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ON THE EFFECTS OF NONCONTINGENT DELIVERY OF DIFFERING MAGNITUDES OF REINFORCEMENT

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We conducted a parametric analysis of response suppression associated with different magnitudes of noncontingent reinforcement (NCR). Participants were 5 adults with severe or profound mental retardation who engaged in a manual response that was reinforced on variable-ratio schedules during baseline. Participants were then exposed to NCR via multielement and reversal designs. The fixed-time schedules were kept constant while the magnitude of the reinforcing stimulus was varied across three levels (low, medium, and high). Results showed that high-magnitude NCR schedules produced large and consistent reductions in response rates, medium-magnitude schedules produced less consistent and smaller reductions, and low-magnitude schedules produced little or no effect on responding. These results suggest that (a) NCR affects responding by altering an establishing operation (i.e., attenuating a deprivation state) rather than through extinction, and (b) magnitude of reinforcement is an important variable in determining the effectiveness of NCR.

DESCRIPTORS: noncontingent reinforcement, satiation, extinction, reinforcement magnitude

In a noncontingent reinforcement (NCR) procedure, the reinforcer responsible for maintaining a problem behavior is delivered on a fixed-time (FT) or variable-time schedule (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Sizemore and Lattal (1977) summarized basic research on NCR by stating that "transitions from response-depen-

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dent reinforcement schedules, in which [reinforcer] delivery is contiguous with the measured response, to response-independent reinforcement schedules are characterized by reductions in response rates" (p. 119). Though not new to the behavioral literature, NCR procedures have received renewed interest in recent years as a treatment for aberrant behavior (e.g., Fischer, Iwata, & Mazaleski, 1997; Hagopian, Fisher, & Legacy, 1994; Hanley, Piazza, & Fisher, 1997; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Lalli, Casey, & Kates, 1997; Mace & Lalli, 1991; Marcus & Vollmer, 1996; Vollmer et al., 1993; Vollmer, Marcus, & Ringdahl, 1995; Vollmer, Ringdahl, Roane, & Marcus, 1997).

Vollmer et al. (1993) compared the effectiveness of NCR and differential reinforcement of other behavior (DRO) in reducing attention-maintained self-injurious behavior (SIB) among 3 adults with mental retardation. The results indicated that NCR and DRO were equally effective in reducing SIB. However, NCR did provide additional benefits over DRO, including ease of implementation. The authors hypothesized that the behavior-change mechanisms operating in NCR were most likely extinction (termination of the response–reinforcer contingency) and satiation (elimination of the behavior's establishing operation).

Hagopian et al. (1994) examined relative response suppression under dense versus lean NCR schedules. The participants were 4 identical quadruplets with pervasive developmental disorder and mild to severe mental retardation who exhibited attention-maintained aggressive, disruptive, and self-injurious behaviors. The authors found that behavior reduction was greater under dense NCR schedules than under lean schedules, a finding previously reported in the basic literature by Lachter, Cole, and Schoenfeld (1971). However, the lean schedules were still effective in reducing the target behavior in 3 of the 4 participants. The authors hypothesized a combination of satiation and extinction mechanisms at work; however, the effects of these variables were not isolated.

Marcus and Vollmer (1996) examined the efficacy of NCR combined with differential reinforcement of an alternative behavior (DRA) to treat self-injurious and aggressive behaviors that were maintained by tangible items in 2 children with moderate to profound mental retardation. The authors reported that the combination of NCR with DRA was effective in reducing aggressive behaviors and did not preclude mand acquisition. These data seem to indicate that NCR worked via the effects of extinction. That is, if NCR reduced the reinforcing value of the tangible items, those same items would not function as reinforcers for the alternative behaviors. However, close inspection of the data suggests another interpretation. For both participants, mands increased only when the NCR schedule was less than continuous. Acquisition strength appeared to be positively correlated with the thinning of the NCR schedule. This suggests that, although extinction still may have been a part of the behavior-change mechanism complex, satiation clearly appeared to be operating, as shown by the differential mand acquisition strengths. Goh (1997) recently conducted an extension of this study to clarify the role of satiation in response suppression. He found that participants did not acquire mands when NCR schedules were kept continuous. However, as soon as the NCR schedules were thinned, mand acquisition was strengthened.

