JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2000, **33,** 419–432 NUMBER 4 (WINTER 2000)

A METHOD FOR IDENTIFYING SATIATION VERSUS EXTINCTION EFFECTS UNDER NONCONTINGENT REINFORCEMENT SCHEDULES

SUNGWOO KAHNG

KENNEDY KRIEGER INSTITUTE AND
THE JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

AND

BRIAN A. IWATA, RACHEL H. THOMPSON, AND GREGORY P. HANLEY

THE UNIVERSITY OF FLORIDA

We evaluated one method for determining whether response suppression under noncontingent reinforcement (NCR) is a function of satiation or extinction. Three individuals with developmental disabilities who engaged in self-injurious behavior (SIB) or aggression participated. Results of functional analyses indicated that their problem behavior was maintained by social-positive reinforcement. NCR procedures, individualized for each participant, were implemented in a multiple baseline across subjects design and were associated with decreases in all participants' problem behavior. Identification of the mechanism by which NCR produced these effects was based on examination of cumulative records showing response patterns during and immediately following each NCR session. Satiation during NCR should lead to a temporary increase in responding during the post-NCR (extinction) period due to a transition from the availability to the unavailability of reinforcement (satiation to deprivation). Alternatively, extinction during NCR should reveal no increase in responding during the extinction period because the contingency for the problem behavior would remain unchanged and the transition from satiation to deprivation conditions would be irrelevant. Results suggested that the operative mechanisms of NCR were idiosyncratic across the 3 participants and appeared to change during treatment for 1 of the participants.

DESCRIPTORS: functional analysis, noncontingent reinforcement, extinction, satiation, self-injurious behavior, aggression

Research on the functional analysis of problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) has led to the development and refinement of various function-based interventions that (a) alter the antecedent events that occasion behavior, (b) eliminate the reinforcement contingency that maintains behavior, and (c) strengthen competing behaviors. One intervention that has been the focus of a considerable amount of research in recent years is noncontingent reinforcement (NCR), which involves the delivery of reinforcers according to a schedule that is response independent. In the original study combining functional analysis methodology with the therapeutic use of NCR, Mace and Lalli (1991) used NCR to treat bizarre vocalizations exhibited by an adult who had been diagnosed with moderate mental retardation. Attention was delivered on a variable-time schedule and resulted in near elimination of bizarre vocalizations.

This research was supported in part by a grant from the Florida Department of Children and Families and was part of a dissertation submitted by the first author in partial fulfillment of requirements for the PhD degree from the University of Florida. We thank Juliet Conners, Jana Lindberg, Eileen Roscoe, Michele Wallace, and April Worsdell for their assistance in conducting the study.

Reprints may be obtained from SungWoo Kahng, Neurobehavioral Unit, Kennedy Krieger Institute, 707 N. Broadway, Baltimore, Maryland 21205 (E-mail: Kahng@kennedykrieger.org).

Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993) compared the effects of differential reinforcement of other behavior (DRO) and NCR on the self-injurious behavior (SIB) of 3 individuals who had been diagnosed with developmental disabilities. Results indicated that both interventions were highly effective in suppressing SIB, but the authors suggested that NCR might have several advantages over DRO (e.g., higher reinforcement rates, relative ease of implementation). More recent research has extended these findings through the examination of parametric, procedural, and functional variations (e.g., Fischer, Iwata, & Mazaleski, 1997; Hagopian, Fisher, & Legacy, 1994; Lalli, Casey, & Kates, 1997).

In most applications of NCR, reinforcers were initially delivered under dense schedules that produced higher rates of reinforcement than those delivered during baseline (when reinforcement was delivered contingent on occurrences of problem behavior). For example, the initial rate of NCR for 1 participant in Hagopian et al. (1994) was approximately twice the baseline rate of contingent reinforcement. These dense NCR schedules may produce decreases in responding by altering the establishing operation (EO; Michael, 1982, 1993) for problem behavior. That is, NCR may produce a temporary state of satiation as a result of frequent reinforcer delivery.

This satiation hypothesis has been supported by findings from two studies in which dense NCR schedules suppressed problem behavior even though each occurrence of behavior also produced reinforcement (Fischer et al., 1997; Lalli et al., 1997). These results indicated that a mechanism other than extinction (presumably satiation) was responsible for behavioral suppression. Carr, Bailey, Ecott, Lucker, and Weil (1998) provided additional support for the satiation hypothesis through a parametric analysis of NCR. The effects of three magnitudes of NCR (high, medium, and low) on the free-operant responding of 5 participants were compared while the rate of reinforcement was held constant. Results showed response suppression for all participants under the high-magnitude condition and suppression for 2 participants under the medium-magnitude condition. Little or no decrease in responding was observed for any of the participants under the low-magnitude condition.

An alternative explanation for the effects of NCR is that it disrupts the response–reinforcer contingency, thereby producing extinction (Rescorla & Skucy, 1969). Results of a study by Marcus and Vollmer (1996) lend some support to the extinction hypothesis. They exposed 2 of 3 participants to a combined schedule of NCR plus differential reinforcement of alternative behavior (DRA), in which the same reinforcers were delivered on an NCR schedule and were contingent on each occurrence of an alternative response. The authors hypothesized that DRA might fail to increase the alternative behavior as a result of satiation to the reinforcer under NCR. Results showed that the combination of NCR and DRA reduced the frequency of problem behavior and that, as the NCR schedule was rapidly thinned, the alternative response increased.

