JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1993, 26, 9–21 NUMBER 1 (SPRING 1993)

THE ROLE OF ATTENTION IN THE TREATMENT OF ATTENTION-MAINTAINED SELF-INJURIOUS BEHAVIOR: NONCONTINGENT REINFORCEMENT AND DIFFERENTIAL REINFORCEMENT OF OTHER BEHAVIOR

TIMOTHY R. VOLLMER
LOUISIANA STATE UNIVERSITY

AND

BRIAN A. IWATA, JENNIFER R. ZARCONE, RICHARD G. SMITH, AND JODI L. MAZALESKI
UNIVERSITY OF FLORIDA

Because there are potentially serious limitations to differential reinforcement of other behavior (DRO) (which is probably the most widely used treatment procedure for behavior problems), we examined an alternative procedure—noncontingent reinforcement (NCR). Three females with developmental disabilities, all of whom engaged in severe self-injurious behavior, participated. During a pretreatment functional analysis, each subject's self-injury was shown to be differentially sensitive to social attention as a maintaining consequence. Next, each subject was exposed to a DRO treatment and an NCR treatment. During DRO, attention was delivered contingent on the absence of self-injury for prespecified intervals. During NCR, attention was delivered on a fixed-time schedule that was not influenced by the subject's behavior. Results showed that both procedures were highly effective in reducing self-injury, probably because the functional reinforcer for self-injury was used during treatment. Furthermore, there was evidence that NCR attenuated several of the limitations of DRO. These results are particularly interesting in light of the long experimental history of NCR as a control rather than as a therapeutic procedure.

DESCRIPTORS: differential reinforcement, noncontingent reinforcement, functional analysis, self-injurious behavior

Differential reinforcement procedures are the most widely used techniques for decreasing undesirable behavior in people who are developmentally disabled (Lennox, Miltenberger, Spengler, & Erfanian, 1988). Of these, perhaps the most widely used is differential reinforcement of other behavior (DRO). Along with related procedures, such as differential reinforcement of alternative behavior (DRA), DRO is appealing because reinforcers are presented contingent on some other or alternative responses and are withheld contingent on a target undesirable response. Such an arrangement presumably teaches a client more appropriate means of obtaining positive reinforcers.

Differential reinforcement procedures have received renewed interest in recent years because functional analyses of severe behavior disorders have identified socially mediated events (i.e., attention) as positive reinforcers maintaining undesirable behavior in some cases (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). Behaviors such as aggression, disruption, and self-injurious behavior (SIB) are particularly susceptible to socially mediated positive reinforcement because the dramatic nature of these behaviors often requires attention, including comfort, delivery of materials, and reprimands from caregivers. One of the earliest studies

This research was supported by a grant from the Developmental Disabilities Council and is based on a dissertation submitted in partial fulfillment of the first author's PhD from the University of Florida. We thank Marc Branch, Vivian Correa, Timothy Hackenberg, and Carol VanHartesveldt for their helpful comments on an earlier draft of this manuscript. We also thank Beth Duncan, Dorothea Lerman, Teresa Rodgers, and Bridget Shore for their assistance in observations, data collection, and other contributions.

Reprints may be obtained from Timothy Vollmer, Department of Psychology, Louisiana State University, Baton Rouge, Louisiana 70803.

to demonstrate this phenomenon was reported by Lovaas and Simmons (1969). When attention was provided contingent on SIB, the rate of the target behavior increased markedly in comparison to baseline, when behavior was ignored. Such findings are not idiosyncratic; a recent behavioral-epidemiological report suggests that the sensitivity of SIB to social positive reinforcement is not rare at all—approximately 23% of functional analyses identify some form of attention as a variable maintaining SIB (Iwata et al., 1991).

Differential reinforcement techniques, such as DRO, are especially relevant to the treatment of positively reinforced behavior. For example, if attention is identified as a reinforcer for SIB, attention can be provided contingent on the absence of SIB, and SIB will no longer produce the reinforcing consequence. This arrangement ensures that a functional reinforcer is provided for behavior other than SIB and that extinction is in effect for SIB. Prior to the development of functional analysis approaches to assessment, DRO typically involved reinforcers that were arbitrary in relation to behavior, such as using food reinforcers when the function of SIB was unknown (e.g., Harris & Wolchik, 1979). Those sorts of applications are less likely to be effective unless the subjectively selected stimulus can compete effectively with the unknown functional reinforcer across time. With the information obtained through a functional analysis, DRO procedures can be prescribed appropriately for clients whose SIB has been shown to be positively reinforced. To date, few applications of DRO have been reported that were explicitly based on a pretreatment functional analysis, although research involving DRA suggests that DRO would be successful if based on the outcome of a functional analysis (e.g., Day, Rea, Schussler, Larsen, & Johnson, 1988).

Despite the wide acceptance of DRO and the conceptual promise of its prescriptive use based on behavioral function, some potential drawbacks exist. First, DRO has been relatively ineffective in treating the most severe behavior disorders (such as self-injury) when compared to other behavior-reduction procedures (e.g., Favell et al., 1982; Romanczyk, 1986). Second, undesirable side effects have been reported, including emotional behavior (Cowdery, Iwata, & Pace, 1990) and aggression (Lennox, Miltenberger, & Donnelly, 1987), which may be related to the extinction component of differential reinforcement schedules. Third, differential reinforcement can be cumbersome to administer over long periods of time because it often requires continuous monitoring of a client's behavior. For example, DRO procedures might require a caregiver to reset an interval timer following each occurrence of the target response, which can be difficult for a parent with other household duties or staff with other clients to assist (Boe, 1977). Finally, DRO procedures can result in relatively low rates of reinforcement, particularly when a target behavior occurs at a high frequency; this is troublesome because many people with developmental disabilities do not receive much interaction, especially in institutional settings (Reid, Parsons, Green, & Schepis, 1991). A resetting DRO, if followed correctly, can validate or even mandate low frequencies of staff interaction and create further deprivation.

