JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1998, **31,** 529–542 NUMBER 4 (WINTER 1998)

FIXED-TIME SCHEDULES ATTENUATE EXTINCTION-INDUCED PHENOMENA IN THE TREATMENT OF SEVERE ABERRANT BEHAVIOR

TIMOTHY R. VOLLMER, PATRICK R. PROGAR, JOSEPH S. LALLI, CAROLE M. VAN CAMP, BARBARA J. SIERP, CARRIE S. WRIGHT, JULIA NASTASI, AND KEVIN J. EISENSCHINK

UNIVERSITY OF PENNSYLVANIA SCHOOL OF MEDICINE AND CHILDREN'S SEASHORE HOUSE

We compared the effects of extinction (EXT) and fixed-time (FT) schedules as treatment for severe problem behavior displayed by 3 individuals with developmental disabilities. First, functional analyses identified the reinforcers maintaining aberrant behavior for all 3 individuals. Next, EXT and FT schedules were compared using a multielement design. During EXT, the reinforcer maintaining problem behavior was withheld. During FT, the reinforcers were presented response independently at preset intervals. Results showed that FT schedules were generally more effective than EXT schedules in reducing aberrant behavior. FT schedules may be used in situations when extinction-induced phenomena are problematic.

DESCRIPTORS: fixed-time schedules, extinction, noncontingent reinforcement, self-injury, aggression, functional analysis

Extinction (EXT) involves the discontinuation of reinforcement (e.g., Catania, 1992). Traditionally, EXT has been accomplished by withholding a previously consequent reinforcer when a response occurs (Lerman & Iwata, 1996), and the result is a disruption in the contingency between response and reinforcer. Response-independent schedules, such as fixed-time (FT) or variable-time (VT) schedules, also eliminate the contingency between a response and a reinforcing event because responding does not alter the probability of a reinforcer delivery (Catania, 1992; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). In this study, we evaluated the effects of EXT and FT schedules in the treatment of severe problem behavior. Extinction involved withholding reinforcers that previously had been presented contingent on problem behavior. Fixed-time schedules involved presenting reinforcers on a response-independent time-based schedule. The FT schedule has been described previously in applied behavior analysis as noncontingent reinforcement (NCR); however, we will use the term FT in this article because the central purpose of the study was to evaluate schedule effects.

There are several reasons to conduct an evaluation of EXT and FT schedules. First, previous studies have shown that FT schedules can be effective as treatment across multiple response functions, including behavior that was maintained by attention (e.g., Hagopian, Fisher, & Legacy, 1994), escape (e.g., Vollmer, Marcus, & Ringdahl, 1995), or access to materials (Lalli, Casey, & Kates, 1997). Vollmer et al. (1993) suggested that FT schedules may reduce the probability of problem behavior for at least two reasons: (a) The motivation to engage in problem behavior is reduced because reinforcers are available on a free and frequent basis; in a sense, the environment is enriched with access to positive reinforcers and the attenua-

We thank Kim Coleman for her assistance in conducting this study.

Reprints may be obtained from Timothy R. Vollmer, who is now at the Department of Psychology, University of Florida, Gainesville, Florida 32611.

tion of aversive stimuli (see Horner, 1980); and (b) the contingent relation between the response and a reinforcer is eliminated. Further, FT schedules are easier to implement than differential reinforcement of other behavior (DRO), for example, because there is never a need to reset a timer contingent on a response or to observe every instance of problem behavior (i.e., problem behavior has no effect on reinforcer delivery). Finally, some prior research has suggested that FT schedules may attenuate extinction-induced phenomena such as response bursts and response variation (Vollmer et al., 1993). Most behavioral treatment packages contain some means of disrupting response–reinforcer relations (such as extinction or NCR). However, no explicit comparison of EXT and FT schedules has been conducted in the applied context.

A second reason to evaluate EXT and time-based schedules is that basic and applied studies have yielded seemingly discrepant outcomes. Whereas applications of response-independent schedules have generally produced immediate and sustained reductions in aberrant behavior (e.g., Hagopian et al., 1994; Vollmer et al., 1993), laboratory research has shown that behavior may persist at a low level despite the absence of a response–reinforcer contingency. For example, Rescorla and Skucy (1969) showed that lever pressing in rats was suppressed relative to a reinforcement baseline with both VT and EXT schedules, but that lever pressing persisted at a higher level during VT than during EXT. It is possible that the VT schedule represented a context that was more similar to the reinforcement baseline (in VT, food was delivered on an average once per 2 min; in a variable-interval [VI] baseline, the response-dependent schedule also revolved around a 2-min average, VI 2 min). Similar findings were reported by Uhl and Garcia (1969), who compared DRO to EXT. Uhl and Garcia's results suggested that food served as a discriminative stimulus for lever pressing because rats pressed a lever almost immediately after receiving a food pellet according to the DRO schedule. Fewer lever presses were observed during EXT, presumably because no food was ever presented to serve as a stimulus for responding.

If the relations reported by Rescorla and Skucy (1969) and by Uhl and Garcia (1969) hold true in applied settings, response-independent schedules may be contraindicated in some cases. For example, noncontingent attention may produce temporary increases in attention-maintained aberrant behavior immediately following an attention delivery despite the absence of a response–reinforcer contingency. However, FT schedules in the applied context are considerably different than schedules that have been compared to EXT in the laboratory context. Specifically, in most applications of response-independent schedules, the FT interval is gradually increased beginning with continuous or near-continuous access to reinforcers and ending with a more manageable schedule (such as FT 5 min or FT 10 min). In contrast, schedules in basic work have typically been arranged to mimic baseline reinforcement rates. As such, it is not clear whether the negative side effect (response persistence associated with the stimulus properties of reinforcer delivery) is relevant to applied work if escalating FT schedules are used.