Most clinical studies of NCR have implemented the procedure with an implicit extinction component. That is, the target behavior's reinforcer was delivered only on a time-based schedule and never contingently. However, two recent studies have shown that NCR can be effective even when the original

contingency remains in place. Lalli et al. (1997) reported a case in which a child with severe mental retardation received NCR treatment for SIB that was maintained by access to tangible items. The authors implemented NCR without extinction in an initial schedule that was less than continuous. They demonstrated that NCR without extinction was effective in suppressing SIB. This indicated that response suppression was not a result of extinction. Fischer et al. (1997) compared the noncontingent delivery of arbitrary versus maintaining reinforcers on the SIB of 2 adults with profound mental retardation. Arbitrary stimuli were identified using a choice preference assessment. A functional analysis identified the maintaining reinforcers as attention for 1 participant and access to tangible items for the other. The results showed that the noncontingent delivery of arbitrary stimuli was effective in reducing SIB, even though the maintaining reinforcer was still presented contingently. This indicates that extinction was not responsible for response suppression in these two cases.

Another manipulable variable that can affect NCR procedures is reinforcer magnitude. Currently, there is no determination of how large or salient the delivered stimulus must be to affect responding. Further, reinforcer-magnitude manipulations might provide additional data on NCR behavior-change mechanisms. If extinction is a primary behavior-change mechanism in NCR procedures, there should be no difference in response reduction between identical FT schedules with different reinforcer magnitudes because the contingency has been eliminated to the same degree under both schedules. If NCR procedures work via satiation or some other mechanism, the schedule associated with a larger magnitude of reinforcement should produce greater reductions than a schedule associated with a smaller magnitude. The purpose of the current study was to examine the effects of reinforcer magnitude on response suppression under NCR schedules.

METHOD

Participants and Setting

Five adults (Tom, Rita, Mary, Zack, and Mike) with severe to profound mental retardation participated in this study. The participants ranged in age from 20 to 48 years. All experimental sessions were conducted at the sheltered workshop facility where the participants were employed. Participants were selected based on their ability to operate the response apparatus and to interact socially with unfamiliar persons. Sessions were conducted at a table in one of two areas in the work facility where noise and other distractions were minimized.

Apparatus

The response apparatus was a large plastic cylinder with a round opening (2 in. diameter) in the top. Located next to the covered cylinder was a box containing many poker chips. The cylinder was enclosed in one of four different colored coverings, depending on the experimental condition, in an effort to facilitate discrimination among experimental contingencies.

Stimulus Preference Assessment

Preferred edible stimuli were identified by first consulting with the staff nutritionist and direct caregivers at the participants' residential and work facilities. A paired-stimulus preference assessment then was conducted using the stimuli recommended by these personnel (Fisher et al., 1992). Because of certain facility restrictions, we were able to assess preference of only four stimuli with each participant, although they were specific to each individual. Each stimulus was presented 10 times across 20 trials. Based on the relative selection percentages, a highly

preferred edible stimulus was identified for use as a consequence throughout the study. The consequences for Mary, Mike, Rita, Tom, and Zack were vanilla wafers, potato chips (low in salt and fat), popcorn, raisins, and vanilla wafers, respectively.

Response Measurement and Interobserver Agreement

A response was defined as the dropping of any number of chips into the cylinder at one time. For example, a participant who dropped one chip in the cylinder and one who dropped five at one time would each be observed as emitting one response. The definition allowed for multiple chips because some participants would not (or could not) place single chips into the cylinder. Data were collected using handheld counters. Response rate, the dependent variable, was calculated by dividing the total number of responses by the number of minutes in that session.

Interobserver agreement data were collected for at least 60% of all sessions by an independent observer using handheld counters. Percentage agreement for the frequency counts was calculated by dividing the lower session frequency by the higher session frequency and multiplying by 100%. The mean score across participants was 95% (range, 94% to 100%). The mean score for Mary was 96% (*SD* = 5; range, 83% to 100%) and was calculated for 63% of sessions. The mean score for Mike was 97% (*SD* = 4; range, 75% to 100%) and was calculated for 75% of sessions. For Rita, the mean score was 95% (*SD* = 4; range, 84% to 100%) and was calculated for 96% of sessions. For Tom, the mean score was 95% (*SD* = 4; range, 83% to 100%) and was calculated for 77% of sessions. The mean score for Zack was 94% (*SD* = 5; range, 84% to 100%) and was calculated for 66% of sessions.