It is possible that some of the shortcomings of differential reinforcement procedures, such as ineffectiveness, are technological rather than limitations of the procedure per se. For example, because recent research has demonstrated that pretreatment functional analyses improve the likelihood of treatment success, and because most existing research did not involve such analyses, the potential effectiveness of DRO is unknown; in short, it is likely that the aforementioned reviews analyzed studies involving primarily arbitrary behavior–reinforcer relations. Some of the other shortcomings of DRO, such as emotional side effects, difficulty of application, and low rates of reinforcement, warrant examination of other reinforcement-based procedures. One possibility is noncontingent reinforcement (NCR).

An NCR procedure can be described as a response-independent or time-based delivery of stimuli with known reinforcing properties. Although several studies have juxtaposed NCR against DRO, with NCR being the control or reversal procedure to demonstrate the relative effects of DRO (e.g.,

Corte, Wolf, & Locke, 1971; Goetz, Holmberg, & LeBlanc, 1975), it is possible that DRO is more effective than NCR only when reinforcers unrelated to the functional properties of a target response are used. With DRO, the subjectively identified reinforcers may compete with the unknown functional reinforcers to some extent, but in NCR both sources of reinforcement are always available to the subject. Conversely, there is an extensive literature suggesting that when the reinforcer responsible for behavioral maintenance is delivered noncontingently, NCR is highly effective in reducing a target response (e.g., Nevin, Tota, Torquato, & Shull, 1990). For example, Rescorla and Skucy (1969) compared extinction (by omission of contingent food delivery) versus response-independent delivery of food on variable-time (VT) schedules. They found that extinction by omission decreased behavior (lever pressing in rats) more effectively than VT extinction, but both procedures resulted in significant decrements.

A number of applied studies on behavior acquisition have increased the rate of some desirable behavior using positive reinforcement, and then delivered the reinforcer noncontingently in a reversal condition as a means of suppressing the target response for the purpose of providing a control for the effects of reinforcement (e.g., Azrin, Rubin, O'Brien, Ayllon, & Roll, 1968; Buell, Stoddard, Harris, & Baer, 1968). The suppressive effect of NCR in acquisition studies supports the interpretation of Rescorla and Skucy (1969) that response-independent reinforcer delivery is functionally an extinction procedure insofar as the contingent relation between response and stimulus is eliminated and the frequency of a target response is subsequently reduced. Additionally, Mace and Lalli (1991) reported a study examining response-independent delivery of attention following a functional analysis that identified attention as a reinforcer for bizarre vocalizations. In that study, the rate of undesirable vocalizations was substantially reduced when attention was made available on VT schedules.

Noncontingent reinforcement might also serve as an establishing operation, an event that alters the reinforcing efficacy of a stimulus (Michael, 1982). The effects of NCR as an establishing operation were examined by Vollmer and Iwata (1991), who demonstrated that presession exposure to noncontingent attention, food, and music reduced the subsequent efficacy of those stimuli as reinforcers in a skill acquisition task. As Boe (1977) pointed out, if NCR is effective in decreasing the rate of appropriate responding as a control in acquisition studies, there is no reason to assume it would not also be effective in decreasing the rate of inappropriate responding.

In comparison to DRO, NCR might have some advantages. NCR might attenuate extinction-induced behavior, because the functional reinforcer can be made available frequently despite the elimination of a contingent relationship between response and consequence. Furthermore, NCR ensures that the programmed and obtained rates of reinforcement would be the same or higher than in DRO (given comparably scheduled delivery intervals). Whereas any occurrence of the target response during DRO essentially results in reinforcer loss (Rolider & Van Houten, 1990), NCR schedules are unaffected by client behavior.

The purpose of the current study was to compare NCR to DRO to assess the viability of NCR as a treatment procedure when behavioral function has been identified. Along with identifying behavioral function, it may be possible to increase the treatment efficacy of NCR by using particular therapeutic operations, such as fading and satiation. A secondary purpose was to evaluate the relative merits of NCR and DRO in terms of ease of implementation, relative rate of reinforcer delivery, and side effects.

METHOD

Subjects and Setting

Three adult females, all living in a public residential facility, participated. They were selected based on referral for treatment of chronic SIB, and were screened for inclusion in this study based on the results of an assessment designed to identify the functional properties of their SIB (see below).

Diane was a 32-year-old woman diagnosed as profoundly mentally retarded. She had a history of SIB (head hitting, body hitting, head banging) dating back several years, but was not generally aggressive or destructive. She could walk independently, but sometimes required assistance due to balance problems or noncompliance. She displayed a limited verbal repertoire, which consisted mostly of imitative vocalizations and some independently produced manual signs. She did not receive psychotropic medication during the course of this study.

Bonnie was a 40-year-old woman diagnosed as severely mentally retarded. She was referred for treatment because of a long history of chronic hand mouthing, which produced tissue damage, limited her social interactions with others, and increased her risk of infection. She also displayed some disruptive and aggressive behaviors. She had a limited verbal repertoire, which consisted of specific words that she repeated almost continuously, and she also echoed some words produced by caregivers. She did not receive psychotropic medication during the course of this study.

Brenda was a 42-year-old woman diagnosed as profoundly mentally retarded. She was referred for treatment because of an extensive history of severe head banging and head hitting, among other SIB. She was also extremely disruptive and sometimes aggressive. She had a minimal verbal repertoire, which consisted of a few modified manual signs to request bathroom breaks, food, or water. She received a constant dose of Haldol® (6 mg) per day throughout the course of this study.

All sessions were conducted at a day-program unit designed for the analysis and treatment of SIB. Chairs and couches were available in the rooms at all times, but other contents of the room varied according to experimental conditions. Sessions lasted 10 min (Diane) or 15 min (Bonnie and Brenda) and usually took place 5 days per week. Two to four sessions were conducted per day, depending on variations in the subjects' daily schedules.

Response Measurement

Topographies of SIB included head hitting, head banging, and body hitting (Diane and Brenda) and hand mouthing (Bonnie). *Head hitting* was defined as forceful contact against the head by any other portion of the body including arms, hands, legs, and feet. *Head banging* was defined as forceful contact by the head against any hard surface including furniture, the wall, or the floor. *Body hitting* was defined as forceful contact against any area of the body other than head by any other portion of the body including arms, hands, legs, and feet. *Hand mouthing* was defined as intrusion of the hand or fingers into the mouth past the plane from the upper lip to the lower lip; also included was any protrusion of the tongue onto the hand or fingers. *Attention* was defined as a 10-s verbal interaction between client and therapist; during baseline, attention included expressions of disapproval and concern while lightly touching the client on the shoulder or arm area. During treatment only the verbal content of attention differed from baseline (i.e., statements were not of concern or disapproval, but instead consisted of praise and general conversation).

