in the session room. During all of Julie's sessions, drawing materials were located on the table. During the CR condition, instances of SIB (Jake) or SIB and aggression (Julie) produced 10-s access to a plate of M&Ms® and a radio (Jake) or 10-s access to social interaction (Julie). During the NCR condition, the materials or social interaction were continuously available, and problem behavior did not result in any programmed consequences. An extinction condition, in which attention was completely unavailable throughout the session, also was included for Julie.

The CR condition of the functional analysis was used as a baseline to evaluate the effects of a DRA intervention in which pressing a microswitch that emitted the sound "talk to me, please" (Julie) or the manual sign "more" (Jake) was reinforced while problem behavior was placed on extinction. During the DRA condition, an FR 1 schedule was arranged such that each instance of the alternative response resulted in 10-s access to reinforcement. Physical and gestural prompts were used initially to occasion the alternative response but were gradually removed during the first treatment session, as described for Karen.

A return to the CR condition, in which reinforcement was delivered contingent upon occurrences of SIB, was conducted with Julie (the microswitch was unavailable in this condition) and was followed by a return to the DRA condition.

Evaluation of Schedule-Related Stimuli: Multiple Versus Mixed Schedules

Karen's data (Study 1) showed that a multiple-schedule arrangement, in which alternative responses resulted in reinforcement only during signaled interspersed periods of time, was effective in maintaining low levels of problem behavior and reducing the overall rate of alternative responding while maintaining its strength as a discriminated operant. Her data also suggested that the stimuli correlated with the FR and extinction schedules may have been instrumental in maintaining high rates of alternative responding during the FR component and low rates during extinction. However, similar patterns of behavior may have been observed simply by introducing gradually longer extinction periods in the absence of any schedule-related stimuli. Therefore, the importance of the schedule-related stimuli was evaluated with Jake and Julie through a comparison of multiple-schedule (alternation between signaled periods of reinforcement and extinction) and mixed-schedule (alternation between unsignaled periods of reinforcement and extinction) arrangements. As was the case for Karen, the multiple schedule consisted of two components: an FR 1 component (white card) in which each alternative response produced 10-s access to reinforcement, and an extinction component (red card) in which alternative responses produced no reinforcement. No experience with the red or white cards was arranged in conditions prior to the evaluation of mixed and multiple schedules. Initially, the component durations were set at 45 s and 15 s for FR 1 and extinction, respectively. Alter-