In an extension of the Marcus and Vollmer (1996) study, Goh, Iwata, and DeLeon (2000) evaluated the effects of NCR plus DRA but did not immediately thin the NCR schedules. Results showed suppression of problem behavior at the outset of treatment, but neither participant showed an increase in the alternative response until the NCR schedules had been thinned to well below baseline rates of reinforcement. These results suggest that NCR may produce both satiation and extinction. That is, initially dense NCR schedules may result in satiation to the reinforcer, thereby reducing problem behavior but also interfering with the acqui-

sition of another response. However, as the NCR schedule is thinned, satiation effects become less likely because fewer reinforcers are delivered. As a result, contingency disruption may be more important than reinforcement delivery per se, thereby producing extinction of problem behavior and rendering alternative behaviors more sensitive to the effects of contingent reinforcement. Under this interpretation, dense schedules of NCR produce satiation, whereas thin schedules produce extinction.

Aside from the theoretical and methodological implications of identifying the operative mechanisms of NCR, there are practical implications as well. For example, if dense NCR schedules reduce the frequency of behavior through satiation, extinction may be unnecessary, at least during the initial stages of treatment (Fischer et al., 1997; Lalli et al., 1997). This may be helpful to parents and therapists attempting to treat severe forms of SIB or aggression, which sometimes cannot be ignored. On the other hand, if extinction is operative, it may highlight the importance of terminating reinforcement for problem behavior or indicate the need for an alternative treatment if extinction cannot be used.

Attempts to identify satiation and extinction effects under NCR by conducting parametric manipulations (Carr et al., 1998) or by implementing additional contingencies for alternative responses (Goh et al., 2000; Marcus & Vollmer, 1996) may be time consuming and somewhat impractical in clinical settings. The purpose of this study was to evaluate a more efficient method for identifying satiation and extinction effects by implementing NCR schedules as treatment for problem behavior and observing response rates following the cessation of each treatment session when a period of extinction was in effect. If NCR produced satiation, the extinction period would represent a transition from satiation to deprivation, which might lead to a temporary increase in responding due to alteration of the EO for problem behavior. Alternatively, if NCR produced extinction, responding should continue to remain low during the extinction period because the contingency for problem behavior would remain unchanged and the discontinuation of reinforcement would be irrelevant. Finally, if dense and thin NCR schedules were associated with different behavioral processes (satiation and extinction, respectively), posttreatment response patterns should change during schedule thinning.

GENERAL METHOD

Participants and Settings

Participants were 3 individuals living in a state residential facility for persons with developmental disabilities who had been referred to a day-treatment program for assessment and treatment of SIB or aggression. All of the participants had severe language deficits and communicated via idiosyncratic gestures (e.g., pointing). One individual (Julia) had participated in two previous studies on NCR (Goh et al., 2000; Kahng, Iwata, DeLeon, & Wallace, 2000). Julia was a 43-year-old woman who had been diagnosed with severe mental retardation and a seizure disorder and who engaged in SIB consisting of skin picking. She received phenytoin and phenobarbital throughout the study to control seizures. Susan was a 31-year-old woman who had been diagnosed with Angelman syndrome, cerebral palsy, profound mental retardation, and seizure disorder (for which she received valproic acid throughout the study). She engaged in SIB (consisting of arm hitting) and aggression (consisting of hitting, scratching, pinching, and kicking others). Matt was a 25-year-old man who had been diagnosed with profound mental retardation and who engaged in SIB (consisting of hand or arm biting). All sessions

were conducted at the day-treatment program in therapy rooms that contained several chairs, a table, and other materials necessary to implement therapy sessions (e.g., work or leisure materials).

Response Measurement and Reliability

Target behaviors consisted of either SIB or aggression. SIB included (a) *skin picking,* defined as scraping a finger against the skin or closing fingers on any part of the skin; and (b) *hand or arm biting,* defined as closing the teeth on any part of the hand or arm. Aggression included (a) *hitting,* defined as forceful contact between the participant's hand and another's body; (b) *scratching,* defined as a participant's finger scraping against another's skin; (c) *pinching,* defined as a participant's fingers closing on another's skin; and (d) *kicking,* defined as a participant's foot contacting another's body.

Data on SIB and aggression were collected on handheld computers (Assistant Model AST102) and were summarized as the number of responses per minute. Data were also collected on experimenters' implementation of assessment and treatment procedures (e.g., delivery of instructions, prompting, and consequences) to determine procedural integrity, which always exceeded 90% accuracy.

Interobserver agreement was assessed by having a second observer collect data simultaneously with but independently of the primary observer. Session time was divided into continuous 10-s intervals, and agreement percentages were calculated based on an interval-by-interval comparison of observers' records. The smaller number of responses in each interval was divided by the larger number of responses; these fractions were averaged across the session and then multiplied by 100%. Interobserver agreement was assessed during 35% of the functional analysis sessions. Mean agreement scores for Julia, Susan, and Matt, respectively, were 99% (range, 99% to 100%), 99% (range, 96% to 100%), and 94% (range, 75% to 100%). Interobserver agreement was assessed during 36% of the baseline and treatment sessions. Mean agreement scores for Julia, Susan, and Matt, respectively, were 99% (range, 96% to 100%), 97% (range, 91% to 100%), and 98% (range, 79% to 100%).