The primary dependent variable of interest was responses per minute of SIB. Data were collected using hand-held computers (Assistant Model A102). Interobserver agreement was assessed by having a second observer simultaneously but independently record data with a primary observer. Percentage agreement scores were computed by dividing the session length into consecutive 10-s intervals. The smaller number of observed responses was divided by the larger number of observed responses in each interval, and these values were averaged across the session. Agreement was assessed during 27.7% of the functional analysis sessions, 30% of the baseline sessions, and 25.6% of the treatment sessions for all subjects combined. Agreement for SIB during the functional analysis averaged 93.8% overall and exceeded 89.5% for each individual subject. Agreement for SIB during baseline sessions averaged 91.7% overall and exceeded 89.3% for each individual subject. Agreement for SIB during treatment sessions was 96.0% overall and exceeded 94.5% for each individual subject. Agreement on the delivery of attention exceeded 98% during baseline and treatment for all 3 subjects.

Functional Analysis (Assessment) Conditions

The assessment was based on procedures described by Iwata et al. (1982). A series of conditions was presented in multielement format to each subject. Briefly, these were (a) Alone—subjects were observed alone in a room without access to leisure materials, and no social consequences were placed on SIB. The purpose of this condition was to identify whether the subject's SIB was maintained independent of social consequences. (b) Attention—leisure activities were available to the subject, although the experimenter did not attend to her except to deliver reprimands and/or statements of concern contingent on SIB. The purpose of this condition was to determine whether the subject's behavior was sensitive to attention as a positive reinforcer for SIB. (c) Demand—the experimenter presented instructional trials to the subject on a fixed-time (FT) 30-s schedule, and a time-out from demands was made contingent on SIB. The purpose of this condition was to assess behavioral sensitivity to escape from instructional demands. (d) Play—the experimenter provided opportunities for interaction and stimulation contingent on the absence of SIB (essentially on an FT 30-s schedule, with a 5-s DRO during the final 5 s). The purpose of this condition was to observe the rate of SIB in an enriched environment; this condition served as a control.

Treatment Conditions

For each subject, baseline sessions were identical to the attention condition described in the functional analysis. Additionally, for Diane and Bonnie, two experimenters alternated in conducting baseline sessions. Following baseline, subjects were exposed to two treatment conditions: DRO and NCR. For Diane and Bonnie, treatment effects were compared in a multielement within-subject design and multiple baseline across-subjects design. One experimenter was associated with the DRO condition; the other was associated with the NCR condition (hence the need for alternating experimenters in baseline to control for experimenter-specific effects). For Brenda, one experimenter conducted all sessions, and the treatments were compared using a reversal (A-B-A-C) design, in which the B condition consisted of NCR and the C condition consisted of DRO.

Differential reinforcement of other behavior (DRO). The experimenter delivered attention according to a resetting DRO schedule. If the subject did not engage in SIB during an interval, attention was delivered at the end of the interval for 10 s. If the subject engaged in SIB at any time during an interval, the timer was reset (Repp & Deitz, 1974). Based on a formula discussed by Poling and Ryan (1982), prior to each session the DRO interval length was determined by computing the mean interresponse time (IRT) for the preceding n sessions (n = 3 for Diane, n = 5 for Bonnie and Brenda), although the interval was never shorter than 10 s and was never decreased even if mean IRTs became shorter (i.e., the schedule could never "back up"). Thus, if the rate of SIB decreased, the mean IRT was increased, and hence the DRO interval was increased. At some points during the experiment, the mean IRTs stopped getting longer; in these cases, the interval was advanced (to the nearest minute) when the rate of SIB fell within the range of several preceding sessions. The eventual goal for the DRO condition was to establish a 5-min DRO interval while maintaining low rates of SIB.

Noncontingent reinforcement. The experimenter delivered attention on a fixed-time schedule, in which the subject's behavior did not influence the frequency of reinforcement. Each interaction between experimenter and subject lasted 10 s, as in the DRO condition. Prior to each session, the schedule was determined according to preestablished fading criteria. The schedule was faded from an initial rate of 6 per minute (continuous attention) to a final rate of 0.2 per minute (one delivery per 5 min). This fading was accomplished by deleting one interaction per minute from the schedule after the rate of SIB was at or below 0.5 responses per minute during any given session. Also, after the rate of attention delivery was reduced to 1 per minute, the schedule was faded first to 0.5 per minute, then to 0.33 per minute, then to 0.25 per minute, and finally to 0.2 per minute. At times (in Bonnie's case), the fading of the fixed-time schedule was based on the observation that her rate

of SIB was within the range of several preceding sessions (because it was rarely 0.5 per minute or lower). The eventual goal of the NCR condition was to establish a 5-min schedule of noncontingent attention (analogous to the 5-min DRO schedule) while maintaining low rates of SIB.

RESULTS

Functional Analysis

Figure 1 displays the results of each subject's functional analysis. The results showed that, for all 3 subjects, SIB was differentially sensitive to attention as a positive reinforcer. In Diane's assessment, with the exception of one demand and one play session, rates of SIB were consistently higher in the attention condition (range, 0 to 14.5 responses per minute) when compared to other conditions (range, 0 to 4.9 responses per minute). Similarly, Brenda's rate of SIB was consistently higher during the attention sessions (range, 3.9 to 9.7 responses per minute) than in all other conditions (range, 0.7 to 3.1 responses per minute). Bonnie's rate of SIB ranged from 3.1 to 7.7 responses per minute during attention sessions, and from 0.2 to 3.1 responses per minute during demand, alone, and play sessions.

