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SCHEDULE EFFECTS OF NONCONTINGENT REINFORCEMENT ON ATTENTION-MAINTAINED DESTRUCTIVE BEHAVIOR IN IDENTICAL QUADRUPLETS

LOUIS P. HAGOPIAN, WAYNE W. FISHER, AND STEVEN M. LEGACY

THE KENNEDY KRIEGER INSTITUTE AND

THE JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

Noncontingent reinforcement (NCR), a response-independent schedule for the delivery of reinforcement, has been found to be effective in reducing behavior when the reinforcer delivered is responsible for behavioral maintenance. In this study, dense and lean schedules of response-independent attention were compared to determine whether it is necessary to begin with a dense schedule before fading to a lean schedule, or whether treatment would be as effective using a lean schedule at the outset. The subjects were 5-year-old identical quadruplets diagnosed with mental retardation and pervasive developmental disorder who displayed destructive behavior that was maintained by social attention. NCR was selected partially because it is not very labor intensive and could be implemented by a single mother simultaneously with all 4 children. Using a combination multielement and multiple baseline design, it was found that (a) a dense schedule of response-independent reinforcement (i.e., fixed-time 10 s) resulted in immediate and dramatic reductions in destructive behavior with no evidence of an extinction burst, and (b) an equivalent reduction in destructive behavior was achieved with a lean schedule of response-independent reinforcement (fixed-time 5 min) only after a systematic fading procedure was implemented. The findings suggest that the effectiveness of NCR may be dependent on the use of a dense schedule initially, and that systematic fading can increase the effectiveness of a lean schedule.

DESCRIPTORS: extinction, functional analysis, noncontingent reinforcement, satiation, self-injury

Assessment procedures derived from functional analysis methodologies are designed to identify the environmental antecedents and consequences that occasion or maintain a target behavior of interest. These methodologies differ from most assessment procedures in that the variables hypothesized to influence behavior are systematically manipulated using single-case designs, and the effects of the manipulation are measured by direct observation. Functional analyses may be used to further our understanding of environmental determinants for aberrant behavior or to prescribe individually tailored interventions to decrease or eliminate the behavior. Functional analysis has led to the development of a number of innovative interventions for behaviors whose occurrence is attributed to social antecedents and consequences (e.g., Carr & Durand, 1985; Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991; R. H. Horner & Day, 1991; Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990; Mace & Lalli, 1991; Touchette, McDonald, & Langer, 1985; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993; Wacker et al., 1990), as well as for behaviors that appear to be maintained independent of such influences (Steege, Wacker, Berg, Cigrand, & Cooper, 1989).

Treatments developed and prescribed from functional analyses can often produce rapid and dramatic decreases in aberrant behavior (e.g., Durand & Carr, 1991; Vollmer et al., 1993). Simplicity and efficiency may be facilitated because the functional analysis often identifies the critical maintaining contingencies, and the subsequent treatment is then focused specifically on the manipulation of

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Requests for reprints should be sent to Louis Hagopian, Neurobehavior Unit, Department of Behavioral Psychology, The Kennedy Krieger Institute, 707 N. Broadway, Baltimore, Maryland 21205.

these contingencies. The magnitude of treatment effects may be enhanced when interventions are based on functional analyses because the specific source(s) of reinforcement for the aberrant behavior can be eliminated (i.e., extinction), presented to the client noncontingently (Mace & Lalli, 1991; Vollmer et al., 1993), or presented contingently on the occurrence of other, more socially appropriate behaviors (e.g., Carr & Durand, 1985; Fisher et al., 1993; Wacker et al., 1990).

One of the most important advances in treatment development resulting from the use of functional analysis has been a substantial increase in the variety and specificity of extinction procedures. Functional analyses can determine when it is most appropriate to use planned ignoring (Mace, Page, Ivancic, & O'Brien, 1986), sensory extinction (Rincover & Devany, 1982), or escape extinction (Iwata et al., 1990). In addition, it has been suggested that extinction may be a critical component of other treatments, such as differential reinforcement of other behavior (Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993).