Phase 1: Functional Analysis

All participants were exposed to a functional analysis to identify contingencies that maintained their problem behavior (Iwata et al., 1982/1994). Julia's and Susan's assessments consisted of four conditions (attention, demand, alone, and play). Matt was exposed to an additional condition (tangible) based on caregiver reports that his problem behavior may have been maintained by access to specific items. All assessments were conducted within a multielement design. Sessions lasted 15 min and were conducted four to five times daily, usually 5 days per week.

Assessment Conditions

Attention. This was a test condition for problem behavior maintained by social-positive reinforcement. The participant and experimenter were in a room containing various leisure materials, to which the participant had free access throughout the session. The experimenter ignored the participant throughout the session except when the participant engaged in problem behavior, at which time the experimenter approached the participant and provided brief attention (e.g., "Don't do that, you'll hurt yourself") and light physical contact (e.g., response interruption).

Tangible. This condition was similar to the attention condition and was a test for problem behavior maintained by access to particular items. An experimenter was present throughout the session and delivered a small bit of food to the participant contin-

gent on problem behavior. No other form of attention was delivered.

Demand. This condition was a test for problem behavior maintained by negative reinforcement (i.e., escape from tasks). The experimenter presented instructional trials to the individual on a fixed-time (FT) 30-s schedule using a three-step graduated prompting procedure (verbal instruction, demonstration, and physical guidance). The experimenter delivered praise contingent upon compliance with the instruction. If the participant emitted problem behavior at any time during the instructional trial, the experimenter terminated all interactions and turned away from the participant until the beginning of the next trial.

Alone. This condition was a test for SIB maintained by automatic reinforcement (persistence of behavior in the absence of social contingencies). The individual was alone in a therapy room without access to leisure materials.

Play. This served as the control condition. Leisure items were available continuously, and the experimenter delivered noncontingent attention on an FT 30-s schedule. No instructions were presented during the session, and problem behavior was ignored.

Results

Figure 1 shows rates of problem behavior across assessment conditions for all participants (Julia's data are reproduced from Kahng et al., 2000). Matt's SIB occurred most frequently during the tangible condition, indicating that his problem behavior was maintained by access to food. Julia's SIB and Susan's SIB and aggression occurred most often in the attention condition. Thus, results of the functional analyses indicated that all participants' problem behaviors were maintained by social-positive reinforcement. These data were used to select the reinforcers to be delivered during the treatment phase of the study.

Phase 2: Evaluation of Responding During and Following NCR

Procedure

Baseline. All sessions lasted 10 min. Baseline conditions were identical to the functional analysis conditions in which problem behavior was highest (tangible for Matt; attention for Julia and Susan). Reinforcers were delivered on a continuous schedule.

Noncontingent reinforcement (NCR). The same reinforcers as those used in baseline were delivered according to FT schedules while occurrences of problem behavior were ignored. The initial NCR schedules for Julia and Susan were based on the mean interresponse time (IRT) of problem behavior during the last three baseline sessions (Kahng et al., 2000) and were subsequently thinned based on the mean IRT of problem behavior during the previous three sessions. Thus, as the rate of problem behavior decreased, the mean IRT increased, resulting in a thinner NCR schedule. Schedule thinning was discontinued when the NCR schedule reached FT 300 s (see exceptions below). Matt's NCR schedule was determined in a different manner because he had a history of difficulty with thin schedules of reinforcement. Prior to this study, Matt had participated in a program involving the use of differential reinforcement, and it was observed that his performance became somewhat erratic as the reinforcement schedules were thinned. Therefore, Matt's initial NCR schedule was FT 5 s (12 reinforcers per minute), which resulted in near-continuous access to reinforcers (food items). Schedule thinning was initiated after the third NCR session using the procedure described by Vollmer et al. (1993). If SIB was at or below 0.5 responses per minute, the delivery of one reinforcer per minute was deleted in the subsequent session. This continued until the NCR schedule reached FT 60 s (one reinforcer per minute). At that point, one reinforcer per