Treatment Conditions

Figure 2 shows the results of Diane's and Bonnie's treatment. For Diane, the rate of SIB during baseline ranged from approximately 3 responses per minute to approximately 12 responses per minute. Following the introduction of treatment, both DRO and NCR were shown to be effective in reducing the rate of SIB. However, NCR initially suppressed SIB more effectively than DRO. In DRO, the rate of SIB was initially variable, and there were several sessions with high rates of SIB. Eventually, the rate of SIB decreased to zero responses per minute during most sessions in both treatment conditions.

For Bonnie, the rate of SIB during baseline ranged from approximately three responses per minute to approximately nine responses per minute. After the introduction of treatment, both procedures resulted in immediate reductions in the rate of SIB. Suppression was more consistent during the DRO condition until the later stages of treatment, when both procedures appeared to be equally effective in reducing SIB.

As noted previously, an inherent feature of DRO is the withholding of reinforcement following SIB, which might produce extinction-induced responding under some circumstances (see Cowdery et al., 1990). Neither of these 2 subjects displayed noticeable emotional behavior, such as crying, in either treatment condition. However, there is some reason to believe that NCR attenuated other undesirable effects of extinction associated with DRO. For Diane, in the first session of both NCR and DRO, there was a burst of responding at the beginning of the session, which eventually subsided during the last one third of the session (thus, it is not noticeable in the overall session rate). In Session 2, there was another burst of responding in DRO, which persisted throughout much of the session; in NCR, very little responding occurred from the outset of the second session. The bursts resulted in a much greater total number of responses in the DRO treatment than in the NCR treatment (see, e.g., the 10th session of DRO).

As further evidence that NCR might attenuate extinction-induced effects, Figure 3 shows the cumulative number of aggressive and disruptive responses displayed by Bonnie during baseline and during both treatment conditions. There were no programmed consequences for either aggression or disruption, and both behaviors occurred infrequently during baseline. More aggression and disruption were seen during the DRO condition, although such responses eventually stopped. A common result of extinction procedures is an increase in aggression and in response variation (Skinner, 1953). Thus, for Diane and Bonnie, there is tentative evidence suggesting that NCR attenuates extinction-induced phenomena.

Figure 4 shows the results of Brenda's treatment. During baseline, the rate of SIB initially approximated the rate seen in her functional analysis but increased to a level of nearly 50 responses per minute. Next, NCR was introduced and immediately

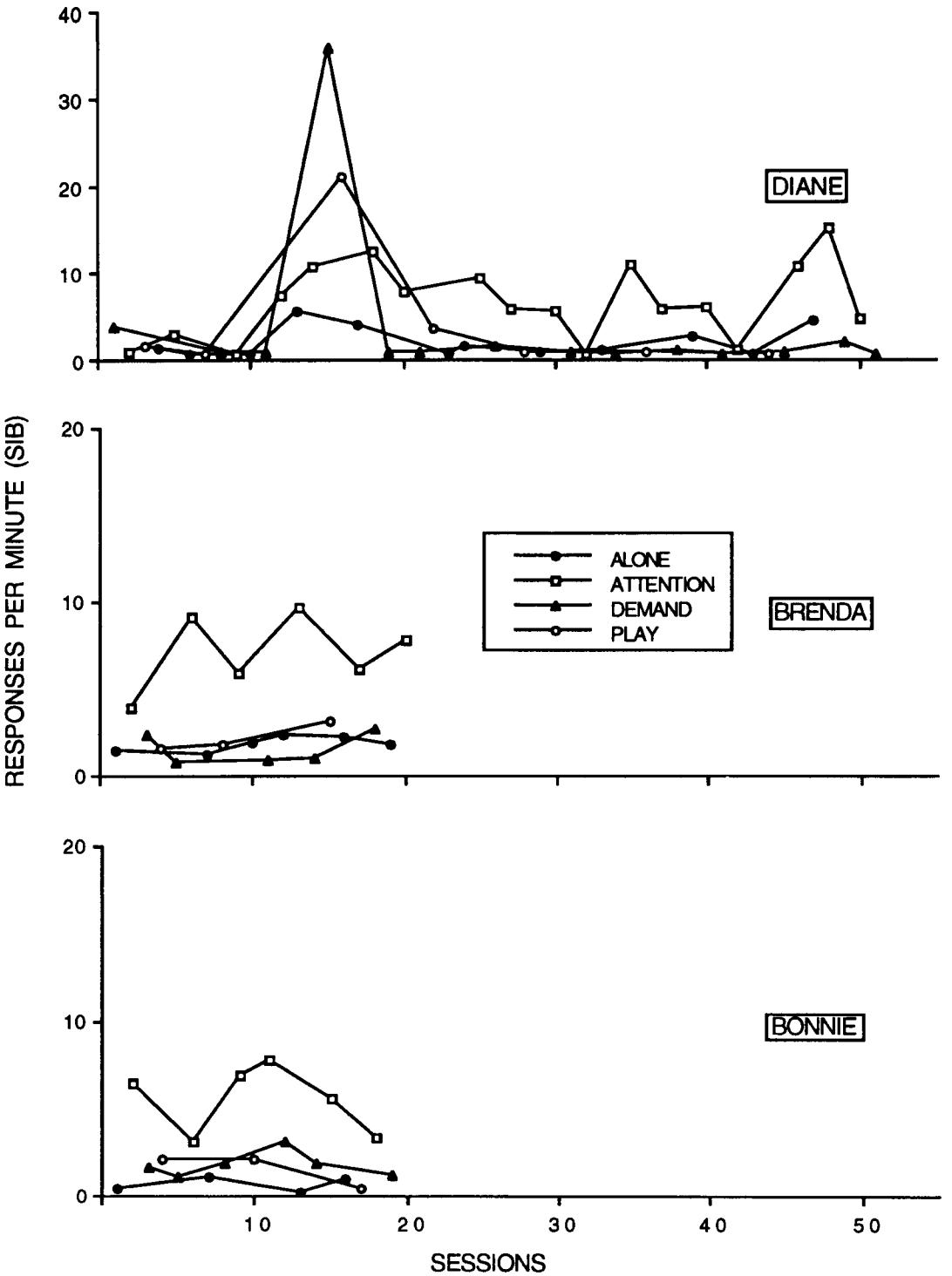

Figure 1. Responses per minute of SIB during functional analysis for Diane (upper panel), Brenda (center panel), and Bonnie (lower panel).