Another type of extinction-based treatment that has been shown to reduce inappropriate behavior involves the delivery of reinforcement on a response-independent schedule (R. D. Horner, 1980; Mace & Lalli, 1991; Vollmer et al., 1993). Vollmer et al. successfully treated self-injury using noncontingent reinforcement (NCR). After conducting a functional analysis to identify the source of reinforcement for self-injury, access to that reinforcer (attention) was provided independent of the behavior on a time-based schedule. Initially, response-independent reinforcement was delivered on a fixed-time (FT) 10-s schedule; the schedule was then gradually changed to FT 5 min. Although the intervention was applied to self-injury maintained by attention, it presumably could be used for other aberrant behaviors maintained by other reinforcing events (e.g., escape). Vollmer et al. identified several advantages of NCR, including (a) reduction of extinction-induced behaviors (e.g., emotional behavior and behavioral bursts), (b) ease of implementation, and (c) the decreased likelihood of the establishment of a deprivation condition.

In this study, we attempted to replicate and extend the findings of Vollmer et al. (1993) through an analysis of schedule effects of NCR with identical quadruplets who all displayed destructive behavior (i.e., self-injury, aggression, and disruption) maintained by attention. The analysis was designed to assess whether it is necessary to begin with a dense schedule before fading to a lean schedule, or whether treatment would be as effective using the lean schedule at the outset.

METHOD

Subjects and Setting

Five-year-old female quadruplets with pervasive developmental disorder (PDD) and mental retardation were admitted to an inpatient unit for the assessment and treatment of destructive behavior. Laurie functioned in the mild range, Lynn and Wanda in the moderate range, and Glenda in the severe range of mental retardation. The severity of PDD symptoms paralleled the level of retardation, with Glenda exhibiting the most severe delays in social interaction, language, and adaptive functioning. Based on physical appearance, it was concluded that the girls were identical quadruplets; however, confirmatory DNA analyses were not completed.

Response Definitions

Aggression was defined as hitting, scratching, kicking, or head-butting others. *Disruption* was defined as striking a surface with the hand or an object from at least 6 in. away, throwing objects, knocking objects off a table, or kicking objects or walls. *Self-injury* was defined as head hitting, body hitting or scratching, head banging, or hair pulling. The specific topographies of aggression, disruption, and self-injury displayed by the 4 siblings were almost identical.

Data Collection and Reliability

Trained observers recorded each child's target responses on laptop computers from behind a one-way mirror. During 66.5% of sessions, an independent observer collected reliability data. Interval-

by-interval agreement percentages were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An agreement was defined as both observers recording the same frequency of a target response during a 10-s interval. For Glenda, Laurie, Lynn, and Wanda, respectively, mean exact agreement percentages were 99.9%, 99.9%, 97.8%, and 99.2% for self-injury; 95.2%, 96.4%, 96.4%, and 92.3% for disruption; and 99.9%, 99.8%, 99.8%, and 99.8% for aggression.

Design

The functional analysis was conducted using a multielement design. With Glenda, additional social attention and demand sessions were conducted using a reversal design, and then a series of social attention sessions was conducted in sequence to help to minimize the potential effects of multiple treatment interference. This sequence of social attention sessions was used as the NCR baseline. The NCR intervention was evaluated with a multiple baseline across subjects design and a multielement design. Following baselines that varied in length, two NCR conditions (dense and lean schedules of response-independent attention) were compared using a multielement design. The comparison was undertaken to assess whether fading was necessary by showing that rates of destructive behavior were higher under the lean schedule than under the dense schedule prior to but not subsequent to fading the schedule of NCR.

Procedure

Functional analysis. A functional analysis was conducted with each of the children following the procedures described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982). Three conditions—social attention, toy play, and demand—were used. Each session was 10 min in length. During social attention, the client was given toys and instructed to play while the therapist looked at a magazine. The therapist provided attention in the form of a mild verbal reprimand contingent upon a target response. During demand, the therapist presented academic demands using sequential verbal, gestural, and physical prompts every 10 s. If the client complied following the verbal or gestural prompt, praise was provided. If the client exhibited a target response, the therapist removed the demand materials and terminated the demands for 30 s. During toy play, the therapist interacted with and praised the client approximately once every 30 s following 5 s of no target responses.

NCR treatment evaluation. Baseline sessions were identical to the social attention sessions conducted during the functional analysis; however, session duration was increased to 20 min to reduce variability across sessions. Session duration remained at 20 min for all subsequent baseline and treatment sessions. During the dense-schedule condition, the therapist delivered attention on an FT 10-s schedule. Six 10-s intervals of attention were delivered each minute (i.e., continuous attention). The lean-schedule condition was identical to the dense-schedule condition except that one 10-s social interaction was delivered on an FT 5-min schedule. The dense- and lean-schedule conditions represented the initial and final schedules, respectively, of attention delivered during NCR in the Vollmer et al. (1993) study.