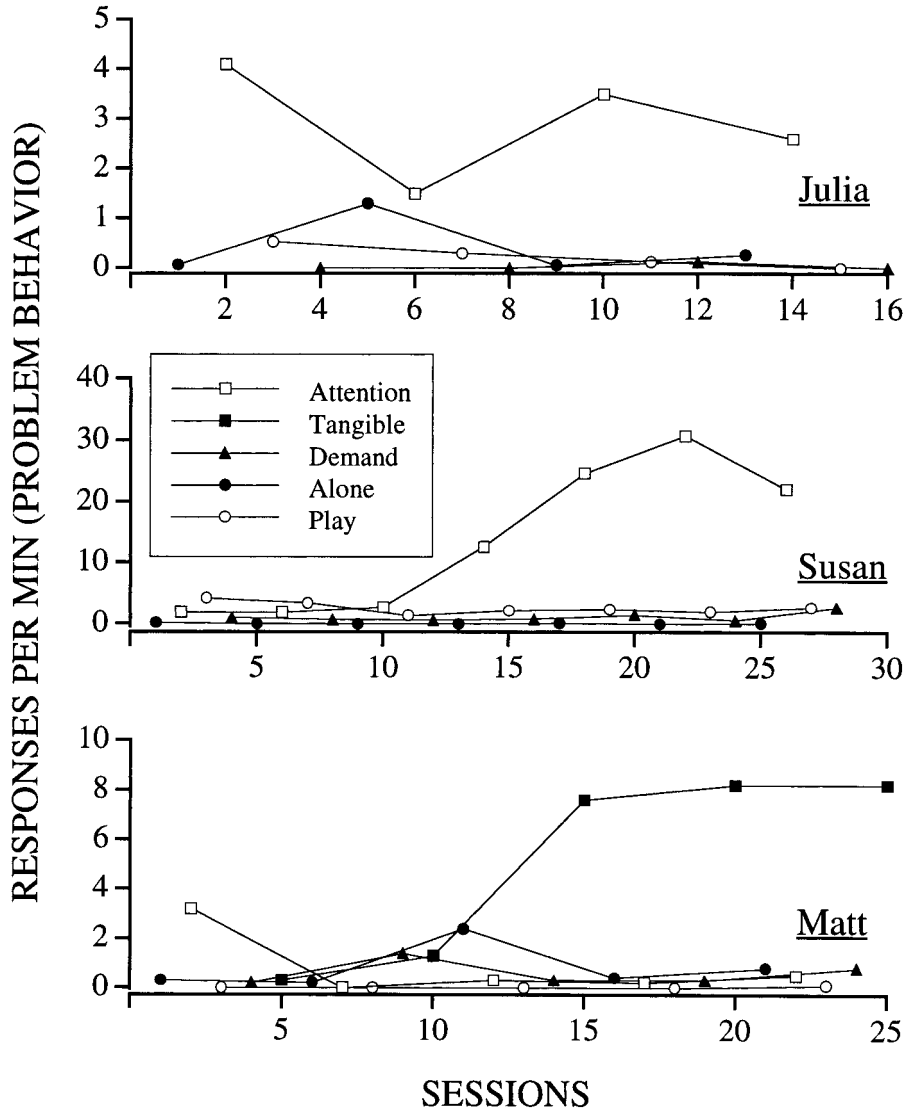

Figure 1. Number of responses per minute of problem behavior (SIB or aggression) during the functional analysis for all participants.

session was deleted in each subsequent session until the terminal schedule of FT 300 s was reached.

Post-NCR (extinction). Immediately following each NCR session, a 20-min extinction session was conducted. This condition was similar to baseline (i.e., same room, therapist, etc.), except that no reinforcers (attention or food) were delivered.

Experimental Design and Data Analysis

The effects of NCR were evaluated in a multiple baseline across subjects design, in which baseline rates of problem behavior were compared with those observed under NCR. To determine whether decreases in problem behavior under NCR were a function of satiation or extinction, we constructed cumulative (minute-by-minute) records

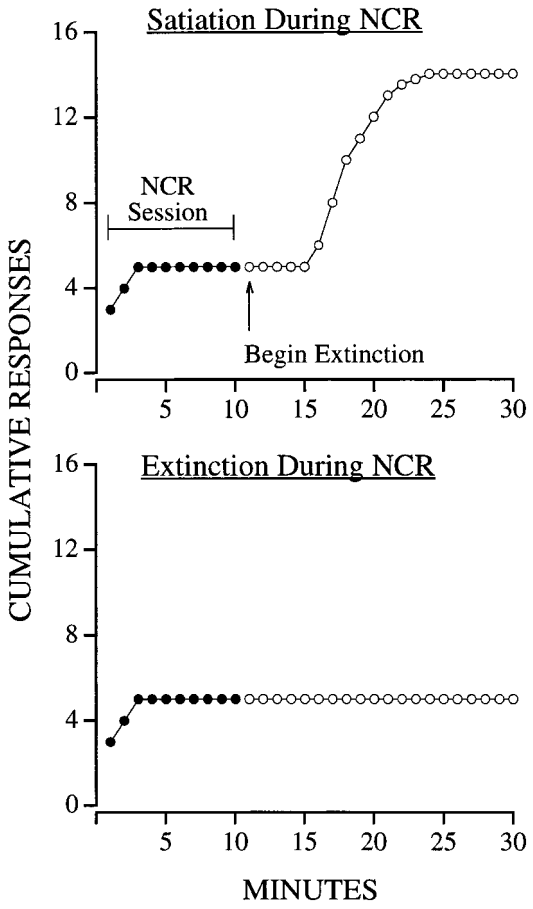

Figure 2. Hypothetical cumulative records of responding expected from satiation (top panel) and extinction (bottom panel) during NCR.

of problem behavior across the 10-min NCR session and the 20-min extinction session that immediately followed it. If the individual was satiated to the reinforcer during NCR, the withdrawal of reinforcers might produce the onset of deprivation, causing a temporary increase in responding during the extinction session (Figure 2, top panel). Alternatively, if extinction was responsible for behavioral suppression during NCR, responding might remain low throughout the extinction session (Figure 2, bottom panel).

Results

Figure 3 shows data on problem behavior during baseline and NCR sessions for all participants. NCR produced immediate decreases in problem behavior for each participant. Julia, Susan, and Matt averaged 3.9, 15.0, and 6.4 responses per minute, respectively, during baseline, and 0.3, 4.4, and 0.4 responses per minute, respectively, during NCR. Matt was exposed to five sessions of extinction at the end of the NCR condition (see below for further details), during which his SIB averaged 0.04 responses per minute.