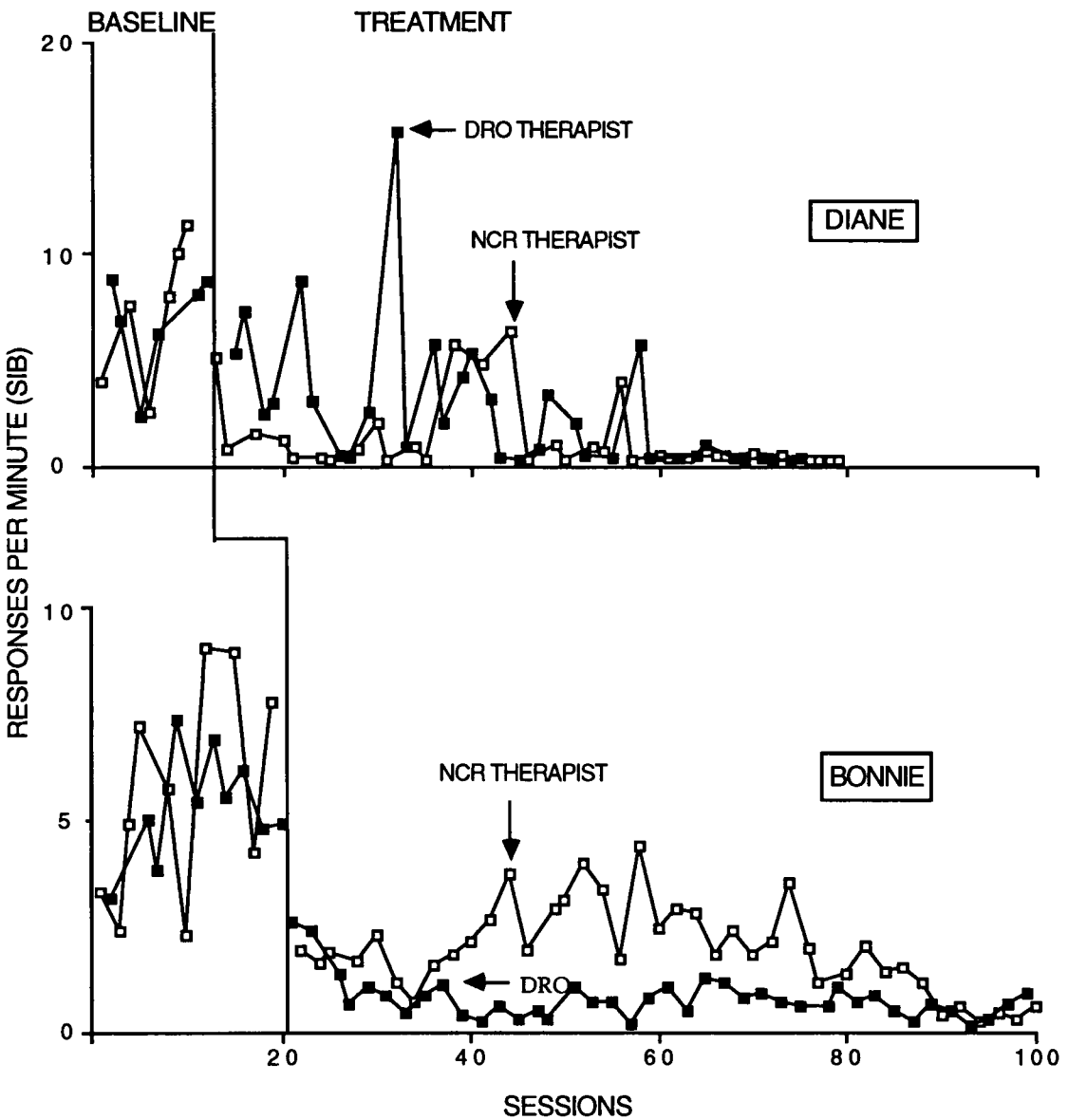

Figure 2. Responses per minute of SIB during treatment conditions for Diane and Bonnie.

reduced the rate of SIB, which remained low throughout the entire condition. A return to baseline resulted in an increase in SIB. Finally, DRO also suppressed SIB, although the overall rate was slightly higher and more variable than it had been in NCR. No evidence of extinction-induced behavior was seen with Brenda; in fact, she was far more aggressive and disruptive during baseline than during either treatment condition, and no bursts in responding (relative to baseline) were observed.

Using the method described previously for increasing interreinforcement intervals within conditions, each condition was terminated with a 5-min programmed reinforcement interval, with one exception. In Brenda's DRO condition, she was no longer receiving reinforcers when the DRO interval

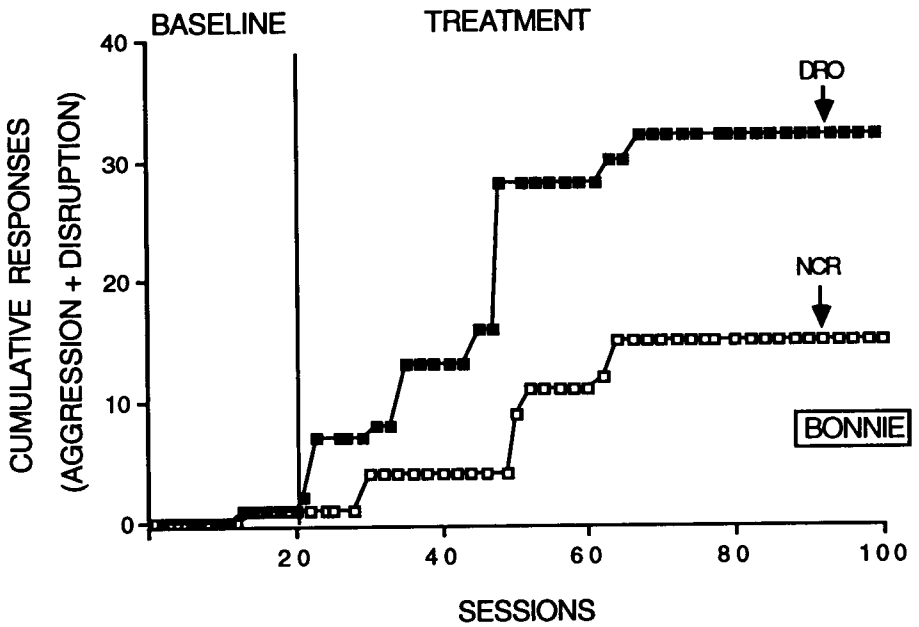

Figure 3. Cumulative number of aggressive and disruptive responses across sessions for Bonnie.