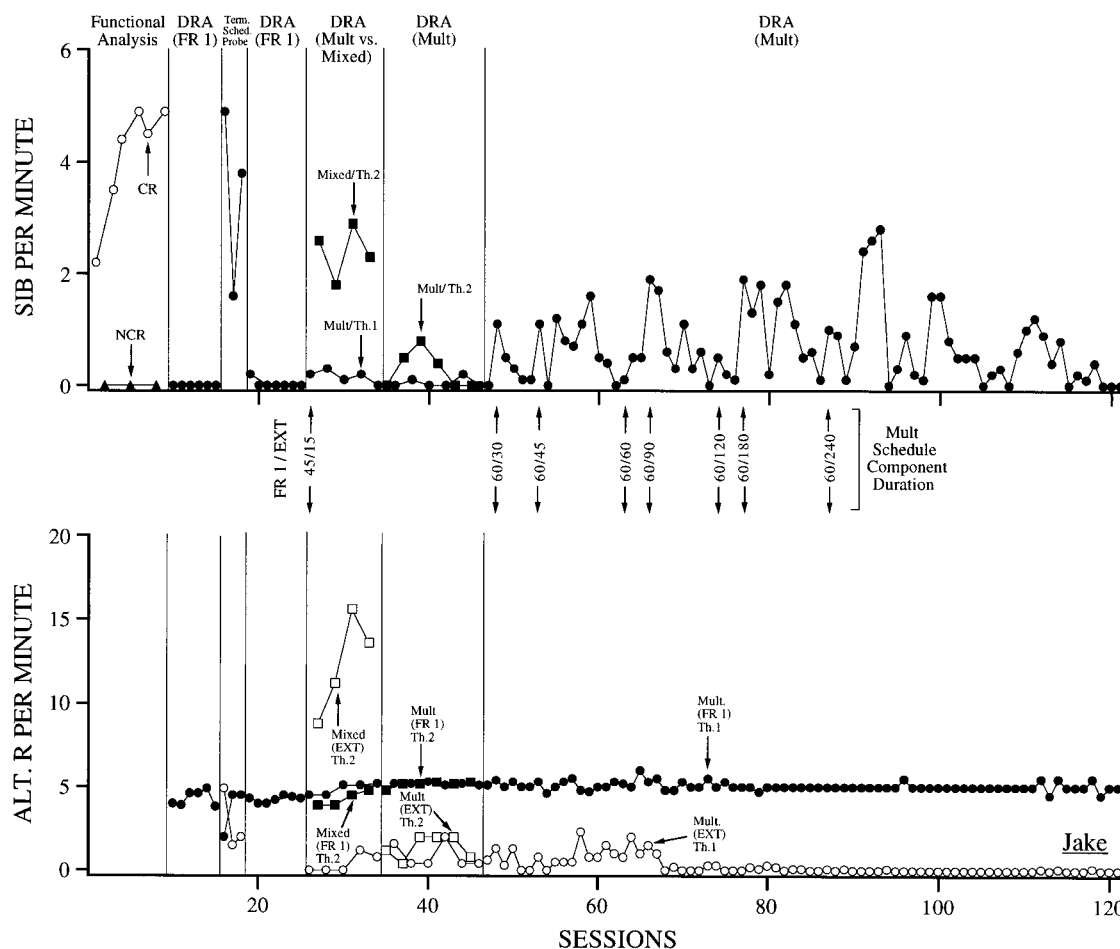


Figure 2. Number of self-injurious (top panel) and alternative (bottom panel) responses per minute during Jake's functional analysis, treatment assessment, and evaluation of schedule-correlated stimuli.

native responses that occurred in the presence of the white and red cards were scored separately. The mixed-schedule condition involved the same contingencies; however, the schedule-correlated stimuli (white and red cards) were not present in these sessions. During both conditions, SIB resulted in no programmed consequences. Schedule thinning was accomplished by gradually altering the durations of the components following two consecutive sessions in which SIB remained at or below 85% of the baseline mean (see Figures 2 and 3 for graduated component durations). Procedural elements particular to each of the participants are described below.

Jake. Prior to the evaluation of schedule-correlated stimuli, probes of the terminal multiple schedule (i.e., alternation between 60 s of FR 1 and 240 s of extinction) were conducted to determine if gradual schedule thinning was actually necessary. Following these terminal-schedule probes, a return to the continuous FR 1 condition was conducted, followed by the comparison of multiple (conducted by Therapist 1) and mixed (conducted by Therapist 2) schedules. During this comparison, the duration of the schedule components was held constant (45 s of FR 1 and 15 s of extinction). Once the relative effectiveness of the multiple and mixed schedules was demonstrated, the