Following the comparison of the dense and lean schedules, NCR with a fading component was implemented with each client. Initially, NCR was identical to the dense-schedule condition (FT 10 s); then it was gradually changed to FT 5 min. For each client, the schedule of response-independent attention was faded to the next step if the rate of destructive behavior during the previous session was less than or equal to a preset criterion that was based on the rate of destructive behavior displayed during baseline. For Wanda and Lynn, the fading criterion was 1.0 and 0.5 destructive responses per minute, respectively, and was based on a 95% reduction from baseline levels. With Laurie and Glenda, who exhibited relatively lower baseline rates, the criterion was 0.3 destructive responses per minute, which represented a reduction greater than 90% from baseline levels for both clients. If the criterion for fading was not achieved for two consecutive sessions and there was an increasing trend in the rates of target behaviors, the schedule

of attention was increased to the previous level and fading proceeded from that step.

Initially, the steps in the fading process were exactly the same as those used by Vollmer et al. (1993). That is, during each step in the fading process, the number of 10-s intervals of social attention delivered each minute was decreased as follows: from 6 per minute to 5, 4, 3, 2, 1, 0.5, 0.33, 0.25, and finally to 0.2 per minute. The fading process was made more gradual after an increase in destructive behavior occurred for Laurie in Session 38. This increase coincided with the fading step that had the largest decrease in the percentage of time the participants received social interaction (i.e., 50% reduction in the rate of attention, compared with a 17% decrease during the first fading step). Therefore, a more gradual set of fading steps was developed such that the rate of attention never decreased by more than 33% between levels (6 per minute to 5, 4, 3, 2, 1.5, 1, 0.75, 0.66, 0.5, 0.4, 0.33, 0.25, and finally to 0.2). This more gradual set of fading steps was then used with all 4 participants.

Generalization and follow-up. Once the schedule of attention was decreased to 0.2 per minute (FT 5 min), treatment was generalized across therapists and settings. Next, generalization sessions were conducted with the mother and 2 to 4 of the participants together. Follow-up data were obtained at 1 and 2 months postdischarge in the home and school. Verbal instruction, modeling, and role playing were used to train the mother and teachers.

RESULTS

Functional Analysis

Results of the functional analysis for each client are presented in Figure 1. For Wanda, Laurie, and Lynn, the highest rates of destructive behaviors were exhibited in the social attention condition. For Glenda, higher rates of destructive behavior were evident in the social attention condition only after the functional analysis was modified and extended. This may have been due to multiple treatment interference effects, which sometimes occur with multielement designs. It was decided to evaluate NCR, using attention as the reinforcer, as a treatment for all clients based on the functional analysis data that suggested that their destructive behaviors were maintained by attention.

NCR Treatment Conditions

Results of baseline and treatment conditions for each client are depicted in Figure 2. During baseline, the mean rates of destructive behavior (responses per minute) were 21.38 for Wanda, 4.40 for Laurie, 10.85 for Lynn, and 3.06 for Glenda. During the multielement phase, the mean rates of destructive behavior decreased from baseline levels by more than 90% for all 4 clients under the dense NCR schedule. Under the lean schedule, mean rates of destructive behavior decreased from baseline levels for Wanda (65% decrease), Laurie (73%), and Lynn (77%), but increased slightly for Glenda. Each client exhibited lower rates of behavior under the dense schedule than under the lean schedule. Wanda showed the greatest differentiation in the mean rate of responses between the two schedules of NCR, whereas Lynn showed the least.

During the second baseline condition, rates of destructive behavior were lower than the original baseline for Wanda, equivalent to the original baseline for Laurie and Lynn, and higher than the original baseline for Glenda. Overall, the rates of destructive behavior were clearly lower under the dense schedule than in both baseline conditions and under the lean schedule for all 4 clients. The rates of destructive behavior under the lean schedule were lower than both baseline conditions for Laurie and Lynn but not for Wanda and Glenda.