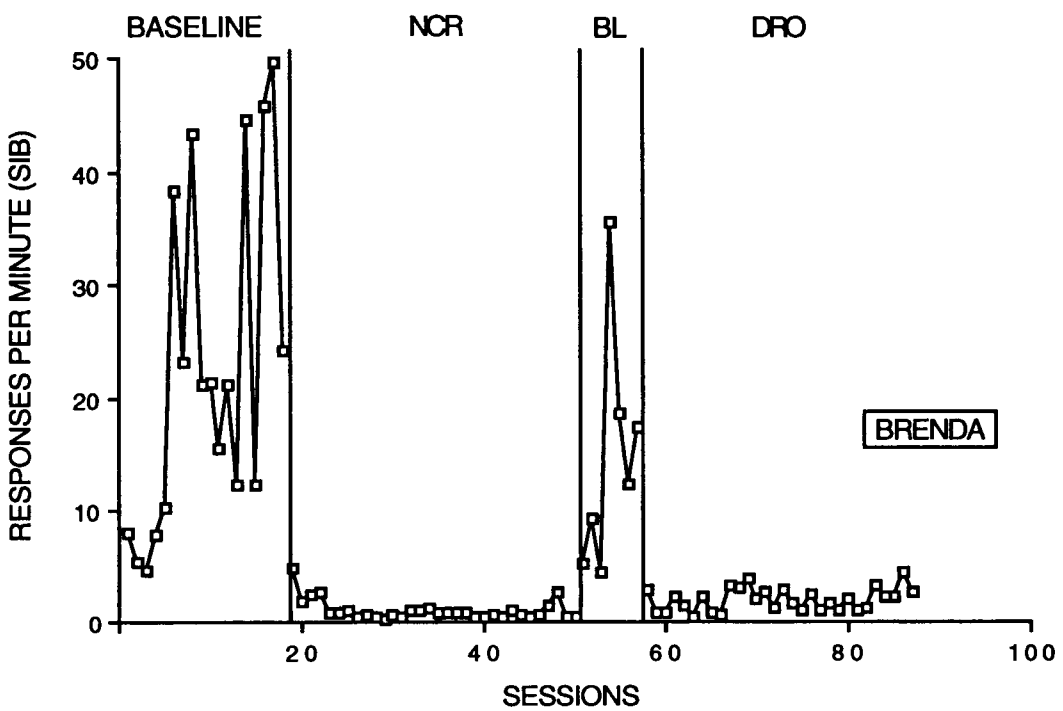

Figure 4. Responses per minute of SIB during treatment conditions for Brenda.

reached 3 min; thus, there was no reason to extend the interval to 5 min. In each case, by definition, the subjects received 0.2 reinforcers per minute in the terminal phase of the NCR condition. Although the programmed (optimal) rate of reinforcement was also 0.2 per minute in the terminal phase of the DRO condition, that rate was not obtained by any of the subjects. In each case, the obtained rate of reinforcement was considerably lower during the terminal phase of the DRO condition than in the terminal phase of the NCR condition (0.08, 0.03, and 0 reinforcers per minute for Diane, Bonnie, and Brenda, respectively, during DRO).

DISCUSSION

The results of this study demonstrate that both DRO and NCR can be effective treatment procedures for SIB that is maintained by socially mediated positive reinforcement. The results are particularly interesting in light of the fact that NCR has been used as a control procedure to demonstrate the effects of DRO (e.g., Corte et al., 1971). Because NCR was about as effective as DRO, the contingent nature of reinforcement delivery in DRO may be of significance only if arbitrary positive reinforcers are used. However, Bonnie's results suggest that this finding should be viewed with caution because DRO was consistently more effective than NCR until both reinforcer-delivery intervals approached 5 min.

Given similar outcomes when attention was delivered contingently (DRO) or noncontingently (NCR), there are several reasons why NCR might be considered a superior treatment. First, data indicated that extinction-induced behavior was attenuated in 2 of 3 subjects. Second, at comparable interval lengths, the rate of reinforcer delivery was considerably higher in NCR. This occurred because the NCR schedule was unaffected by the subject's behavior. By contrast, reinforcer delivery was delayed contingent on SIB during the DRO condition. Bonnie received only two reinforcers across a four-session span in DRO—a schedule that approximates an extinction procedure *without* a differential reinforcement component. Brenda's schedule, in fact, became an extinction schedule when the DRO interval increased to 3 min. This can be seen as a significant shortcoming of DRO because, even at intervals as short as 3 min, it is possible that some subjects would rarely receive social interaction if it were contingently delivered throughout the day.

A third advantage of NCR is ease of implementation. In DRO, a caregiver must observe each instance of SIB to ensure that the resetting schedule is implemented correctly. This is not true for NCR because the schedule is unaffected by the subject's behavior. This is a particularly important point for caregivers responsible for monitoring and delivering treatment for several students or clients at once, as in classrooms or residential settings.

Several unanswered questions arise from the current study. Because the NCR procedure contained several features, it is unclear which component or components were responsible for behavior change. For example, it is unknown whether it was necessary to start the NCR condition with continuous attention and then fade to a less dense schedule. It is possible that intermittent presentations of attention would have reduced occurrences of SIB (see Mace & Lalli, 1991). Also, the effects could have been the result of a relatively dense schedule of reinforcer delivery in comparison to DRO. In this study, rates of reinforcer delivery in NCR and DRO were not yoked because the nonresetting feature of NCR was seen as an inherent advantage of the procedure that should be explored. To yoke the rate of reinforcer delivery would have been to imbue NCR with one of the limitations of DRO. However, future research could control for rate of reinforcer delivery and compare the relative effects of the two procedures for the purposes of a component analysis.