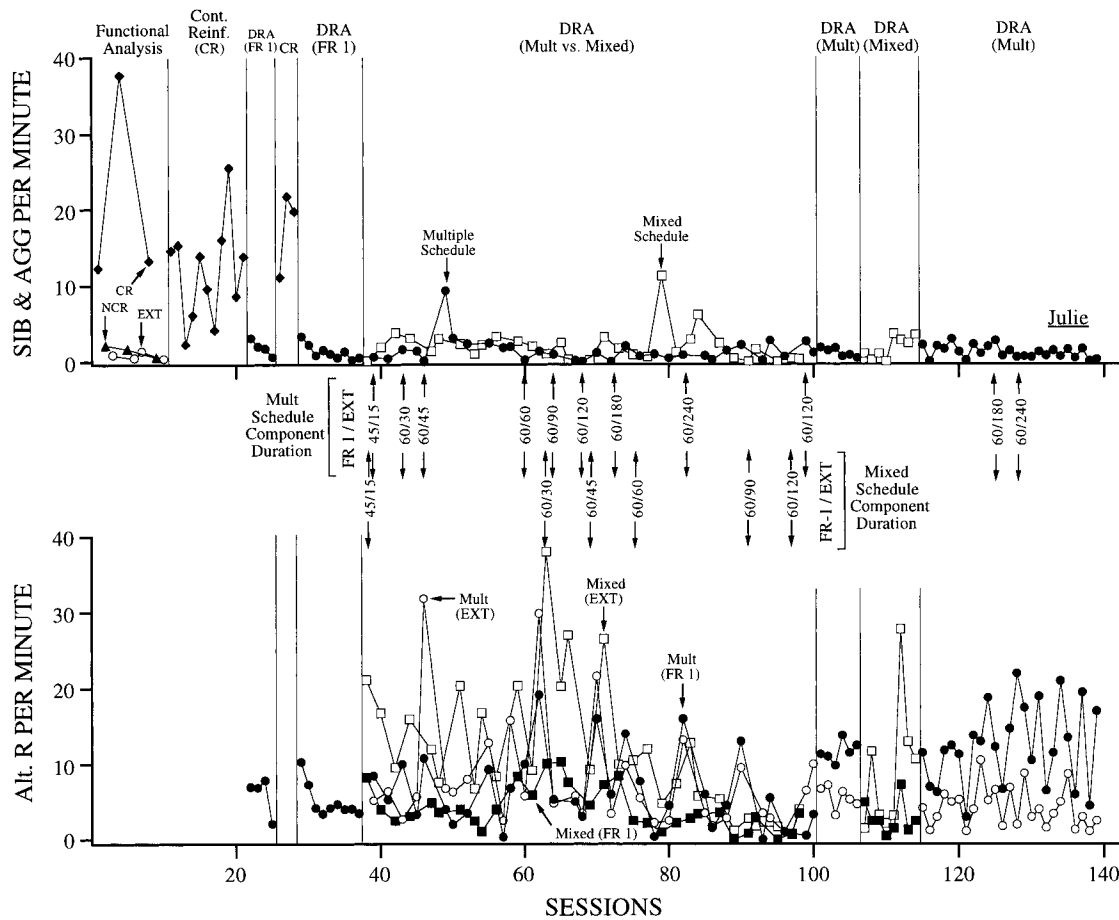


Figure 3. Number of self-injurious and aggressive behaviors (top panel) and alternative responses (bottom panel) per minute during Julie’s functional analysis, treatment assessment, and evaluation of schedule-correlated stimuli.

schedule-correlated stimuli were incorporated into the mixed-schedule sessions conducted by Therapist 2. This addition, in essence, changed the mixed schedule into a multiple schedule. Finally, the multiple-schedule sessions were conducted until low levels of SIB occurred under the terminal-schedule arrangement.

Julie. Following the initial evaluation of schedule-correlated stimuli (red and white cards) in a multielement design, supplemental schedule-correlated stimuli were added to the multiple-schedule condition beginning with Session 101. During the FR 1 (white card) component, the therapist sat facing Ju-

lie while attending to a magazine (no eye contact or interaction occurred unless an alternative response was emitted); during the extinction (red card) component, the therapist sat with his or her back towards Julie while attending to a magazine. Prior to conducting the series of multiple- and mixed-schedule sessions in a reversal design, the multiple-schedule component durations were altered to match those operating in the mixed schedule (60 s of FR 1 and 120 s of extinction). Finally, the multiple-schedule sessions were conducted until low levels of SIB occurred under the terminal-schedule arrangement.

RESULTS AND DISCUSSION

The top panels of Figures 2 and 3 show rates of problem behavior during the functional analyses, DRA evaluations, and assessments of schedule-correlated stimuli for Jake and Julie, respectively. The bottom panels of Figures 2 and 3 show rates of alternative responding under FR 1 and extinction throughout the analyses.

Functional Analyses and Initial DRA Evaluations

Jake. Rates of SIB were high during the test condition in which food and a radio were available following instances of SIB ($M = 4.1$), but no SIB was observed when the same reinforcement was available continuously. These data support the hypothesis that Jake's SIB was maintained by tangible items. During the DRA condition, immediate decreases in SIB ($M = 0$) and increases in alternative responding ($M = 4.3$) were observed.