Procedure

One or two experimenters (undergraduate research assistants) were present during each session, which lasted approximately 10 min or until no more responses could be emitted. The primary observer stood within 3 ft of the participant. Secondary observers were stationed at the next table. Sessions were terminated upon any participant request or any physical signs of distress, including the emission of SIB or crying. Fewer than five sessions were canceled because of these criteria. Sessions were conducted approximately twice per day during mid-morning and mid-afternoon times to capitalize on preexisting states of food deprivation. All sessions lasted 10 min, with the exception of a few that were terminated early.

Experimental design. A multielement design was used to evaluate the effects of the differing magnitude NCR conditions on response rate for Rita, Zack, and Mary. After a variable-ratio (VR) 3 baseline condition, Rita was exposed to low- and medium-magnitude NCR schedules in a multielement fashion. Zack and Mary were exposed to the same conditions plus an additional high-magnitude NCR schedule. Combination reversal and multielement designs were used to evaluate the effects of the different NCR conditions on response rate for Mike and Tom. The treatment conditions each contained two counterbalanced NCR variations. After an initial VR 3 baseline phase, Mike was presented with low- and medium-magnitude NCR schedules in a multielement fashion, an additional VR 3 condition, and a final presentation of high- and medium-magnitude NCR schedules in multielement format. After an initial VR 5 baseline phase, Tom was presented with low- and medium-magnitude NCR conditions (VR 5 was chosen because of his high response rate). Stimulus magnitudes were not parametric, in that the medium-magnitude stimuli were three

times greater than the low-magnitude stimuli, but the high-magnitude stimuli were only two times greater than the medium-magnitude stimuli. The reinforcement magnitudes were chosen in collaboration with the staff nutritionist, who requested reductions in the high-magnitude stimuli that were originally scheduled to be three times greater than the medium-magnitude stimuli.

Baseline. The experimenter picked up one chip, told the participant to "do this," and dropped the chip in the cylinder at the beginning of each baseline session. This prompt was not repeated at any time during the session. Initially, the high-preference stimulus identified for each participant was presented contingent on this response on a fixed-ratio (FR) 1 schedule. Over several acquisition sessions (range, 4 to 9), the schedule was gradually changed. The first change was to an FR 2 schedule, then to an FR 3, and finally to a VR schedule (VR 5 for Tom and VR 3 for all other participants). VR schedules were the final schedules used during baseline to provide some resistance to extinction so the different intervention data could be compared without immediate response cessation. The magnitude of reinforcement delivered during baseline was identical to that delivered in the NCR (low-magnitude) condition (see below). This procedure continued until 10 min elapsed or all of the chips were placed in the cylinder. The experimenters were given a written prompt on when to deliver the reinforcers on VR schedules.

NCR (high magnitude). During this condition, the experimenter issued the initial session prompt as in the baseline condition, but delivery of the high-preference stimulus was changed from a contingent VR schedule to a noncontingent FT schedule. The mean baseline interresponse time (IRT) multiplied by the ratio schedule requirement (i.e., 3 or 5) for each participant determined the length of the FT intervals. This ensured approximately consistent reinforcement rates across conditions. After the initial prompt was delivered, the observer delivered one large unit of food to the participant every *n* seconds (FT *n* s) until the end of the session. The high-magnitude stimuli were two cookies presented during each reinforcement interval for Mary and Zack and two potato chips for Mike.

NCR (medium magnitude). This session was identical to the NCR (high-magnitude) condition except that a smaller amount of food was delivered on an FT basis (one cookie for Mary and Zack, one potato chip for Mike, three pieces of popcorn for Rita, and three raisins for Tom).

NCR (low magnitude). This session was identical to the NCR (medium-magnitude) condition except that a smaller amount of food was delivered on an FT basis (one third of a cookie for Mary and Zack, one third of a potato chip for Mike, one piece of popcorn for Rita, and one raisin for Tom).