Following the second baseline, the dense-schedule condition was implemented for all clients because it was associated with lower rates of target responses during the multielement phase. During this final phase of NCR, wherein attention was faded from 6 per minute (FT 10 s) to 0.2 per minute (FT 5 min) and then generalized across therapists and settings, the mean rate of destructive behavior was 1.32 for Wanda, 0.67 for Laurie, 0.18 for Lynn, and 0.60 for Glenda. The schedule of attention was increased seven times due to increased rates of destructive behavior (Wanda, 3;

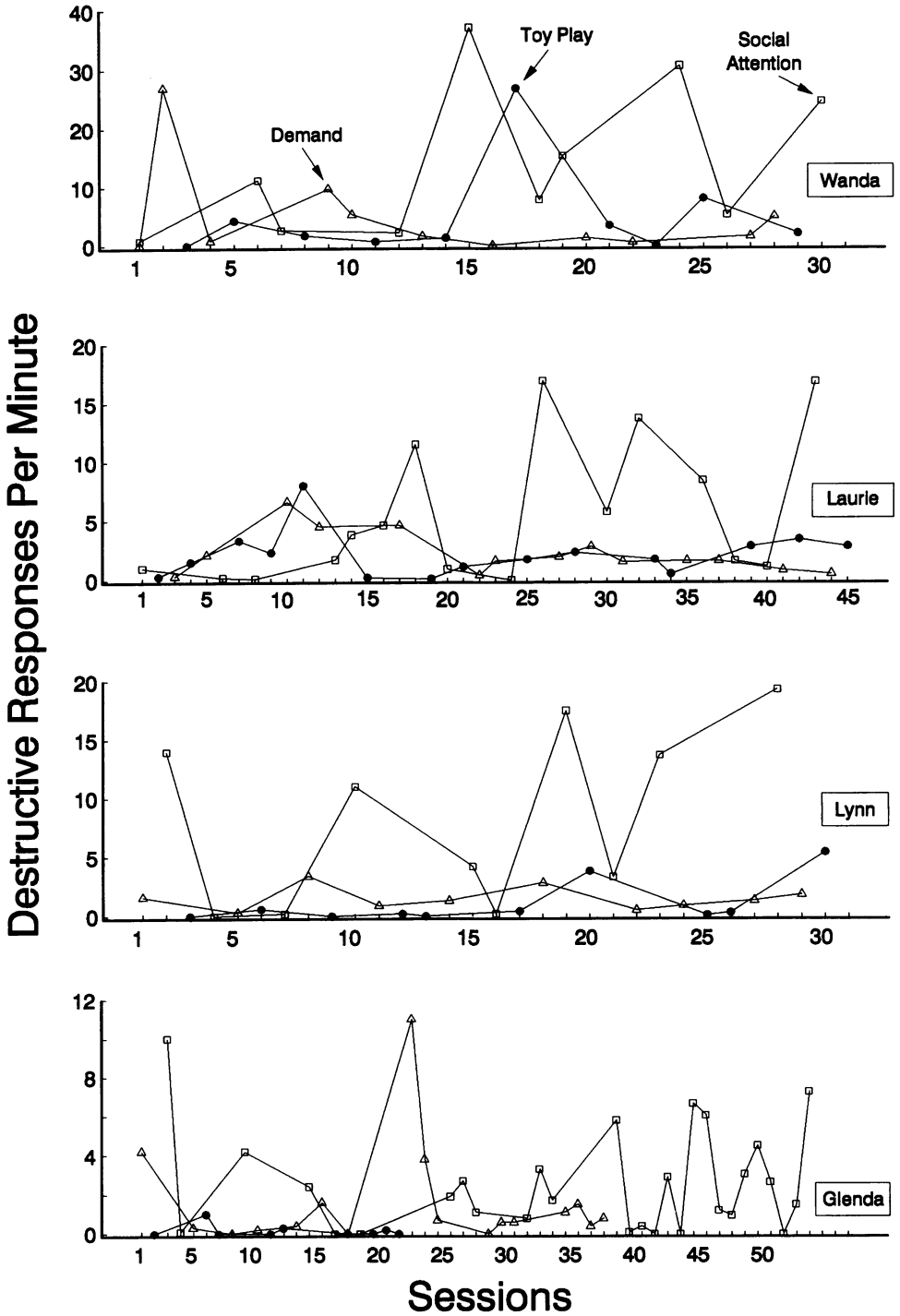

Figure 1. Rates of destructive responses for each client during the functional analysis of social attention, demand, and toy-play sessions.