A third reason to evaluate EXT and FT schedules is to identify potential adverse side effects of either procedure, such as incidental reinforcement (with FT) or extinction-induced behavior (with EXT). Incidental reinforcement might occur if reinforcer delivery is contiguous to responding. Although incidental reinforcement is rare in published studies using FT or VT applications, it has been reported to occur under some conditions (e.g., Vollmer, Ringdahl, Roane, & Marcus, 1997). One potential advantage of EXT schedules is that, if they are applied

correctly, incidental reinforcement cannot occur. However, the possibility of extinction-induced phenomena (such as response bursting and response variation) needs to be balanced with the possibility of incidental reinforcement or other potential side effects of FT. Recently, reviews of the EXT literature have suggested that commonly referenced extinction-induced phenomena are actually rare in applied research (e.g., Lerman & Iwata, 1995, 1996). If extinction-induced phenomena are not common in applied settings, the putative adverse side effects of extinction may be exaggerated and previous claims that FT schedules should attenuate such side effects may have been unfounded. On the other hand, the Lerman and Iwata reviews of the literature on extinction also suggested that use of extinction alone is rare in applied work because it is usually a component of treatment packages that include reinforcement of an alternative behavior. Thus, the effects of extinction in isolation have been rarely studied in applied contexts, and no definitive conclusions about the relative effects or side effects of FT and EXT schedules can be gleaned from existing data. Indeed, until the advent of functional analysis procedures as a form of assessment (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994), it was not clear whether applications that were called extinction actually involved discontinuation of reinforcement (because the reinforcer had not been identified). For example, the variation of extinction known as "ignoring" would not be an actual application of extinction if the target behavior was maintained by escape (Iwata, Pace, Cowdery, & Miltenberger, 1994). To accurately evaluate the effects of extinction, a functional analysis must be conducted so that a known reinforcer can be withheld.

To date, no studies have directly evaluated FT schedules in comparison to extinction as treatment for aberrant behavior. Although escalating FT schedules are known to be effective (e.g., noncontingent attention or noncontingent escape), it is not known whether such schedules attenuate extinction-induced effects, as has been previously suggested (e.g., Vollmer et al., 1993). Also, although most behavioral applications have involved extinction in combination with other procedures such as differential reinforcement, extinction remains a commonly recommended procedure in practice (e.g., "just ignore the behavior"); therefore, evaluation of its effects in isolation (as a point of comparison) seems appropriate from a clinical as well as a conceptual standpoint. In this study, after completing functional analyses based on Iwata et al. (1982/1994), escalating FT schedules and EXT were compared as treatment with 3 individuals who displayed severe aberrant behavior. The effects of both schedules were evaluated across three different behavioral functions (attention, escape from instructional activity, and escape from social proximity) and across three behavioral topographies (aggression, disruption, and self-injury).

METHOD

Participants

Dana was a 22-year-old woman who had been diagnosed with severe mental retardation and who displayed repetitive behaviors such as stereotypic rocking and repetitive playing with unusual objects. Dana did not speak, although she used some modified manual signs to request access to the bathroom, food, or drinks. She required moderate assistance with most self-care activities and was able to feed herself. Throughout the study she received Tegretol as treatment for a seizure disorder and Risperdal (held constant throughout the study) for behavioral concerns. She was referred for treatment, in part, due to severe aggression in the form of hitting other people (usually directed toward the eyes) and pinching.

Alan was a 6-year-old boy who had been diagnosed with moderate mental retardation and severe hearing loss. Alan used American sign language and had a vocabulary of several dozen signed words. He required moderate assistance with his self-care needs and was progressing well in basic academic skills such as number and letter identification. Throughout the study he received Risperdal, but the dosage was held constant. Alan was referred for treatment due to severe disruption (e.g., kicking holes in walls, throwing objects), self-injury (e.g., self-hitting), and tantrums (e.g., screaming and flopping to the floor).

Matthew was a 16-year-old boy who was blind and who had been diagnosed with moderate mental retardation. He communicated vocally with the approximate vocabulary of a typical 4- to 6-year-old child. He responded to verbal prompts to complete self-care and activities of daily living, although he sometimes became aggressive and disruptive during those activities. Matthew hit people with objects such as chairs, shoes, or other items that were in the room during an instructional activity.

Setting

All sessions were conducted on an inpatient unit in domicile-style therapy rooms that contained couches, chairs, beds, or other items as necessary for sessions. During functional analysis sessions, the contents of the room varied depending on the condition in effect. Sessions were usually conducted two to eight times per day, 5 days per week. All sessions lasted 10 min.

Recording and Interobserver Agreement

During observational sessions, each instance of problem behavior was scored. The primary dependent variable was the rate of problem behavior. Problem behavior produced the consequences being tested as reinforcers in the functional analysis, the baseline, or both, but did not produce the identified reinforcers during extinction. For Dana, problem behavior was *aggression,* which was defined as hitting or pinching others. For Alan, problem behaviors were disruption and self-injury, each scored individually. We also scored the duration of tantrums for Alan (reported as the percentage of a session) as a potential side effect of the procedures (tantrums produced no social consequences). *Disruptions* were defined as throwing objects, destroying objects, and hitting or kicking the floor, desk, or wall. *Self-injury* was defined as self-slapping or self-punching (nail picking was also scored, but was observed only once). *Tantrums* were defined as screaming and crying. For Matthew, problem behaviors were aggression and disruption. *Aggression* was defined as hitting, kicking, biting, or throwing objects in the direction of the therapist. *Disruption* was defined as throwing or destroying objects. Observers also scored the therapist's behaviors to assess procedural integrity; no integrity failures were reported.