RESULTS AND DISCUSSION

As shown in Figure 1, all participants responded at high and stable rates during baseline (M = 26.2, 7.5, 10.2, 11.3, and 6.0 for Tom, Rita, Mary, Zack, and Mike, respectively). The low-magnitude condition resulted in rates of responding similar to baseline for Tom, Rita, and Mike (M = 28.3, 9.3, and 6.6, respectively). Response rates were slightly to somewhat lower than baseline for Zack and Mary during the low-magnitude condition (M = 8.0 and 6.1, respectively). Response rates during the medium-magnitude condition were only slightly lower than baseline for Tom (M = 24.5), but were clearly lower than baseline for the other 4 participants (M = 5.5, 4.0, 1.7, and 2.2 for Rita, Mary, Zack, and Mike, respectively). For Rita and Mike, responding persisted during medium NCR conditions (albeit at rates lower than baseline). For Mary and

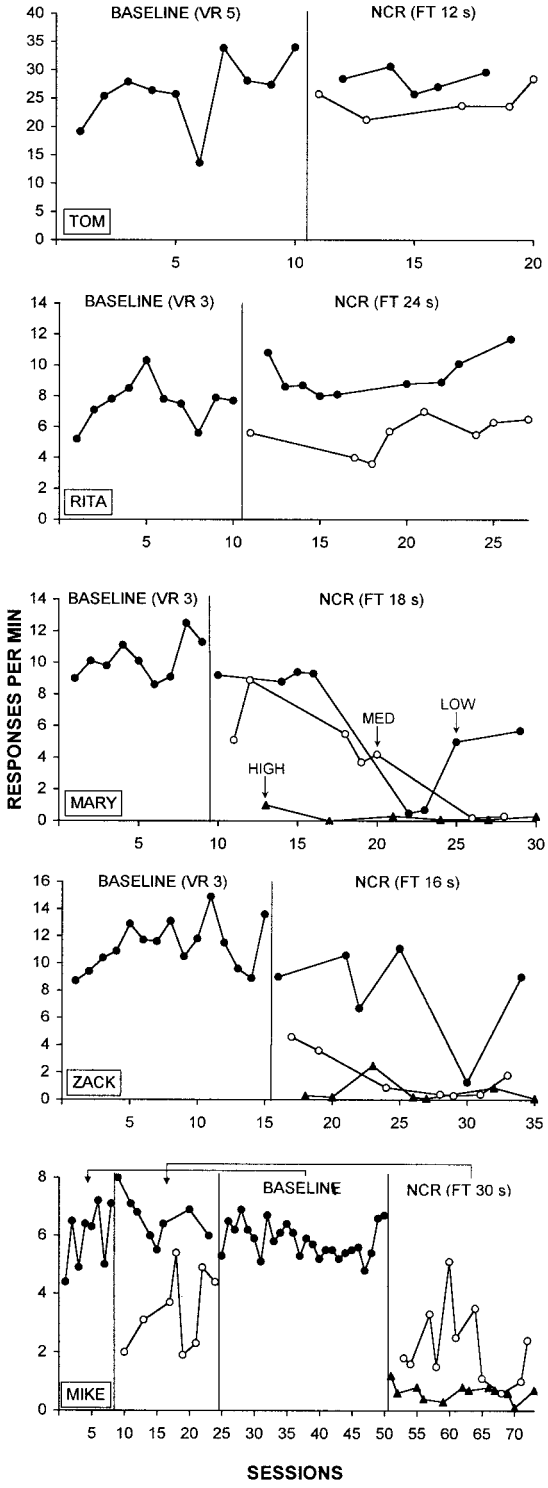

Figure 1. Response rates during baseline and NCR conditions for Tom, Rita, Mary, Zack, and Mike. FT = fixed time, HIGH = high magnitude, LOW = low magnitude, MED = medium magnitude, VR = variable ratio.

Zack, response rates gradually decreased to near-zero levels in the medium-magnitude condition. Finally, the high-magnitude condition produced rapid, large, and consistent reductions in response rates for the 3 participants exposed to this condition (M = 0.3, 0.6, and 0.6 for Mary, Zack, and Mike, respectively).

The results confirmed an earlier prediction that NCR schedules with larger magnitudes would produce greater response reductions. Extinction did not seem to play a role in the behavior reductions, or there would have been no difference between NCR conditions. The current data indicate that there were always clear differences between magnitude effects, with no evident extinction bursts.

The data for Mary, Mike, and Zack show clear reductions in responding that differ across reinforcer magnitude conditions. The most likely explanation for these differences is that the NCR behavior-change mechanism was satiation. The delivery of FT stimuli may have acted as an establishing operation that altered the saliency of food as a reinforcer for the target behavior. The delivery of the higher magnitude stimuli can be conceptualized as a more powerful establishing operation that produced greater reductions.