Julie. High rates of both SIB and aggression were observed ($M = 21.1$) in the contingent attention condition (CR). By contrast, low rates of SIB and aggression were observed when therapist attention was either unavailable throughout the session (extinction; $M = 1.5$) or available continuously (NCR; $M = 0.8$). Thus, results of Julie's functional analysis indicated that her problem behavior was maintained by attention. Due to the variability of Julie's problem behavior during the functional analysis (and the brevity of her assessment), a CR baseline was conducted prior to the DRA evaluation ($M = 11.8$). During the DRA condition, immediate decreases in problem behavior ($M = 1.9$) and increases in alternative responses ($M = 6.0$) were observed. These effects were replicated by observing behavior during a return to baseline (CR; $M = 17.5$) and a return to the DRA condition (M for SIB and aggression = 1.3; M for alternative responses = 5.1). Thus, clear shifts in the

patterns of problem and alternative behaviors were observed for both participants when the reinforcers identified in their functional analyses were withheld following instances of problem behavior and delivered for alternative responses.

Evaluation of Schedule-Correlated Stimuli: Multiple Versus Mixed Schedules

Jake. Prior to evaluating the effects of schedule-correlated stimuli, responding was observed under the terminal multiple-schedule arrangement, in which 1-min periods of signaled FR 1 were alternated with 4-min periods of signaled extinction. Under this condition (labeled terminal-schedule probe on Figure 2), Jake engaged in high rates of SIB ($M = 3.4$) even though SIB was placed on extinction. Jake also continued to engage in the alternative response during both the FR 1 ($M = 3.7$) and extinction ($M = 2.8$) components; however, alternative responding approached zero during the extinction components in the latter part of each session. These data indicated that an abrupt shift to a thin schedule of reinforcement for alternative behavior was unwarranted, and we returned to the FR 1 schedule (DRA) to reestablish low rates of SIB and stable rates of alternative responding prior to evaluating the effects of schedule-correlated stimuli.

During the multiple-schedule arrangement, in which 45-s periods of signaled FR 1 were alternated with 15-s periods of signaled extinction, Jake engaged in low rates of SIB ($M = 0.2$), low rates of alternative responding during the extinction components ($M = 0.4$), and high rates of the alternative response during the FR 1 schedule component ($M = 4.9$). Presumably, discrimination between the red and white cards had developed during the terminal-schedule probes, as evidenced by initial zero rates of the alternative response during the extinction component of the multiple schedule. During the mixed arrangement conducted

by a second therapist, in which schedule-correlated stimuli were not present, Jake engaged in high rates of SIB ($M = 2.4$) and alternative responding during both the FR 1 ($M = 4.3$) and extinction ($M = 12.3$) components. These data show that the addition of the schedule-correlated stimuli resulted in two important outcomes: (a) Alternative responding occurred almost exclusively during the FR 1 component under the multiple-schedule arrangement but almost indiscriminately throughout the sessions under the mixed-schedule arrangement, and (b) SIB occurred at near-zero rates under the multiple-schedule arrangement but at higher rates under the mixed-schedule arrangement. Although both the multiple and mixed schedules programmed extinction continuously for SIB and intermittently for alternative responding (i.e., for 15 s out of every minute), few alternative responses contacted extinction in the multiple-schedule condition (about 8%) whereas a larger percentage of alternative responses (about 74%) contacted extinction in the mixed-schedule condition. In addition, higher rates of aggression were observed under the mixed-schedule condition ($M = 2.4$) relative to the multiple-schedule condition ($M = 0.1$) (aggression had not been observed in Jake's assessment until this phase of the evaluation). Thus, it appears that nonreinforcement of the newly acquired alternative response (engendered by the absence of salient stimuli correlated with reinforcement and extinction in the mixed-schedule condition) may have had the undesirable effect of evoking other behavior that either had an established (SIB) or presumed (aggression) history of producing similar reinforcement (Goh & Iwata, 1994).

Further evidence of control exerted by the schedule-correlated stimuli was demonstrated by introducing these stimuli in sessions conducted by the second therapist; this functionally changed the mixed schedule to a multiple

schedule. Both multiple-schedule conditions resulted in low rates of SIB ($M = 0.04$ and 0.3) and alternative responding ($M = 0.8$ and 1.4) during signaled extinction periods and stable levels of alternative responding during signaled FR 1 periods ($M = 5.2$ and 5.2) for Therapists 1 and 2, respectively.