Figure 4 shows the cumulative number of responses for Julia and Susan across the 10-min NCR sessions and the 20-min extinction sessions that followed (only representative sessions are depicted). Julia's SIB decreased almost immediately to zero during NCR. Therefore, the extinction sessions following her first two NCR sessions (Sessions 11 and 12 at FT 15 s) were extended to 30 min and 45 min, respectively, to ensure a sufficient period of deprivation from the reinforcer. However, no increase in Julia's SIB was observed during these sessions (Figure 4, top panel). Subsequently, her NCR schedule remained at FT 15 s to allow continued observation of her behavior following dense delivery of reinforcers while the extinction period was reduced to 20 min. Julia's SIB remained low throughout these NCR and extinction sessions (e.g., Sessions 16 and 22). The absence of SIB for relatively long periods of time (up to 45 min) following protracted exposure to a dense NCR schedule suggested that decreases in SIB observed during the NCR sessions were likely a function of extinction.

Susan's first treatment session was NCR delivered on an FT 4-s schedule. Her cumulative response pattern showed a sharp increase in problem behavior immediately following the termination of NCR, suggesting a satiation effect during the first NCR session (Figure 4, bottom panel, Session 15). An increase in problem behavior was also observed following Session 17 (FT 15 s), although it was more gradual than that ob-

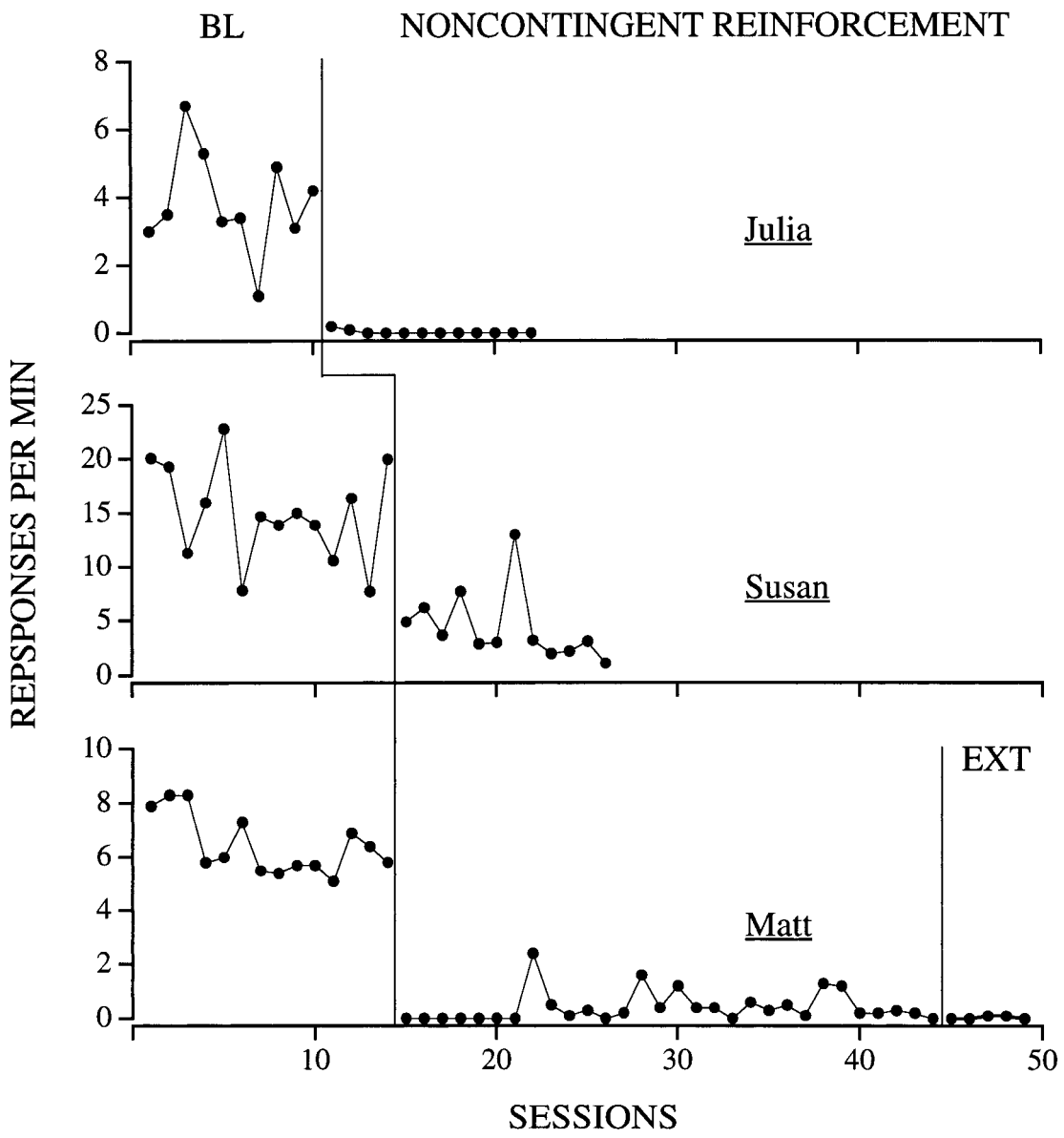

Figure 3. Number of responses per minute of problem behavior during baseline and NCR for all participants.

served following Session 15. Because Susan's problem behavior increased during Session 21 (not shown), the NCR schedule was changed to FT 9 s. Her response patterns following this and subsequent sessions showed little or no increases in problem behavior, suggesting that problem behavior had been extinguished during the NCR sessions.