At first glance, it may appear that the participants would naturally respond less when consuming a quantity of food, much like a differential-reinforcement-of-incompatible-behavior contingency. Anecdotally, responses were emitted on many occasions when participants were still chewing, or responses were made with the hand not involved with consumption. However, it is still unclear how food consumption affected the current data. This methodological limitation could be corrected by measuring responding within and outside of reinforcement intervals. Differences between these data would sug-

gest that food consumption suppressed responding, independent of NCR effects.

Of particular interest are the NCR failures. The low-magnitude FT conditions for Mike, Rita, and Tom did not reduce responding and, at some points, seemed to elevate it. There are several possible reasons why these individuals did not experience response reductions in the low-magnitude NCR conditions. The most likely explanation is that the delivery of a low-magnitude stimulus on an FT schedule did not alter the behavior's establishing operation to the extent necessary for reduction. That is, the quantity of food delivered to the participants was not enough to produce satiation effects. Another possible explanation is that responding could have been under instructional control that was unrelated to the current experimental preparation. That is, merely being in a situation in which another person requested task performance could have been discriminative for historical reinforcement contingencies. It is also possible that the behavior acquired automatically reinforcing properties. Instructional control and automatic reinforcement hypotheses could be addressed by future researchers by including an extinction condition. Persistence in the extinction condition would support these possible explanations.

Another explanation of NCR failure in the low-magnitude conditions is that the FT delivery resulted in adventitious reinforcement of the target behavior. If behaviors were adventitiously reinforced in these conditions, the FT delivery of food could have instead produced fixed-interval (FI) schedules that maintained responding. Vollmer et al. (1997) recently reported a case in which NCR eventually failed to reduce aberrant responding. The authors analyzed within-session cumulative data that showed response "scallops," indicative of an FI schedule. The lack of such a within-session analysis is a limitation of the current investigation, and the adventitious reinforcement hypothesis cannot be confirmed without it. An additional methodological limitation in the current study is the lack of independent variable integrity measures for VR and FT food delivery.

A logical study of NCR and reinforcer magnitude is to address the relation between reinforcer magnitude and schedule density. Hagopian et al. (1994) demonstrated that dense NCR schedules produced greater reductions than did lean ones. Results from the current study indicate that the magnitude of the delivered stimulus is similarly important. Perhaps the combination of a high-magnitude stimulus with a dense schedule would produce even greater reductions, as long as the baseline response rate is not susceptible to adventitious reinforcement. Further, if response rates are kept constant, similar reductions might be expected under high-magnitude/lean schedules versus low-magnitude/dense schedules. If such differences are negligible, practitioners may opt to deliver lean schedules of high-magnitude reinforcers, which would require less response effort than the alternative.

Further studies could explore the relation between extinction and establishing operations in NCR schedules using several methods. First, concurrent-operant experiments could be conducted with simultaneous extinction and NCR schedules. This relation could also be examined by simply comparing NCR with extinction in a multielement format in terms such as rate of reduction and response-burst phenomena. Response differences in such an experiment could be attributed to mechanisms other than extinction. In conclusion, the current study extends the NCR literature in several ways by providing (a) further evidence of successful NCR implementation with the current population, (b) controlled manipulations of reinforcer magnitude that have implications for NCR technology development, and (c) further ev-

idence on the role of satiation in NCR response suppression.

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STUDY QUESTIONS

1. Results of previous research suggest that decreases in responding under noncontingent reinforcement (NCR) may be the result of either of two processes. What are these processes and how do they operationally affect behavior during NCR?

2. How would the authors' proposed manipulation of reinforcer magnitude clarify the mechanisms by which NCR reduces behavior?

3. How did the dependent variable differ from those examined in previous applied research on NCR? Why do you suppose the authors selected such a response?

4. Why did the authors use variable-ratio (VR) schedules during baseline? That is, why was reinforcement not delivered continuously?

5. Describe the three NCR conditions.

6. Summarize the results obtained and the conclusion that is supported by them.

7. Results obtained for Mary and Zack, who also showed decreasing rates of responding under the medium- and low-magnitude NCR conditions, seemed to show evidence of an extinction effect. Although the authors controlled for the presence of extinction by including it as a constant, what additional control might they have included to isolate (or eliminate) the effects of extinction?

8. What four reasons do the authors give to account for behavioral maintenance (i.e., the absence of response suppression) under low-magnitude FT conditions? How might the baseline schedule of reinforcement also have affected results?

Questions prepared by SungWoo Kahng and Eileen Roscoe, The University of Florida