Observers were seated behind a one-way observation window and recorded data during all functional analysis and treatment sessions. Data were usually collected using laptop computers. Interobserver agreement was assessed by having a second observer simultaneously but independently score each of the relevant behaviors during 20.9% of the sessions. Each session was divided into a series of 10-s bins, and the smaller number of observed responses (by one observer) was divided by the larger number of observed responses (by the other observer). For duration measures (i.e., Alan's tantrums), the smaller number of seconds within a 10-s bin was divided by the larger number of seconds within the 10-s bin. Thus, for both rate and duration measures, each 10-s bin created an agreement score, and the agreement scores for each bin were averaged across the session. Overall, session-by-session agreement for

problem behavior averaged 98.3%. In addition, 46 of the 59 sessions in which interobserver agreements were scored yielded 100% agreement (overall range, 84% to 100%). Interobserver agreement was not lower than 93.5% for any response of any participant in any single condition.

Experimental Design and Procedure

Each individual participated in a functional analysis, conducted within a multielement design to identify the reinforcers that maintained aberrant behavior. Then, following a baseline, each participant received an EXT treatment and an FT treatment within a multielement design, in which session order was either quasi-random (Dana and Alan) or counterbalanced (Matthew). For all participants, one therapist was correlated with EXT and one therapist was correlated with FT, and no single therapist was a therapist for more than 1 individual.

Functional analysis. The functional analyses were based on the procedures described by Iwata et al. (1982/1994). The responses that received consequences during the analysis were aggression (Dana and Matthew) and disruption or SIB for Alan. For Matthew, disruptions were also scored but did not receive the planned consequences. As it turned out, disruption occurred in only one condition. The test conditions included attention, materials, escape, social escape (Dana only), and alone (Alan only). A control condition was implemented for all 3 participants, consisting of no instructional demands and free access to attention and preferred materials.

During the attention condition, a therapist provided statements of concern or mild reprimands on a continuous reinforcement schedule (CRF) contingent on aberrant behavior. The therapist engaged in work to divert attention, and the participants were given preferred items with which to interact. For Alan, a modified attention condition was included, in which the therapist began the session by stepping out of the room (rather than engaging in work) and returned and provided mild reprimands and comfort statements for 30 s contingent on SIB or disruption.

During the materials condition, a therapist began a session by withdrawing access to a preferred item, which remained in view (for Dana and Alan) or just out of reach (for Matthew). Contingent upon each aberrant behavior, the materials were returned for 30 s.

During the escape condition, a therapist presented instructions using a three-prompt instructional sequence (verbal, touch, guidance) on an FT 30-s schedule (for Alan) or whenever on-task behavior stopped (for Matthew). For Matthew, tasks involved activities of daily living such as bed making or cleaning. For Alan, tasks involved basic academic activities such as counting, sorting, or tracing. Contingent upon aberrant behavior, instructional activity was terminated for 30 s (and the therapist stated, "Never mind, you may take a break now").

During social escape (Dana only), a therapist stood within 1 m of Dana and spoke to her (e.g., about the weather, her schedule, visitors, etc.). Contingent upon each instance of aggression, the therapist stopped talking and moved away for 20 s to a distance of at least 3 m. This condition was arranged as a test for escape as a reinforcer because Dana was observed (outside of sessions) to become agitated and aggressive when she was being closely examined, assisted, or otherwise required to stand near other people.

An alone condition was not conducted for Dana and Matthew because by definition aggression could not occur when the person was alone. Only one alone session was conducted for Alan; the session began with a therapist leaving the room and was followed by a high rate of disruption directed toward

the door. The behavior appeared to be related to withdrawal of attention.

Baseline. The condition that produced problem behavior during the functional analysis for each participant was used as a baseline. For Dana, the baseline was social escape. For Matthew, the baseline was escape from specific tasks (bed making and table cleaning), and we included disruption in addition to aggression because these responses appeared to be correlated. For Alan, the baseline was the modified attention condition. In addition to recording Alan's disruption and SIB, observers recorded instances of tantrums as a possible side effect of the treatments that followed baseline. However, tantrums did not produce attention. Two therapists (one who was eventually correlated with extinction and one who was eventually correlated with FT) alternated as baseline therapists.

Extinction. During EXT sessions, the reinforcer was withheld for problem behavior and was never presented otherwise. For Dana and Matthew, aggression or disruption did not produce negative reinforcement. For Alan, disruption and SIB did not produce positive reinforcement. Although data collection ended for Alan after 10 min, the adult never reentered the room until at least a 30-s period had elapsed without aberrant behavior.

Fixed time. During FT sessions, the reinforcer (escape for Dana and Matthew; attention for Alan) was presented on a response-independent schedule. The reinforcer–reinforcer interval increased across sessions, and the progression was based on the procedures described by Vollmer et al. (1993). As a general rule, when aberrant behavior was reduced by 80% or more from baseline levels for one (Dana) or two (Alan and Matthew) consecutive FT sessions, the schedule was advanced to the next level. This general rule for schedule advancement was altered occasionally after weekends when sessions were not conducted (an additional session at a given schedule was conducted), or when the participant was doing consistently well in FT toward the end of treatment (in which case only one session at a given schedule was required for advancement). Initially, the participants received continuous access to escape (Dana and Matthew) or attention (Alan). Next, the FT component was implemented, during which 10 s of reinforcer access was removed from every minute. A therapist stood next to Dana for 10 s, presented instructions for 10 s to Matthew unless he was working, or left the room for 10 s for Alan. This schedule represents an FT 10-s schedule with 50-s reinforcer access. For Matthew, breaks were signaled verbally (i.e., "You can take a break, Matthew"). The next schedule progression consisted of an increase to 20 s (with 40 s of access to the reinforcer), then to 30 s (with 30 s of access to the reinforcer), and then (for Dana only) to 40 s (with 20 s of access to the reinforcer). When the schedule progressed to 30 s for Alan and Matthew, it was functionally equivalent to an FT 1-min schedule with a 30-s reinforcer interval (because the reinforcer delivery occurred once per minute independent of behavior). Thus, for Alan and Matthew, the next progression was to FT 1 min, and all subsequent reinforcer deliveries lasted 30 s. When the schedule progressed to 40 s for Dana, it was functionally equivalent to an FT 1-min schedule with a 20-s reinforcer interval. Thus, the next progression was to FT 1 min, and all subsequent reinforcer deliveries lasted 20 s. For all participants, after FT 1 min, the schedule progressed as follows: FT 1.5 min, FT 2 min, FT 2.5 min, FT 3 min, FT 3.5 min, FT 4 min, FT 5 min. For Matthew, as in baseline, on task was considered any time he was actively engaged or receiving instructional prompts (which occurred whenever he stopped working unless the escape period was in effect). For Alan, a timer with large numbers was