Figure 5 shows representative cumulative records of Matt's SIB during and following NCR sessions. His initial NCR schedule was FT 5 s (Session 15). SIB increased during the extinction period following that session, as well as following subsequent sessions during which the NCR schedule was thinned (Sessions 24, 27, 29, 31, 35, 39, 41, 42, and 43). The terminal NCR value of FT 300 s

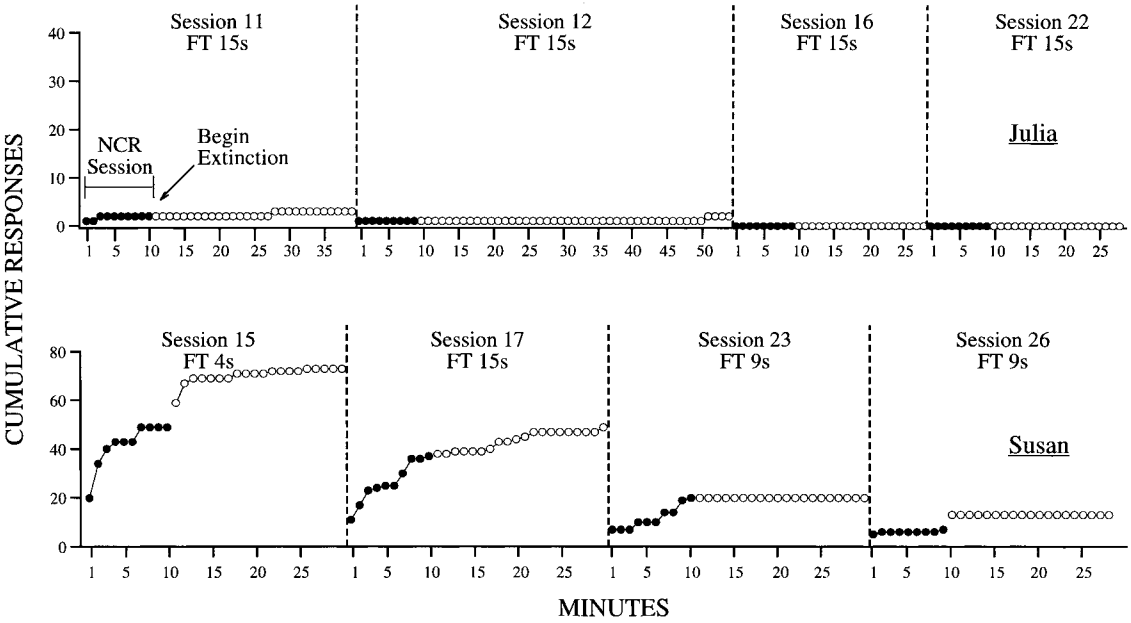

Figure 4. Selected cumulative records of responding during NCR and post-NCR (extinction) sessions for Julia and Susan.

was reached by Session 43, yet Matt's SIB continued to show increases during the extinction period. Thus, NCR was discontinued during treatment sessions and was replaced with extinction for five sessions. Following each of these sessions (Sessions 45, 46, 47, 48, and 49), SIB showed little or no increase during the extinction period.

DISCUSSION

As a therapeutic intervention, NCR may influence behavior through two different processes. First, high rates of reinforcement typically used at the outset of treatment may produce satiation and thereby alter the EO for problem behavior. Second, the response-independent nature of the schedule may produce extinction. Furthermore, these processes may change during the course of treatment as the NCR schedule is progressively thinned. Results of the present study revealed all three of these effects.

Matt's data consistently showed an increase in SIB at the end of NCR sessions, regardless of whether the preceding NCR schedule was dense (FT 5 s) or thin (FT 300 s). This pattern of responding suggested that SIB was not extinguished during NCR. Instead, the termination of reinforcement at the end of each NCR session apparently reinstated a condition of deprivation (the EO for SIB), which occasioned SIB during the post-NCR extinction session. Although it seems unlikely that the thinner NCR schedules would have produced satiation, the treatment may have been sufficient to suppress SIB as long as *some* reinforcers were forthcoming under NCR. It is conceivable that the delivery of reinforcers functioned as a surrogate conditioned EO (Michael, 1993). A conditioned EO is a previously neutral event that acquires reinforcer-establishing and evocative effects through correlation with an existing EO. That is, reinforcement delivery during the initial portion of the NCR sessions and its absence during the initial portion of the extinction sessions could have functioned as a surrogate conditioned EO. The establishment of this con-