The remainder of Jake's assessment involved the gradual lengthening of extinction periods. Rates of SIB were somewhat variable across this phase of the assessment, but were consistently lower than those observed in baseline. An increase in SIB was observed each time a longer extinction component duration was introduced (see arrows below the horizontal axis of the top panel in Figure 2), suggesting that changes in the multiple-schedule component durations should have been more gradual. However, this conclusion is speculative given the overall variability in alternative responding observed throughout this phase in the absence of schedule changes. Nevertheless, low rates of SIB (and zero rates of aggression) were observed at the terminal schedule, in which 1-min periods of reinforcement alternated with 4-min periods of extinction. Rates of alternative responding became less variable under the extinction component and eventually were extinguished (zero in 32 of the last 40 sessions), whereas alternative responding was maintained at a stable rate in the FR 1 component throughout the entire assessment ($M = 5.1$). At the end of the assessment, Jake was not engaging in SIB (or other problem behaviors such as aggression) and was emitting alternative responses only at times in which the likelihood of reinforcement was high.

Julie. The multiple- and mixed-schedule conditions both maintained relatively low rates of aggression and SIB throughout the multielement evaluation ($M = 1.4$ and 2.1 , respectively) relative to baseline. Although Julie's alternative responding was highly variable within the multielement comparison, a

few general patterns emerged. Higher rates of the alternative response were observed during the FR 1 component in the multiple-schedule condition ($M = 6.4$) than in the mixed-schedule condition ($M = 4.1$), and lower rates of the alternative response were observed during the extinction component in the multiple-schedule condition ($M = 7.9$) than in the mixed-schedule condition ($M = 11.8$). These data suggest that the schedule-correlated stimuli (colored cards) exerted some control over alternative responding; however, the effects may have been mitigated by multiple treatment interference engendered by the multielement design or simply were weak due to the schedule-correlated stimuli not being sufficiently salient. As a result, changes were made in the experimental design (repeated observations within a single condition were conducted in lieu of rapid alternation between two conditions) and the saliency of the schedule-correlated stimuli (the therapist oriented towards or away from Julie during the FR 1 and extinction conditions, respectively).

During the initial multiple-schedule condition, relatively high rates of the alternative response were observed during the FR 1 component ($M = 11.7$) relative to the extinction component ($M = 5.7$), whereas rates of SIB remained low ($M = 1.0$). These patterns were reversed during the mixed-schedule condition, in that relatively higher alternative response rates were observed during extinction ($M = 9.2$) than during FR 1 ($M = 2.9$). A return to the multiple-schedule condition replicated the initial pattern in which higher rates of the alternative response were observed during the FR 1 component. Julie's data replicate the effects of schedule-correlated stimuli observed with Jake (and suggested by Karen's data). At the end of the study, Julie's SIB remained near zero (mean for the last 10 sessions was 0.8) and most of her alternative responses (74.9%) were emitted

under the FR 1 schedule component as reinforcement was available for 1 of every 5 min within the multiple schedule.

Within-Session Analysis

If intermittent schedules are used to increase the practicality or acceptability of DRA interventions, and if the components of these schedules are not discriminable to the individuals for whom these treatments are planned, two undesirable patterns of behavior may emerge. Both of these patterns were evident in Julie's data and can be seen in Figure 4, which shows the cumulative number of alternative responses across schedule components (e.g., FR 1 and extinction) within 10-s bins for three sessions from her assessment of schedule-correlated stimuli. These three particular sessions were selected because they provide clear examples of likely patterns of performance under these different schedule arrangements.

During Mixed Session 107, alternative responding continually occurred during the initial 1-min FR 1 component; however, after contacting the extinction contingency in the second component, alternative responding never recovered. In the absence of stimuli associated with the resumption of reinforcement for alternative responses, periods of extinction for newly acquired alternative responding may have weakened the contingency sufficiently to extinguish this behavior. If this pattern continued for an extended period, behaviors that historically produced similar reinforcement might reemerge.