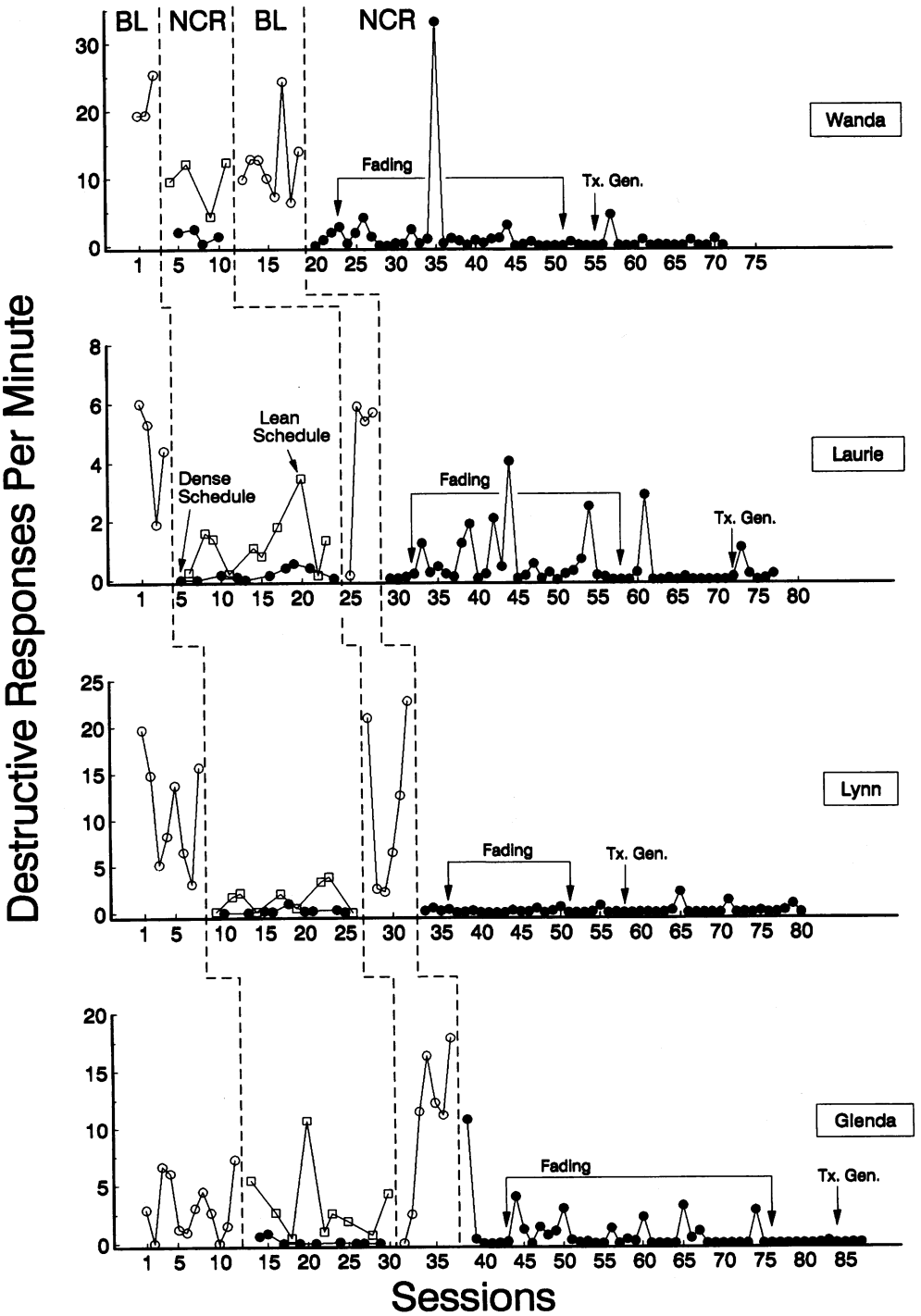

Figure 2. Rates of destructive responses for each client during sessions under the conditions of baseline (BL) and lean and dense schedules of noncontingent reinforcement (NCR). Arrows indicate fading and treatment generalization (Tx. Gen.).

Laurie, 1; Lynn, 0; Glenda, 3). The FT 5-min schedule of NCR was reached in 16 sessions for Lynn, 27 sessions for Laurie, 29 sessions for Wanda, and 34 sessions for Glenda. During generalization, rates of target responses remained low for all clients. No disruptive behaviors were observed during two 10-min sessions at 1 month postdischarge or during three 10-min sessions conducted with each child at 2 months postdischarge.

DISCUSSION

The results of this investigation replicate the findings of Vollmer et al. (1993) by demonstrating that NCR, using the reinforcer responsible for behavioral maintenance, can be an effective treatment for destructive behavior maintained by social attention. The analysis of dense and lean schedules suggests that a dense schedule is necessary at the outset of treatment, and that with systematic fading, the effectiveness of a lean schedule can be enhanced. The current investigation also extends the work of Vollmer et al. by showing that NCR treatment effects can be generalized to the clients' school and be maintained at 1-and 2-month follow-ups.