used to count down the seconds to the scheduled attention delivery. The therapist pointed to the timer and then left the room. For Matthew, a timer with a bell was introduced at one stage of treatment (described in the Results section). For Dana, no timer was used.

RESULTS

Functional Analysis

Figure 1 shows the results of the functional analysis for all 3 participants. Alan's disruption was consistently highest in the modified attention condition (M = 0.93 responses per minute) compared to all other conditions except alone (M for all other conditions combined = 0.05 responses per minute), suggesting that the behavior was maintained by positive reinforcement in the form of attention (or adult proximity). Recall that only one alone session was conducted because the intended purpose of the condition (low stimulation, no social reinforcement for aberrant behavior) seemed to be confounded by attention withdrawal. Discounting the alone session, self-injury (not graphically displayed) occurred mostly in the modified attention and regular attention conditions (M = 0.16 responses per minute in attention sessions; M = 0.01 responses per minute in all other sessions combined), but at a lower rate than disruption.

Dana's aggression occurred during the social escape condition only (M = 0.5 responses per minute). These results suggest that Dana's aggression was maintained by escape from social proximity.

Matthew's aggression was observed in the escape condition only (M = 0.22 responses per minute; range, 0 to 0.8), suggesting that Matthew's aggression was maintained by escape from instructional activity. Although no consequences were presented for disruption, the behavior occurred in the escape condition only (not graphically displayed; M = 0.35 responses per minute; range, 0 to 2.0). Within-session analyses of behavior sequences showed that Matthew often was disruptive first and then was aggressive.

Treatment

Figure 2 shows the results of EXT and FT for Alan across three topographies. During baseline, disruption averaged 0.74 responses per minute (range, 0.4 to 1.8). Extinction produced an immediate, large increase in responding (M for the first five sessions = 5.54 responses per minute; range, 2.2 to 9.8). In contrast, FT immediately eliminated responding. Overall, disruption rates were generally higher and more variable during EXT (M = 2.0 responses per minute; range, 0 to 10.0) compared to FT response rates (M = 0.3 responses per minute; range, 0 to 4.9). Disruption rates increased above baseline levels during only two FT sessions (Sessions 32 and 40).

The center panel of Figure 2 shows the results for Alan's SIB. The same general patterns observed for disruption are seen in the analysis of SIB. In baseline, the mean rate of SIB was 0.08 responses per minute (range, 0 to 0.2). Extinction produced an immediate increase in SIB (M for the first five sessions = 0.6 responses per minute; range, 0.4 to 1.1) and FT produced an immediate decrease in SIB (M for the first five sessions = 0 responses per minute). The initial burst in EXT is especially notable because we had previously observed only low rates of SIB. Overall, SIB rates remained generally higher and more variable during EXT (M = 0.22 responses per minute; range, 0 to 1.2) when compared to SIB rates during FT (M = 0.01).

The lower panel of Figure 2 shows the results for Alan's tantrums. Tantrums are of interest as a potential negative side effect. During baseline, tantrums occurred at notable levels but were on a decreasing trend (M = 9.8% of the session; range, 1% to