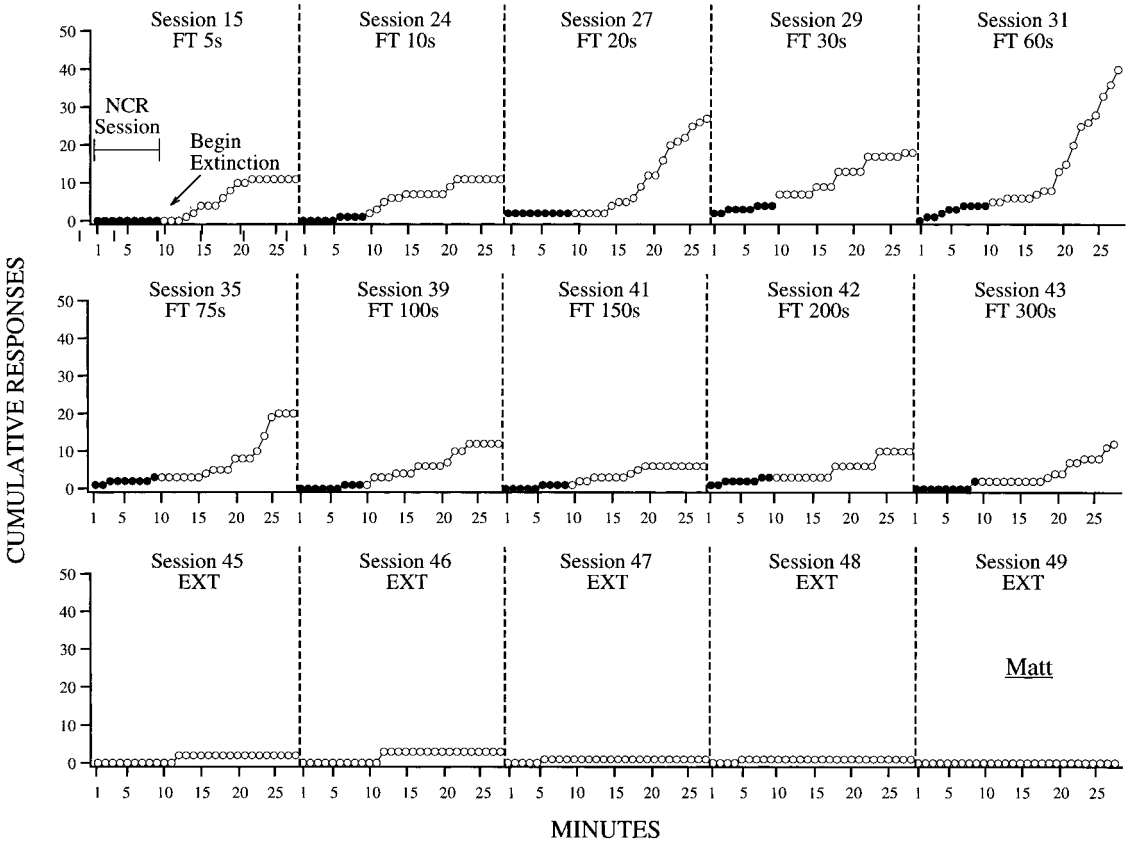

Figure 5. Selected cumulative records of responding during NCR and post-NCR (extinction) sessions for Matt.

ditioned EO may have been promoted by regularly alternating NCR and extinction sessions. We included the final extinction phase to compare response rates following the presence (NCR) versus the absence (extinction) of reinforcement. Response patterns during the extinction phase were markedly different from those during the NCR phase, adding further support to the conclusion that extinction was not responsible for the efficacy of NCR throughout the thinning process.

Susan's response patterns during NCR and the post-NCR sessions also suggested that satiation was initially responsible for behavioral suppression under NCR. Noticeable increases in problem behavior were observed soon after NCR was discontinued (see Figure 4, bottom panel, Session 15). As the NCR schedule was thinned, post-NCR response patterns changed until Susan eventually engaged in little or no problem behavior during extinction. These results suggest that problem behavior was extinguished under NCR as the delivery of reinforcers became less frequent. Alternatively, it is possible that these response patterns were indicative of extinction effects only. Research suggests that extinction often produces a relatively gradual decrease in responding accompanied by periodic fluctuations in response rates (Lerman & Iwata, 1996). Thus, if problem behavior were in the process of being extinguished across the first few NCR sessions, within-session response patterns might resemble those attributed to EO effects. This alternative interpretation could be evaluated in future studies by holding the

initial NCR schedule constant across several sessions to determine if initial satiation response patterns gradually resemble extinction response patterns with continued exposure to treatment.

Julia's response patterns were different from those observed for other participants. Her problem behavior remained low throughout NCR and post-NCR sessions, even though the NCR schedule was dense (FT 15 s) and was followed by an extended period of deprivation. These findings were somewhat unusual, suggesting that SIB was extinguished almost immediately under NCR. However, Julia's behavior had twice been exposed to NCR as part of her participation in two previous studies (Goh et al., 2000; Kahng et al., 2000). It is likely that prior exposure to controlled baseline and treatment conditions decreased resistance to extinction and enhanced discriminability of the transition from reinforcement to extinction, rendering the interpretation of her data somewhat difficult. Nevertheless, Julia's data illustrate the utility of conducting post-NCR observations because they revealed that rapid schedule-thinning procedures would not have had a deleterious effect on her behavior.

Data from several studies appear to be consistent with the findings in this study, assuming that response suppression under NCR could result from either satiation or extinction, and that a transition from one to the other may occur as NCR schedules are thinned. For example, 2 of the 3 participants in the Vollmer et al. (1993) study (Diane and Bonnie), 2 of the 4 participants in the Hagopian et al. (1994) study (Wanda and Laurie), 2 of the 3 participants in the Lalli et al. (1997) study (Donny and Tony), and both participants in the Fischer et al. (1997) study showed temporary increases in problem behavior as NCR schedules were thinned. These increases may have constituted response bursting due to a transition from satiation to extinction effects.

The methodology used in this study also yielded some results that were not entirely expected. For example, although it seemed unlikely that thin NCR schedules would produce satiation, Matt's post-NCR response patterns were consistent with such an interpretation. Similarly, although data presented by Fischer et al. (1997) and Lalli et al. (1997) clearly showed that dense NCR schedules can produce satiation effects, Susan's response patterns following a series of NCR sessions indicated that a dense NCR schedule (FT 15 s) produced extinction.