Also unclear is whether the effects of NCR are a result of extinction (because the contingent relationship between SIB and attention was eliminated) or a result of satiation (because attention was provided on a relatively rich schedule). It is likely that some combination of the two processes was in effect. In Brenda's case, SIB continued at rates up to 50 responses per minute during baseline, suggesting that her "satiation point" for attention

was very high. As such, it is unlikely that when attention was delivered noncontingently at 5-min intervals, the obtained effects were solely a function of satiation. Also, when her DRO schedule was increased to 3 min and extinction was in effect, higher rates of SIB were seen than in the terminal phase of NCR, suggesting that more than just extinction was influencing the rate of SIB during NCR.

To the extent that NCR attenuates a relative state of deprivation, our study extends previous findings on the treatment of escape behavior to the treatment of positively reinforced behavior. Specifically, Pace, Iwata, Cowdery, Andree, and McIntyre (in press) demonstrated that when the establishing operation for escape as negative reinforcement (the presentation of instructional demands) was completely removed from the environment, escape SIB did not occur. By fading in the frequency of demands, the experimenters were able to maintain low rates of SIB. Similarly, the current study began by eliminating the relevant establishing operation (deprivation from attention) by providing attention continuously. The schedule of attention was then gradually made more lean while maintaining a low rate of SIB.

A finding of this study that is somewhat surprising was that adventitious reinforcement (Skinner, 1948) was not problematic in the NCR condition. It might seem that some attention would incidentally follow SIB and, hence, reinforce its occurrence. There was partial evidence of this phenomenon in Bonnie's case, because there was some SIB throughout most of the NCR treatment. Additionally, a review of the time course of Bonnie's SIB showed that the behavior occurred most frequently within 10 s after attention delivery, suggesting that Bonnie's history of reinforcement was such that therapist presence was discriminative for further attention. As Morse and Kelleher (1977) pointed out, it is likely that baseline schedules of reinforcement are important factors in the adventitious maintenance of responding. In this case, SIB was reinforced on a continuous (CRF) schedule during baseline, and the eventual schedule of reinforcer delivery in NCR was very different (and presumably highly discriminable) from baseline. If SIB had been reinforced on an intermittent schedule in baseline, and NCR produced intermittent accidental reinforcer deliveries, adventitious reinforcement may have been more likely. In Brenda's case, however, because baseline rates of SIB were so high, there was also nearly continuous attention provided during baseline. Interestingly, when the condition changed to continuous NCR, SIB persisted for approximately the first 4 min of the session, at which time Brenda paused and attention was still delivered. This pattern continued for several sessions, with the duration of near-continuous bouts of responding becoming progressively shorter across sessions. This finding further supports the notion that similarity in scheduled reinforcer deliveries might produce adventitious reinforcement.

When a baseline CRF schedule is impractical or impossible, designing schedules of reinforcer delivery to combine the features of NCR and DRO might be useful to avoid adventitious reinforcement. For example, a nonresetting DRO interval (Repp, Deitz, & Deitz, 1976) might be used, which would increase the likelihood of the subject receiving at least some attention, yet no instances of the target response would be followed by attention. Perhaps even better, a momentary time sample of behavior could be conducted on a fixed-time schedule, and if the subject was not engaging in SIB at that moment, attention could be delivered (see Repp, Barton, & Brulle, 1983). These applications may increase the low rate of reinforcement obtained as a result of the resetting feature used in this study.

Apart from the possibility of accidental reinforcement, another limitation of NCR is that, like DRO, it does not explicitly promote alternative adaptive behavior. Durand and Carr (1991) have pointed out that by making reinforcement differentially available contingent on an alternative response, an individual would not necessarily display an extinction burst because the alternative response might provide an accessible means of obtaining reinforcement. However, for some individuals with extremely limited behavioral repertoires, shaping an alternative response can be time consuming; therefore, extinction bursts might occur when ab-

errant responding is no longer reinforced. In these cases, NCR might be useful because the functional reinforcer can be made available frequently despite the elimination of a contingent relationship between response and consequence. Shaping procedures could then be initiated to establish gradually the alternative attention-getting responses. In fact, each of the subjects in this study eventually became involved in treatment procedures that included the reinforcement of alternative behavior (Mazaleski, Iwata, Vollmer, Zarcone, & Smith, in press). Thus, there is nothing in principle about NCR that precludes contingent reinforcement as a component of a treatment package.

Further research could also explore the possibility that NCR is not necessarily limited to applications involving behavior maintained by positive reinforcement. For example, intermittent noncontingent escape (breaks) from instructional demands might reduce undesirable escape behavior. Previous demand-fading studies have contained an escape-extinction component and made escape from demands contingent on the absence of self-injury (e.g., Pace et al., in press; Zarcone et al., 1993). Similarly, when behavior is automatically reinforced, it is possible that response-independent access to alternative sources of stimulation would reduce stereotyped responding, assuming the alternative stimulation is similar in nature to that produced by the behavior; such an interpretation is relevant to the "environmental enrichment" approach described by Horner (1980). An examination of these issues across behavioral functions is warranted.

In conclusion, this study demonstrated that both DRO and NCR can be effective treatments for aberrant behavior. Previous mixed findings with these procedures probably resulted from a failure to identify behavioral function and from the use of subjectively identified reinforcers. Because there are several practical advantages to NCR over DRO, clinicians are provided with an alternative reinforcement-based procedure. On a theoretical level, this study brings into question the necessity of providing reinforcement contingent on the absence of responding and questions the place of differential reinforcement as the traditional "least restrictive" approach to treatment.

REFERENCES

Azrin, M., Rubin, H., O'Brien, F., Ayllon, T., & Roll, D. (1968). Behavioral engineering: Postural control by a portable operant apparatus. *Journal of Applied Behavior Analysis, 1,* 99–108.

Boe, R. B. (1977). Economical procedures for the reduction of aggression in a residential setting. *Mental Retardation, 15,* 25–28.

Buell, J., Stoddard, P., Harris, F. R., & Baer, D. M. (1968). Collateral social development accompanying reinforcement of outdoor play in a preschool child. *Journal of Applied Behavior Analysis, 1,* 167–173.