A second undesirable pattern that may be engendered by the absence of schedule-correlated stimuli was evident in the data for Mixed Session 112, in that high levels of alternative responding may occur during a scheduled extinction period and culminate in reinforcement. Successively higher rates of responding observed within each extinction period during Session 112 were followed by access to reinforcement when responding

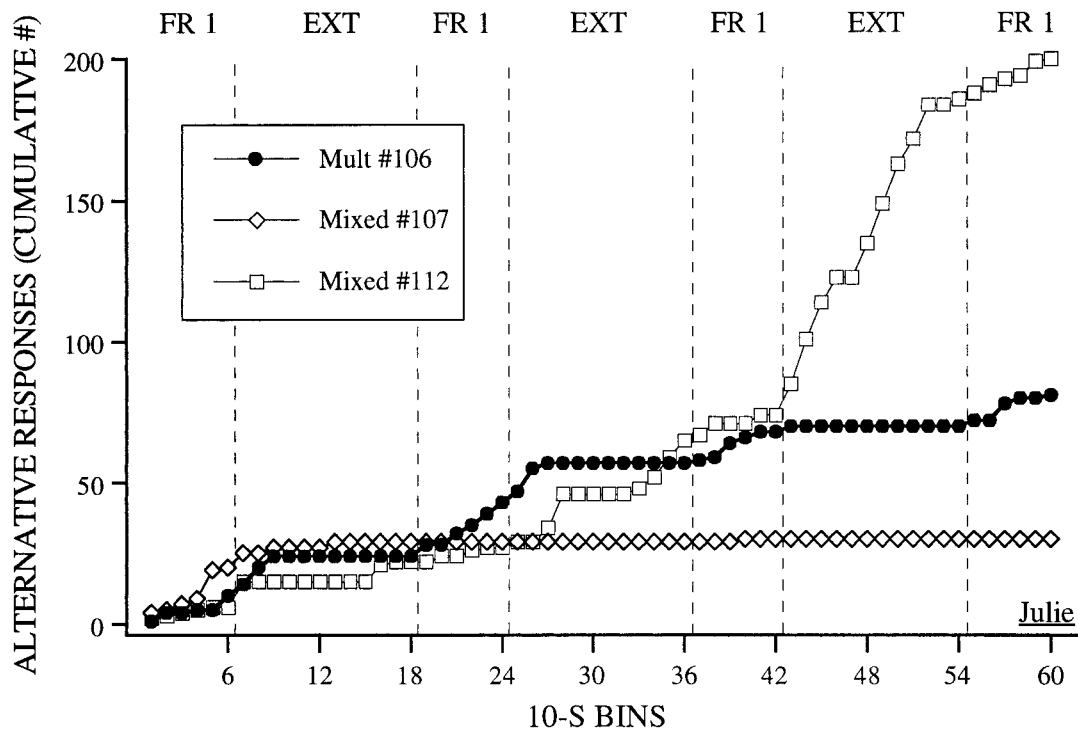


Figure 4. Cumulative number of alternative responses across schedule components for three sessions from Julie's assessment of schedule-correlated stimuli. Open symbols represent two mixed-schedule sessions; filled symbols represent a single multiple-schedule session.

continued into the FR 1 component. This pattern seemingly increased the likelihood that high rates of alternative behavior continued to occur under extinction and is undesirable for the same reason that FI schedules may not be preferred: High rates of the alternative behavior (even though they may not be reinforced) may be disruptive in certain contexts (e.g., classrooms, restaurants).

The pattern of behavior evident in the data from Multiple Session 106 exemplifies the benefits of including schedule-correlated stimuli. During the signaled FR 1 components, alternative responding occurred at steady rates. However, when the contingency as well as the schedule-correlated stimuli changed from reinforcement to extinction, responding rapidly ceased. These data show that the alternative response was not completely eliminated following a period of extinction (e.g., Mixed Session 107), nor did

unacceptably high rates of responding during extinction result in reinforcement (e.g., Mixed Session 112); rather, the alternative response predominantly occurred when and only when reinforcement was available. Although the clinical outcome of Julie's evaluation is compromised somewhat by the continued high rates of alternative responding at the end of the study, her data clearly demonstrate the importance of schedule-correlated stimuli when attempting to decrease the availability of reinforcement within DRA interventions.