These results, along with those of several other studies (e.g., Goh et al., 2000; Hagopian et al., 1994), indicate that the operative mechanisms of NCR may be idiosyncratic across individuals and may change during the course of treatment. Identification of these mechanisms through periodic post-NCR observations, such as those used in the present study, has several beneficial applications. First, as previously noted, the identification of satiation effects under dense NCR schedules would suggest that extinction is unnecessary. This information would be important for determining if NCR should be used when reinforcement for problem behavior cannot be completely withheld. Second, if suppression of behavior results more from extinction effects than satiation effects as NCR schedules are thinned, caregivers should be informed that temporary increases in responding may occur. Finally, reinforcer delivery under thin NCR schedules may be somewhat incidental if response suppression results from extinction.

Some limitations of the procedures should also be noted. First, identification of these operative mechanisms was somewhat indirect because the NCR schedules contained an explicit extinction component. Furthermore, our interpretations of the findings were based on expected response patterns due to satiation versus extinction effects, which can be influenced by many other fac-

tors (e.g., history). Additional support for the validity and utility of this approach might be obtained by combining the present methodology with procedures used in previous studies (e.g., Fischer et al., 1998; Goh et al., 2000). For example, post-NCR observations could be conducted following NCR sessions in which contingent reinforcement is and is not available for problem behavior. Alternatively, one could attempt to establish an alternative response in conjunction with NCR while evaluating postsession response patterns for both problem behavior and the alternative response.

Another limitation was that, although the removal of reinforcement for 20 min to 45 min did not consistently lead to reoccurrence of problem behavior, these extinction intervals were chosen arbitrarily. It is conceivable that lengthier post-NCR sessions would have been associated with increases in problem behavior. Finally, because different results were obtained across participants, it is perhaps convenient to attribute these differences to individual histories. However, factors that determine how an individual's behavior is affected by dense and thin NCR schedules, including the transition from one to the other, are important and remain unknown. Exposure to a variety of pretreatment reinforcement conditions and initial NCR schedules may help to identify these factors, although there may be practical constraints in conducting such analyses within a treatment context. In the present study, the only "unnecessary" condition that was added was the post-NCR session, which merely involved further observation.

Additional research should be conducted on the utility of this methodology for identifying operative mechanisms during extended NCR sessions. Most studies, including the present one, evaluated NCR during brief (10-min or 15-min) sessions. However, it is unclear what effect longer exposure to NCR would have on responding or on the operative mechanisms of NCR. Post-NCR observations could be periodically interspersed within extended NCR sessions.

Finally, additional support for the utility of this methodology may be provided by its application to other behavior-reduction procedures. That is, although the present study was limited to a consideration of behavior change under NCR, the questions posed here are also relevant to DRO contingencies. In application, initial DRO schedules typically involve very brief interval requirements that result in high rates of reinforcement, which are gradually thinned. Therefore, it is possible that the omission contingency in many DRO procedures is unnecessary because dense DRO schedules may essentially function as NCR schedules in producing satiation. Likewise, reinforcer delivery under thinner DRO schedules may be incidental to the process of extinction. Thus, further application of the present methodology or one similar to it may show that, although NCR and DRO are procedurally different, they affect behavior through similar if not identical processes.

REFERENCES

Carr, J. E., Bailey, J. S., Ecott, C. L., Lucker, K. D., & Weil, T. M. (1998). On the effects of noncontingent delivery of differing magnitudes of reinforcement. *Journal of Applied Behavior Analysis, 31,* 313–321.

Fischer, S. M., Iwata, B. A., & Mazaleski, J. L. (1997). Noncontingent delivery of arbitrary reinforcers as treatment for self-injurious behavior. *Journal of Applied Behavior Analysis, 30,* 239–249.

Goh, H., Iwata, B. A., & DeLeon, I. G. (2000). Competition between noncontingent and contingent reinforcement schedules during response acquisition. *Journal of Applied Behavior Analysis, 33,* 195–205.

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

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)
Kahng, S., Iwata, B. A., DeLeon, I. G., & Wallace, M. D. (2000). A comparison of procedures for programming noncontingent reinforcement schedules. *Journal of Applied Behavior Analysis, 33,* 223–231.
Lalli, J. S., Casey, S. D., & Kates, K. (1997). Noncontingent reinforcement as treatment for severe problem behavior: Some procedural variations. *Journal of Applied Behavior Analysis, 30,* 127–137.
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.
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.
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.
Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37,* 149–155.
Michael, J. (1993). Establishing operations. *The Behavior Analyst, 16,* 191–206.
Rescorla, R. A., & Skucy, J. C. (1969). Effect of response-independent reinforcers during extinction. *Journal of Comparative and Physiological Psychology, 67,* 381–389.
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 and differential reinforcement of other behavior. *Journal of Applied Behavior Analysis, 26,* 9–21.

Received May 9, 2000
Final acceptance August 22, 2000
Action Editor, Dorothea Lerman

STUDY QUESTIONS

1. What behavioral processes might account for response reduction during noncontingent reinforcement (NCR), and what is the practical importance of distinguishing between these processes?

2. Why were the functional analyses and NCR treatment conditions necessary prerequisites for the post-NCR assessment?

3. How were the initial NCR schedules determined for Julia and Susan during Phase 2?

4. How did the authors determine whether NCR produced satiation or extinction?

5. Describe the response patterns observed for each participant during the post-NCR sessions and the authors' interpretations of these data.

6. What is a conditioned establishing operation (CEO), and how might its influence have affected Matt's results?

7. What other methods might be used to clarify some of the ambiguous findings in this study?

8. Why is the distinction between satiation and extinction also relevant to the interpretation of results obtained with differential reinforcement of other behavior contingencies?

Questions prepared by Stephen North and Eileen Roscoe, The University of Florida