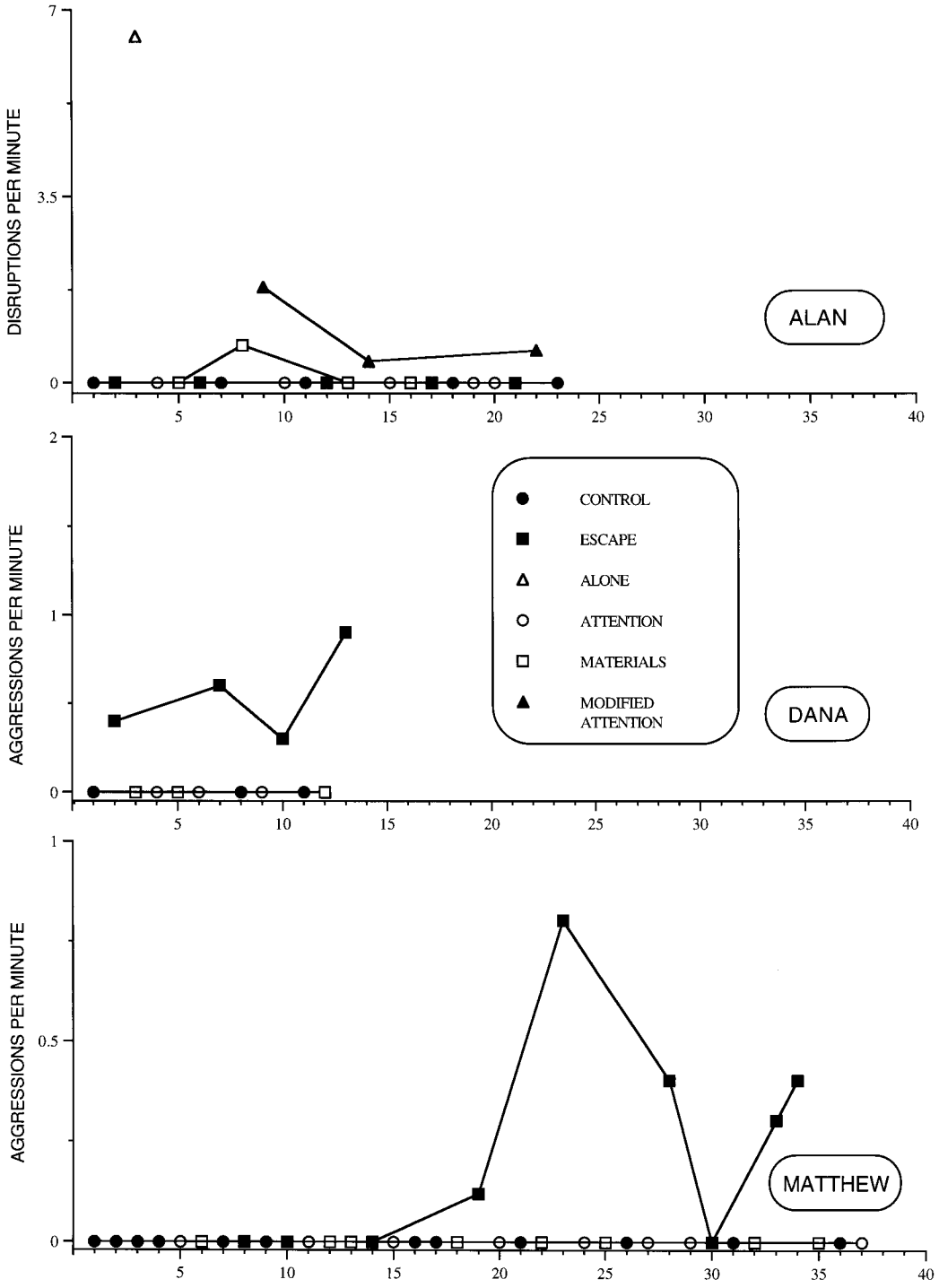

Figure 1. Results of the functional analysis for Alan (upper panel), Dana (center panel), and Matthew (lower panel).

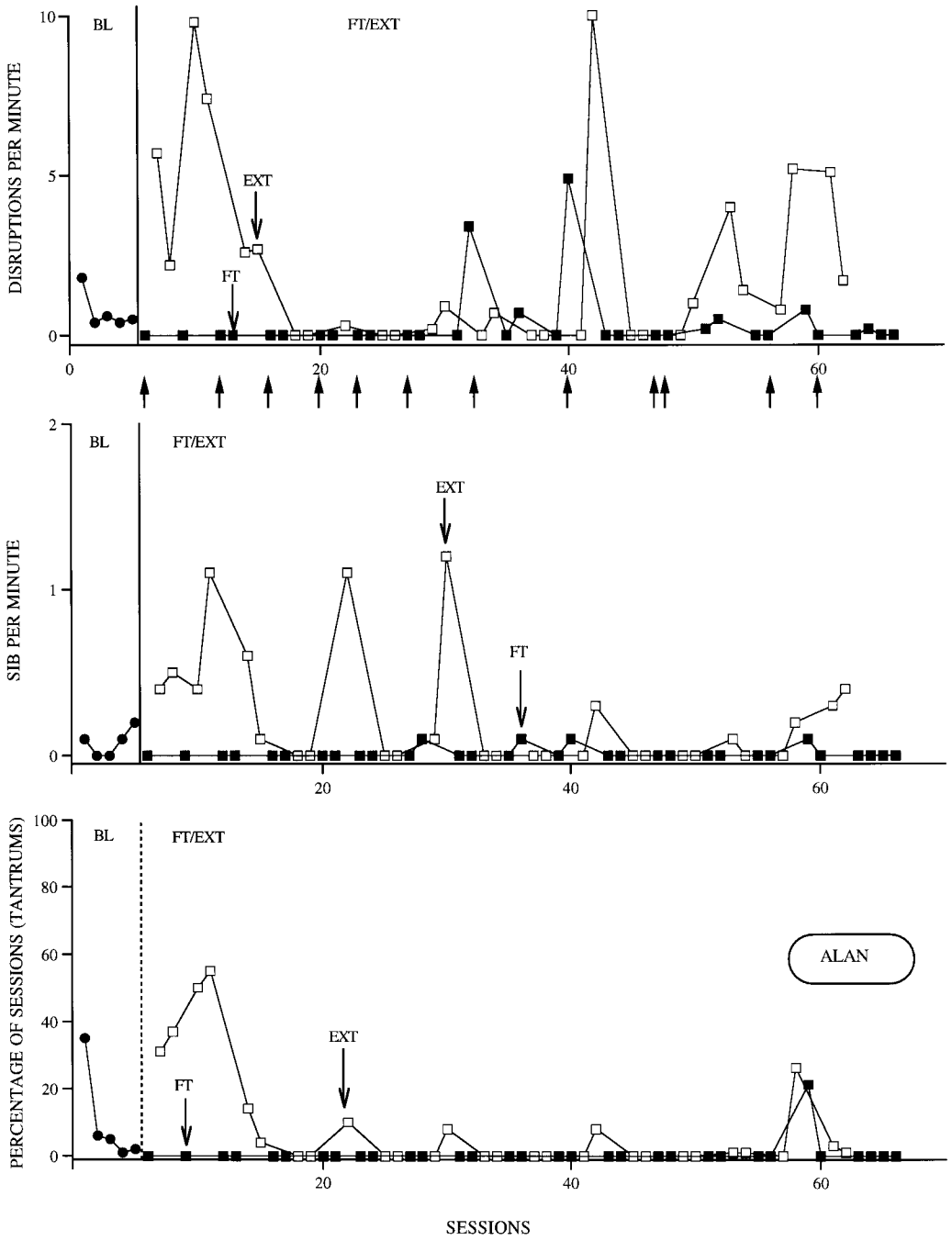

Figure 2. Results of extinction (EXT) and fixed-time (FT) schedules for Alan's disruption (upper panel), SIB (center panel), and tantrums (lower panel). Arrows indicate sessions when the FT schedule progressed. The dashed condition-change line is used for tantrums to indicate that the behavior was not reinforced during baseline.