The importance of fading the schedule of NCR was illustrated through the relative effects of decreasing and increasing the density of reinforcement during the fading procedure. There were seven occasions on which a decrease in the density of reinforcement was directly followed by an increase in destructive behavior that was sufficient to meet our criterion for returning to the previous step in the fading schedule. Each time this occurred, rates of destructive behavior immediately decreased when the density of reinforcement was increased to the previous level. These data suggest that it may be useful to have criteria for both decreasing and increasing the density of reinforcement when attempting to fade NCR. Vollmer et al. (1993) used a criterion for decreasing but not for increasing the schedule, and in two of the three cases presented, increases in self-injury occurred during the fading process and were sustained for a number of sessions. In the current investigation, increasing the density of reinforcement resulted in an immediate reduction in destructive behavior, making it possible to decrease the density of reinforcement on the subsequent session.

Noncontingent reinforcement may alter the behavior's establishing operation (Michael, 1982) through the elimination of a deprivation state that induces increased responding. Vollmer et al. (1993) raised the possibility that satiation (in addition to extinction) may play a role in the effects of NCR, at least during the early part of treatment when response-independent reinforcement is presented on a dense schedule. However, the reduction in destructive behavior that occurred with 3 of the 4 clients in the present study during the lean-schedule condition is difficult to explain by satiation. During this condition, reinforcement was delivered only once every 5 min. Satiation is defined as a condition in which a reinforcer has been presented repeatedly to a point at which the effectiveness of the reinforcer is decreased (Malott, Whaley, & Malott, 1993). It is possible that the difference in the rates of responding under the dense and lean schedules was the result of satiation; alternatively, the lean schedule attenuated the deprivation condition, whereas the dense schedule eliminated it. The increased effectiveness of the lean schedule following fading was probably a result of extinction.

Although this investigation establishes the importance of beginning treatment with a relatively dense schedule of NCR, it is not clear that continuous or near-continuous reinforcement schedules are necessary. If it is possible to obtain equivalent reductions in destructive behavior with a less dense schedule, then fewer fading steps would be required and the treatment would be more efficient and easier to implement. Iwata, Vollmer, Zarcone, and Rodgers (1993) have suggested that it may be reasonable to determine the initial rate of reinforcement for NCR based on the interresponse interval of the target behavior during baseline. Future investigators may wish to determine the minimum schedule of reinforcement necessary to produce clinically significant reductions in destructive behavior.

Extinction bursts have been reported to occur with interventions that involve extinction in the

form of withholding reinforcement (e.g., Iwata et al., 1990). Such dramatic reductions in the density of reinforcement may induce deprivation, altering the behavior's establishing operation, and thereby increase responding. With NCR, extinction bursts may be averted because the continued delivery of the reinforcer prevents deprivation. Another advantage of NCR that was important to the current investigation was its ease of implementation (Vollmer et al., 1993). The 4 clients in our study were identical siblings; thus, the intervention had to be one that the mother could implement simultaneously with all 4 children. It would not have been possible to use interventions that involve the contingent application of consequences, because such procedures require the change agent to monitor client behavior continuously in order to implement treatment contingencies accurately.

One potential limitation of NCR is that response-independent reinforcement may be delivered immediately following a maladaptive target response and provide adventitious reinforcement (Vollmer et al., 1993). Such effects were not evident in the current investigation or in the study by Vollmer et al.; one potential explanation is that reinforcement was initially delivered on a dense schedule in which the rate of reinforcement exceeded the rate of maladaptive behavior. Thus, the clients received reinforcement more often in the absence of destructive behavior than in its presence. Furthermore, as attention was faded, both the destructive behavior and reinforcement occurred infrequently, making adventitious reinforcement unlikely.

The approach of selecting interventions on the basis of functional analyses allows the behavior analyst to choose from a variety of treatments once the maintaining stimuli have been identified (Iwata et al., 1993). In situations in which there are limited resources relative to the magnitude of the problem, as in the current investigation, ease of implementation may be a primary consideration. Procedures that minimize the risk of an extinction burst may be most appropriate when the severity of the destructive behavior is extremely high. In cases in which promoting alternative behaviors (such as communication) is an important treatment goal, functional communication training or differential reinforcement of alternative behavior may be the treatment of choice. Other considerations relevant to selecting among interventions based on functional analyses include social acceptability and the extent to which a treatment might eventually be replaced by contingencies that are normally present in the natural environment.

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