Corte, H. E., Wolf, M. M., & Locke, B. J. (1971). A comparison of procedures for elimination of self-injurious behavior of retarded adolescents. *Journal of Applied Behavior Analysis, 4,* 201–213.

Cowdery, G. E., Iwata, B. A., & Pace, G. M. (1990). Effects and side effects of DRO as treatment for self-injurious behavior. *Journal of Applied Behavior Analysis, 23,* 497–506.

Day, R. M., Rea, J. A., Schussler, N. G., Larsen, S. E., & Johnson, W. L. (1988). A functionally based approach to the treatment of self-injurious behavior. *Behavior Modification, 12,* 565–589.

Durand, V. M., & Carr, E. G. (1991). Functional communication training to reduce challenging behavior: Maintenance and application in new settings. *Journal of Applied Behavior Analysis, 24,* 251–264.

Favell, J. E., Azrin, N. H., Baumeister, A. A., Carr, E. G., Dorsey, M. F., Forehand, R., Foxx, R. M., Lovaas, O. I., Rincover, A., Risley, T. R., Romanczyk, R. G., Russo, D. C., Schroeder, S. R., & Solnick, J. V. (1982). The treatment of self-injurious behavior. *Behavior Therapy, 13,* 529–554.

Goetz, E. M., Holmberg, M. C., & LeBlanc, J. M. (1975). Differential reinforcement of other behavior and noncontingent reinforcement as control procedures during the modification of a preschooler's compliance. *Journal of Applied Behavior Analysis, 8,* 77–82.

Harris, S. L., & Wolchik, S. A. (1979). Suppression of self-stimulation: Three alternative strategies. *Journal of Applied Behavior Analysis, 12,* 185–189.

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. (1982). Toward a functional analysis of self-injury. *Analysis and Intervention in Developmental Disabilities, 2,* 1–20.

Iwata, B. A., Pace, G. M., Kalsher, M. J., Cowdery, G. E., Cataldo, M. F., McCosh, K. C., Willis, K. D., Rodgers, T. A., Zarcone, J. R., Vollmer, T. R., Smith, R. G., &

Mazaleski, J. L. (1991, May). *The functions of self-injurious behavior: An experimental-epidemiological analysis.* Paper presented at the 17th annual convention of the Association for Behavior Analysis, Atlanta, GA.

Lennox, D. B., Miltenberger, R. G., & Donnelly, D. R. (1987). Response interruption and DRL for the reduction of rapid eating. *Journal of Applied Behavior Analysis, 20,* 279–284.

Lennox, D. B., Miltenberger, R. G., Spengler, P., & Erfanian, N. (1988). Decelerative treatment practices with persons who have mental retardation: A review of five years of the literature. *American Journal on Mental Retardation, 92,* 492–501.

Lovaas, O. I., & Simmons, J. Q. (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behavior Analysis, 2,* 143–157.

Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. *Journal of Applied Behavior Analysis, 24,* 553–562.

Mazaleski, J. L., Iwata, B. A., Vollmer, T. R., Zarcone, J. R., & Smith, R. G. (in press). Differential reinforcement with and without extinction in the treatment of self-injury maintained by attention. *Journal of Applied Behavior Analysis.*

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37,* 149–155.

Morse, W. H., & Kelleher, R. T. (1977). Determinants of reinforcement and punishment. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant conditioning* (pp. 174–200). Englewood Cliffs, NJ: Prentice-Hall.

Nevin, J. A., Tota, M. E., Torquato, R. D., & Shull, R. L. (1990). Alternative reinforcement increases resistance to change: Pavlovian or operant contingencies? *Journal of the Experimental Analysis of Behavior, 53,* 359–379.

Pace, G. M., Iwata, B. A., Cowdery, G. E., Andree, P. J., & McIntyre, T. (in press). Stimulus (instructional) fading during extinction of self-injurious escape behavior. *Journal of Applied Behavior Analysis.*

Poling, A., & Ryan, C. (1982). Differential reinforcement of other behavior schedules: Therapeutic applications. *Behavior Modification, 6,* 3–21.

Reid, D. H., Parsons, M. B., Green, C. W., & Schepis, M. M. (1991). Evaluation of components of residential treatment by Medicaid ICF-MR surveys: A validity assessment. *Journal of Applied Behavior Analysis, 24,* 293–304.

Repp, A. C., Barton, L. E., & Brulle, A. R. (1983). A comparison of two procedures for programming the differential reinforcement of other behaviors. *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 behavior. *Journal of Applied Behavior Analysis, 7,* 313–325.

Repp, A. C., Deitz, S. M., & Deitz, D. E. D. (1976). Reducing inappropriate behaviors in a classroom and in individual sessions through DRO schedules of reinforcement. *Mental Retardation, 14,* 11–15.

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

Rolider, A., & Van Houten, R. (1990). The role of reinforcement in reducing inappropriate behavior: Some myths and misconceptions. In A. C. Repp & N. N. Singh (Eds.), *Perspectives on the use of nonaversive and aversive interventions for persons with developmental disabilities* (pp. 119–128). Sycamore, IL: Sycamore.

Romanczyk, R. G. (1986). Self-injurious behavior: Conceptualization, assessment, and treatment. In K. D. Gadow (Ed.), *Advances in learning and behavior disabilities* (Vol. 5, pp. 29–56). Greenwich, CT: JAI Press.

Skinner, B. F. (1948). 'Superstition' in the pigeon. *Journal of Expermental Psychology, 38,* 168–172.

Skinner, B. F. (1953). *Science and human behavior.* New York: Macmillan.

Vollmer, T. R., & Iwata, B. A. (1991). Establishing operations and reinforcement effects. *Journal of Applied Behavior Analysis, 24,* 279–291.

Zarcone, J. R., Iwata, B. A., Vollmer, T. R., Jagtiani, S., Smith, R. G., & Mazaleski, J. L. (1993). *Extinction of self-injurious escape behavior with and without instructional fading.* Manuscript submitted for publication.

Received May 14, 1992
Initial editorial decision July 30, 1992
Revision received November 9, 1992
Final acceptance November 9, 1992
Action Editor, David Wacker