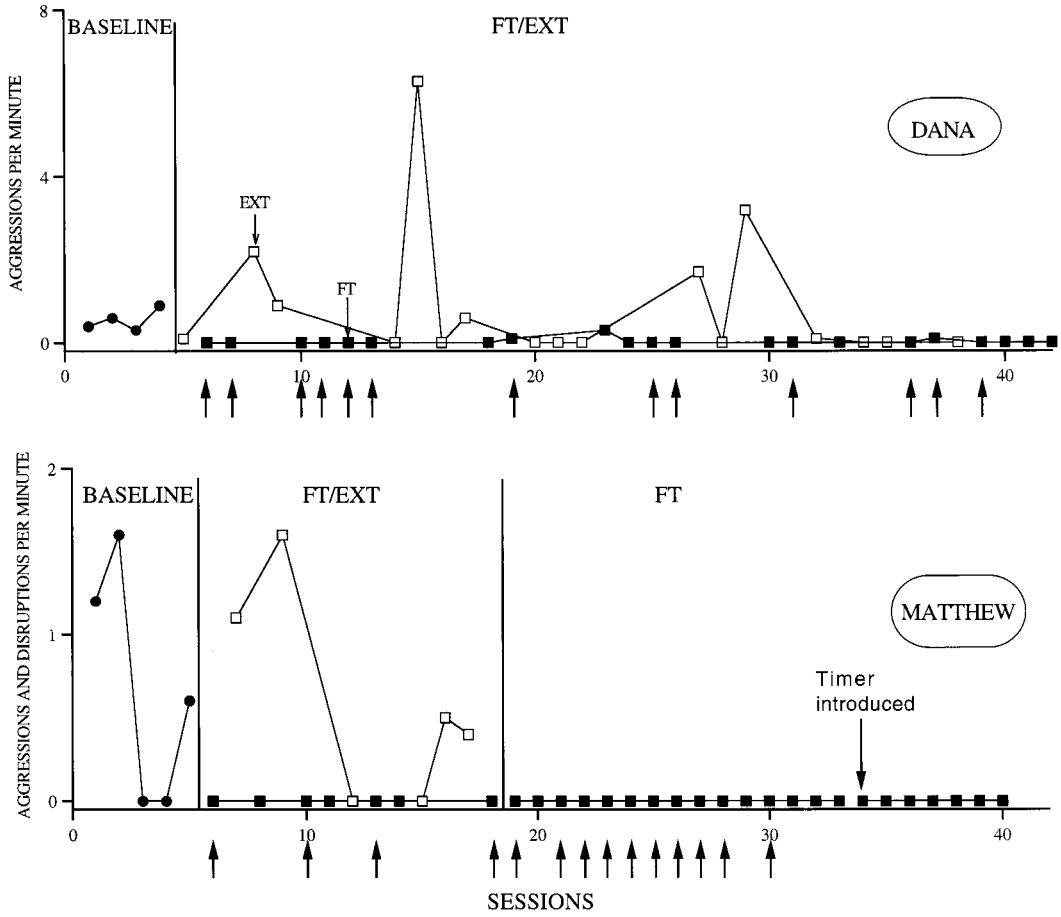

Figure 3. Results of extinction (EXT) and fixed-time (FT) for Dana (upper panel) and Matthew during bed making (lower panel). Arrows indicate sessions when the FT schedule progressed.

35%), presumably because they were never reinforced and other aberrant behaviors (disruption and SIB) produced attention. Extinction of disruption and SIB produced an immediate increase in tantrums (*M* for the first five sessions = 37.4% of the session; range, 14% to 55%). By contrast, an immediate decrease in tantrums was observed during FT sessions (*M* for the first five sessions = 0%). Overall, tantrums remained generally higher and more variable during EXT (*M* = 8% of the session; range, 0% to 55%) when compared to levels during FT (*M* = 0.7%; range, 0% to 21%).

Figure 3 shows the results of EXT and FT for Dana and Matthew (for bed making only). During baseline, Dana's aggression occurred at an average of 0.53 responses per minute (range, 0.3 to 0.9). During EXT and FT, the general response patterns are similar to those observed with Alan. Although the first session was lower than the baseline mean, EXT produced a general increase in aggression in the early stages of treatment (*M* for the first five sessions = 1.9 responses per minute; range, 0 to 6.3), whereas FT immediately decreased responding to zero. Overall, aggression was generally higher and more variable during EXT (*M* = 0.89; range, 0 to 6.3) than levels during FT (*M* = 0.02; range, 0 to 0.3).