GENERAL DISCUSSION

Based on data obtained during pairwise functional analyses, which showed that the problem behaviors (SIB and aggression) of 3 individuals were maintained by social-positive reinforcement, DRA interventions com-

monly described as FCT were successful in decreasing the frequency of problem behaviors and increasing the frequency of alternative behaviors. Several methods for thinning the schedule of reinforcement for alternative behavior were then evaluated. A reinforcement-delay procedure resulted in extinction of the alternative response and slight recovery of SIB for 1 participant (Karen). An FI schedule resulted in unacceptably high rates of the alternative response for the same participant. A mixed schedule resulted in indiscriminate alternative responding (Jake and Julie) and recovery of SIB (Jake only). Finally, a multiple schedule involving the alternation of signaled periods of reinforcement and extinction was successful in decreasing the overall rate of alternative responding and its rate of reinforcement while maintaining near-zero levels of problem behavior for the 3 participants.

The thinning of reinforcement schedules for alternative behavior is rarely demonstrated or discussed in most research on FCT; nevertheless, procedures for accomplishing this goal are important to the integrity of FCT interventions under more natural conditions. Some authors have reported that rates of communication occur at manageable levels immediately following training (Durand, 1999; Durand & Carr, 1991, 1992); however, this outcome is not evident in most studies in which data on communication are presented (e.g., Campbell & Lutzker, 1993; Carr & Durand, 1985; Fisher *et al.*, 1993; Frea & Hughes, 1997; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997; Shukla & Albin, 1996; Wacker *et al.*, 1990). Typically, rates of communication following training are often as high as those observed for the problem behavior prior to training. Given that most FCT studies also involve FR 1 reinforcement for the alternative response, it seems unlikely that caregivers could maintain consistency under such an arrangement.

Results obtained with the delay procedure (Karen) replicated those of basic research on the effects of delays to reinforcement (Lattal, 1984; Williams, 1976) as well as those reported by Fisher *et al.* (2000) and Hagopian *et al.* (1998), in that increasing delays were associated with decreases in the target or alternative behavior and increases in problem behavior. However, responding has been maintained during delays to reinforcement when a brief (Schaal, Schuh, & Branch, 1992) or continuous (Lattal; Richards, 1981) signal was present during the delay. For example, Vollmer, Borrero, Lalli, and Daniel (1999) showed that, in the absence of a stimulus signaling a delay to reinforcement for appropriate behavior, their participant engaged in problem behavior (which produced immediate reinforcement); these results were reversed with the addition of a continuous signal during delays to reinforcement. These data provide some evidence of the importance of signaled delays to reinforcement in FCT interventions.

Signaled delays, however, may pose some limitations. Hagopian *et al.* (1998) reported that a brief signal at the beginning of delay periods resulted in limited success (only 42% of participants reached the terminal goal under these conditions). Even under continuously signaled delays, contingency-weakening effects may be evident (Lattal, 1984), in that rates of responding are lower during delayed reinforcement relative to conditions of immediate reinforcement (independent of the length of the delay or the signaling procedure). By shifting the delay from between the emission of a response and reinforcement to the time period between successive reinforcements (essentially changing a delay procedure to an FI schedule), a strong contingency is maintained. Although the FI schedule may engender different problems (excessive response rates) than those observed with the reinforcement-delay procedure, this arrangement may be prefer-

able if high rates of the alternative response are tolerable. For instance, if social reinforcement were to be delivered for academic or vocational behavior whose occurrence at high rates would not be disruptive (as opposed to potentially distracting vocal mands for reinforcement), an FI schedule might be attractive as a maintenance procedure. Alternatively, Long (1962) showed that the use of an external "clock" (a light that changed from dim to bright as the interval was to expire) reduced responding during the inter-reinforcement interval of an FI schedule. A similar signaling procedure may be helpful in generating desirable patterns of behavior during FCT interventions.

As an alternative to both reinforcement delay and FI schedules, the multiple-schedule arrangement was most effective in thinning reinforcement for alternative behavior while maintaining adequate rates of the alternative response and suppression of problem behavior. The multiple schedule facilitated rapid schedule control and subsequent stimulus control over alternative responding such that it occurred either when and only when (Jake) or predominantly when (Karen and Julie) reinforcement was available for such behavior. The successive FR 1 periods allow the newly acquired alternative response to be reinforced frequently and immediately, thereby maintaining a strong contingency. Although periods of nonreinforcement are introduced, the contingency between the alternative response and reinforcement should remain strong due to the infrequent occurrence of unreinforced responses engendered by the inclusion of a distinctive stimulus (S^A) during periods of extinction. Thus, the multiple schedule may facilitate the programming of extended periods during which alternative behavior is not reinforced without degrading the alternative response-reinforcer relation.