The lower panel of Figure 3 shows the

results for Matthew during the bed-making task. During baseline, aggression and disruption occurred at an average of 0.72 responses per minute (range, 0 to 1.7) and was variable. The comparison between EXT and FT was terminated early for Matthew (discussed below), but an emerging pattern in the relative response rates was similar to that seen with the other participants after six EXT and seven FT sessions. During EXT, aggression and disruption averaged 0.63 responses per minute (range, 0 to 1.8), which does not represent a burst when the mean is compared to baseline rates, but was higher than during FT. During FT, no aggression or disruption was observed throughout treatment. Matthew's EXT sessions were discontinued for three reasons: (a) Aggression intensity had increased with the onset of treatment, placing the therapist at risk; (b) no aggression was observed in the FT condition during bed making, which made it a preferred treatment option from a clinical standpoint; and (c) clear differentiation between EXT and FT at the outset of treatment was consistent with the results for Alan and Dana, precluding the need for a more extended analysis. That is, combined with Alan's and Dana's results, Matthew's results in bed making provide additional support for the relative efficacy of FT. It should be noted that an additional comparison of FT and EXT was conducted for Matthew during a table-cleaning task, but the results were equivocal, with high rates of aggression and disruption during both FT and EXT. Results remained equivocal up to the point when EXT was terminated due to the severity of aggression. During table cleaning, aggression and disruption rates averaged 0.88 responses per minute (range, 0.3 to 1.5) in baseline. Rates increased to an average of 3.92 responses per minute (range, 0 to 6.5) in EXT and to an average of 2.08 responses per minute (range, 0 to 5.3) in FT. Because no experimental control or clear differentiation between EXT and FT conditions was demonstrated (as a result of the discontinuation of EXT), results for table cleaning are not depicted graphically.

DISCUSSION

Extinction and fixed-time schedules were presented in a multielement design to compare their relative effects on severe behavior problems. Using five-session means as indicators of bursting at the onset of treatment, EXT produced an increase in aggression, disruption, and tantrums for Alan, and aggression for Dana. For all 3 participants, FT yielded lower overall response rates than EXT and eventually yielded zero rates of aberrant behavior. The absence of bursting in the early stages of FT is consistent with previously reported results (e.g., Hagopian et al., 1994; Lalli et al., 1997; Vollmer et al., 1993). For at least two reasons, the current results should be viewed with a degree of caution: (a) A high rate of aggression was observed in both FT and EXT during an incomplete analysis with Matthew's table-cleaning task (not depicted graphically), and (b) although incidental reinforcement effects were not observed during FT, another paper recently detailed incidental reinforcement effects on an FT 1-min schedule (Vollmer et al., 1997). Thus, practitioners might expect increased rates during FT in some cases, as a result of reinforcement.

The overall treatment package used in the FT condition contains several potentially operative components, including (a) extinction of aberrant behavior, because the contingency between aberrant behavior and its reinforcer is disrupted; (b) changes in establishing operations, because reinforcers are available freely and frequently; and (c) the progressive escalation of the FT schedule, which perhaps functions to teach a "tolerance" to delays to reinforcement. This latter component has been infrequently studied

and may be helpful in augmenting the effects of other procedures. For example, in functional communication training, difficulty may arise if a communicative response cannot be immediately reinforced (e.g., dinner is delayed; a favorite toy is being used by someone else). A history with progressive FT schedules may promote tolerance to such delays.

It might be argued that a comparison involving EXT is moot if few practitioners recommend EXT in isolation of other procedures (such as functional communication training, differential negative reinforcement, etc.). However, a common recommendation given to parents and teachers is to "ignore" problem behavior. Perhaps ignoring (extinction) is recommended over FT because consultants are unfamiliar with FT applications (see Blampied & France, 1993, for a recent discussion). Also, a potential clinical limitation of both FT and EXT schedules is that no alternative behavior is explicitly reinforced (Vollmer et al., 1993). However, recent research has shown that alternative behaviors can be reinforced and maintained even though the same reinforcers are available noncontingently (Marcus & Vollmer, 1996). Further, following the conclusion of this study, each of the participants received additional treatment that involved reinforcement of communication skills such as sign language (Alan and Dana), communication cards (Dana), and vocalizations (Matthew).

To a degree, aspects of the results appear to be inconsistent with some previous findings. For example, in laboratory work with rats as subjects, Rescorla and Skucy (1969) showed that EXT was superior to response-independent schedules in suppressing lever pressing rates. However, the VT schedules used in the Rescorla and Skucy analysis resembled the VI schedules used in a baseline reinforcement condition because the reinforcement rates were similar. By contrast, in our study, the treatment began with continuous access to the reinforcer. As such, discrimination between baseline and treatment conditions may have been enhanced. At the same time, the establishing operation (deprivation from attention; aversive stimulation) was not in effect during the early stages of our FT treatment. The absence of an establishing operation at the outset of treatment probably accounts for the immediate response suppression seen in the cases we evaluated. Again, by contrast, the establishing operation (food deprivation) was in effect during Rescorla and Skucy's VT schedule analysis. In addition, the establishing operations (deprivation from attention; aversive instructional demands) *were* in effect during our EXT sessions. Future studies should evaluate (a) the effects of different baseline schedules of reinforcement on subsequent EXT and FT interventions, and (b) the effects of different schedule parameters during FT. There is evidence that the initial continuous access used in FT in this study is not always necessary (e.g., Lalli et al., 1997), but it is not clear how baseline and treatment schedule parameters interact.

Also, evidence of the so-called extinction burst was obtained in this study. This finding seems to contradict the conclusions of Lerman and Iwata (1995, 1996), who reported that the extinction burst is rather uncommon in applied studies. However, many studies reviewed by Lerman and Iwata either had not used extinction in isolation or had not systematically identified the functional reinforcer prior to the implementation of extinction. In this study, we used extinction alone, and we systematically identified the reinforcer that maintained the target response (to ensure that it was withheld during extinction). In addition to observing the extinction burst, we found evidence for possible undesired response variation (the emergence of higher rates of tantrums for Alan) and response-rate variability with all participants. However, the rates of behavior ob-

served during EXT could have been enhanced because of low rates of access to reinforcement *relative* to the FT condition; EXT alone may not have yielded response bursts had it not been alternated with FT. Future comparisons could use a reversal design format, with conditions counterbalanced across subjects, to help control for design-induced contrast effects (Reynolds, 1961).

The results of this study are by no means definitive. For example, various baseline and FT schedule parameters could produce very different effects of both FT and EXT, as the Rescorla and Skucy (1969) study suggests. Furthermore, more direct comparisons of prototype behavior-reduction procedures using various formats and parameters could be evaluated systematically (e.g., differential reinforcement of other behavior, differential reinforcement of alternative behavior). For example, Repp and colleagues conducted a series of elegant studies during the 1970s and 1980s on DRO parameters (e.g., Repp, Barton, & Brulle, 1983; Repp & Deitz, 1974; Repp & Slack, 1977). However, those studies were conducted prior to the widespread application of functional analysis technology as a pretreatment assessment, so it is not known how DRO parameters influence responding when the functional reinforcer is both withheld and delivered in a differential reinforcement arrangement (just as EXT and FT influence behavior much differently when functional rather than arbitrary reinforcers are identified). In short, the effective application of reinforcement schedules is inseparable from the functional analysis of those schedules and their parameters.

REFERENCES

Blampied, N. M., & France, K. G. (1993). A behavioral model of infant sleep disturbance. *Journal of Applied Behavior Analysis, 26,* 477–492.

Catania, A. C. (1992). *Learning* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Hagopian, L. P., Fisher, W. P., & Legacy, S. M. (1994). Schedule effects of noncontingent reinforcement on attention-maintained destructive behavior in identical quadruplets. *Journal of Applied Behavior Analysis, 27,* 317–325.

Horner, R. D. (1980). The effects of an environmental "enrichment" program on the behavior of institutionalized profoundly retarded children. *Journal of Applied Behavior Analysis, 13,* 473–491.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27,* 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2,* 3–20, 1982)

Iwata, B. A., Pace, G. M., Cowdery, G. E., & Miltenberger, R. G. (1994). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis, 27,* 131–144.

Lalli, J. S., Casey, S. D., & Kates, K. K. (1997). Noncontingent reinforcement as treatment for severe problem behavior: Some procedural variations. *Journal of Applied Behavior Analysis, 30,* 127–136.

Lerman, D. C., & Iwata, B. A. (1995). Prevalence of the extinction burst and its attenuation during treatment. *Journal of Applied Behavior Analysis, 28,* 93–94.

Lerman, D. C., & Iwata, B. A. (1996). Developing a technology for the use of operant extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29,* 345–382.

Marcus, B. A., & Vollmer, T. R. (1996). Combining noncontingent reinforcement and differential reinforcement schedules as treatment for aberrant behavior. *Journal of Applied Behavior Analysis, 29,* 43–51.

Repp, A. C., Barton, L. E., & Brulle, A. R. (1983). A comparison of two procedures for programming the differential reinforcement of other behavior. *Journal of Applied Behavior Analysis, 16,* 435–445.

Repp, A. C., & Deitz, S. M. (1974). Reducing aggressive and self-injurious behavior of institutionalized retarded children through reinforcement of other behaviors. *Journal of Applied Behavior Analysis, 7,* 313–325.

Repp, A. C., & Slack, D. (1977). Reducing responding of retarded persons by DRO schedules following a history of low-rate responding: A comparison of ascending interval lengths. *Psychological Record, 3,* 581–588.

Rescorla, R. A., & Skucy, J. (1969). Effects of response-independent reinforcement during extinction. *Journal of Comparative and Physiological Psychology, 67,* 381–389.

Reynolds, G. S. (1961). Behavioral contrast. *Journal of the Experimental Analysis of Behavior, 4,* 57–71.
Uhl, C. N., & Garcia, E. E. (1969). Comparison of omission with extinction in response elimination in rats. *Journal of Comparative and Physiological Psychology, 69,* 554–562.
Vollmer, T. R., Iwata, B. A., Zarcone, J. R., Smith, R. G., & Mazaleski, J. L. (1993). The role of attention in the treatment of attention-maintained self-injurious behavior: Noncontingent reinforcement (NCR) and differential reinforcement of other behavior (DRO). *Journal of Applied Behavior Analysis, 26,* 9–26.
Vollmer, T. R., Marcus, B. A., & Ringdahl, J. E. (1995). Noncontingent escape as treatment for self-injurious behavior maintained by negative reinforcement. *Journal of Applied Behavior Analysis, 28,* 15–26.
Vollmer, T. R., Ringdahl, J. E., Roane, H. S., & Marcus, B. A. (1997). Negative side effects of noncontingent reinforcement. *Journal of Applied Behavior Analysis, 30,* 161–164.

Received February 10, 1997
Initial editorial decision April 25, 1997
Final acceptance June 15, 1998
Action Editor, James W. Halle

STUDY QUESTIONS

1. What is one discrepancy between findings in the basic and applied literature with respect to the effects of fixed-time (FT) schedules of reinforcement? What procedural differences might account for this discrepancy?

2. Why was it important to conduct a functional analysis of participants' problem behaviors before undertaking the treatment comparisons proposed by the authors?

3. Although the extinction component was described functionally, no procedural details were given by the authors. Describe what procedures might have been used as extinction for the 3 participants.

4. Describe the general procedures used in the FT condition and the method used for lengthening the FT schedule.

5. Reinforcement was available continuously during the initial FT sessions. What are two potential advantages of beginning treatment with a very dense FT schedule?

6. The authors initially suggested that both FT schedules and EXT may be associated with negative side effects. What are these side effects, and to what extent were they observed in this study?

7. How might the experimental design used in this study have increased the likelihood of observing problem behavior in the extinction condition?

8. Although the FT schedule suppressed Dana's behavior more effectively than did EXT, why might EXT be a more practical treatment, given the function of her behavior?

Questions prepared by SungWoo Kahng and Rachel Thompson, The University of Florida