An alternative to the multiple-schedule procedure used in the present study consists

of limiting access to the alternative response (i.e., the microswitch or other augmentative communication systems such as picture cards) to times when reinforcement is available. The augmentative device itself should come to occasion responding; no responding would occur when reinforcement is unavailable (simply because it cannot occur in the absence of the device). However, this arrangement may be feasible only when it is possible to restrict access to the alternative response, which would not be the case if the alternative response were vocal or gestural.

The procedures described in the present study involved arbitrary, but salient and transportable, discriminative stimuli to occasion (white cards) or inhibit (red cards) responding. Although a variety of stimuli that typically precede the delivery of reinforcement in natural settings may, over time, occasion responding, these stimuli may not necessarily be predictive of the availability of reinforcement (e.g., social reinforcement is not always available each time a parent enters the room, especially if he or she is about to answer the phone). Arbitrary stimuli may be preferred to more naturally occurring stimuli because better stimulus control might develop and override preexisting, but only somewhat predictive, naturally occurring discriminative stimuli. However, additional research is needed to identify methods for selecting discriminative stimuli (artificial or naturally occurring) that are salient, functional across a variety of settings, and preferred by those who will use them. Questions regarding the speed with which extinction periods can be introduced, the relative effectiveness of fixed versus variable component durations, and alternative strategies for producing desirable performance under DRA contingencies also could be addressed in future studies. For example, differential-reinforcement-of-low-rate-behavior schedules (see Vollmer & Iwata, 1992, for a discussion of the clinical utility of these sched-

ules) or increasing the effort involved in emitting an alternative response (cf. Horner & Day, 1991) may prove useful in producing outcomes similar to those observed in this study.

Finally, although the signaling procedures produced generally desirable response patterns during schedule thinning for the 3 participants in this study, the procedures inevitably involve gradual reintroduction of the establishing operation for problem behavior over successively longer periods of time. Although discriminative control over alternative responding may be achieved, schedule thinning may eventually evoke the problem behavior, especially as one nears the terminal schedule. Jake's data (Figure 2) provide evidence of this phenomenon. This problem might be avoided by making other sources of reinforcement available at times when the reinforcer that maintains problem behavior is unavailable. For example, Fisher *et al.* (1998) arranged a second alternative response to produce an arbitrary reinforcer (i.e., one that was not functionally related to the problem behavior) when the maintaining reinforcer was unavailable. This procedure resulted in suppression of problem behavior even as the maintaining reinforcer was available intermittently. The noncontingent delivery of arbitrary reinforcers has also been shown to maintain low rates of problem behavior even when its establishing operation is present (Fischer, Iwata, & Mazaleski, 1997; Hanley, Piazza, & Fisher, 1997) and may be effective in eliminating problem behavior during periods of extinction for newly acquired alternative responses (see Fisher *et al.*, 2000, for an example of this strategy).

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STUDY QUESTIONS

1. How are NCR and DRO schedules typically thinned, and why are these procedures not applicable to DRA thinning?
2. How were the functional analyses conducted? What are the advantages and disadvantages of this approach relative to a more typical full-scale assessment?
3. Describe the results of the three thinning procedures for Karen in terms of their effects on target behaviors, alternative responses, percentage of reinforcers earned, and percentage of alternative responses resulting in reinforcement.
4. What is the difference between mixed and multiple schedules?
5. What was the terminal-schedule probe to which Jake was exposed, and what was its purpose?
6. Summarize the results obtained for Julie.
7. Summarize the results depicted in Figure 4. What undesirable characteristics of mixed schedules are reflected in these data?
8. What characteristics of multiple schedules make them attractive as a means of thinning reinforcement schedules during DRA interventions?

Questions prepared by Juliet Connors and Eileen Roscoe, The University of Florida