Noncontingent Reinforcement: Behavioral Mechanisms Involved in Response Suppression and Treatment Efficacy

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Noncontingent reinforcement (NCR) has been found to be an effective treatment for a variety of undesirable behaviors maintained by various types of reinforcement (e.g., social positive, social negative, and automatic). Throughout the last decade, over 100 research articles have been published on the topic of NCR as a treatment for maladaptive behavior. Research has involved questions ranging from treatment comparisons and efficacy to parametric analyses. Specifically, much of the research has questioned the specific behavioral mechanisms involved in the reduction of undesirable behavior. In addition, more recent studies have started to evaluate the efficacy of NCR with respect to both short- and long-term outcomes. This paper reviews these two prominent areas; highlighting particular research that is indicative of current views in the field of behavior analysis. In addition, suggestions for future research on NCR are provided.

Research conducted on antecedent interventions used to decrease behavioral problems has been a major growth area of applied behavior analytic research over the past decade (e.g., Friman & Oliver, in press; Luiselli & Cameron, 1998; Smith & Iwata, 1997). One particularly active area of research on antecedent interventions is focused on the use of Noncontingent Reinforcement (NCR) (e.g., Carr et al., 2000). Briefly, NCR involves the delivery of response independent reinforcement. The term itself presents some logical problems because, by definition, reinforcement is a contingent process. Not surprisingly, these problems have instigated debate about the appropriateness of the term (e.g., Carr et al., 2000; Poling & Normand, 1999; Vollmer, 1999). Yet, while acknowledging that a more accurate and logically consistent term is preferred, reviews of the rapidly growing NCR literature employing the term suggests its use has become conventional and thus unlikely to soon change (cf. Carr et al., 2000). Many NCR interventions circumvent the logical problems inherent in the use of the term by identifying the reinforcers that maintain problem behavior and then delivering them according to schedules involving time rather than response. Many classes of problem behavior are maintained by automatic reinforcement, however, and for them the contingent relation between response and reinforcement is much harder to revise (although not impossible—sensory reinforcement can be muted or blocked) in a way that creates the possibility of solely noncontingent delivery. Investigators addressing this problem identify reinforcers that are arbitrary with respect to target behavior but known to influence other classes of behavior and deliver them on time based schedules. Both attempts to address the logical problems with the term leave at least a portion unsolved, leading some authors to place the term in quotes (e.g., Carr et al., 2000). Having acknowledged the problem ourselves, we will proceed from here as if it did not exist and use the term NCR, free of quotes, throughout the remainder of this paper.

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Over the last decade, more than 100 articles have been published investigating NCR from a variety of perspectives including initial schedule density, schedule thinning methodologies, utility and efficacy of variable-time (VT) schedules, mechanisms of response suppression, magnitude of reinforcement, treatment efficacy compared to other interventions (e.g., differential reinforcement procedures, extinction procedures, etc.), and substituting the delivery of preferred stimuli that are not functionally linked to the target behavior for delivery of reinforcers that are. The results of such a magnitude and variety of research have placed NCR procedures at the forefront of behavior analytic treatments for decreasing or eliminating undesirable behavior. This diversity of perspectives coupled with the magnitude of published and ongoing research supports the plausibility of the following claim: NCR research is one of the most vital areas of current applied behavior analysis. The special issue will address NCR from some of the more promising perspectives. This brief paper will review the literature in order to identify the principle mechanisms of response suppression associated with NCR, the efficacy of select NCR treatment procedures, and suggest possible directions for future research.

NCR as a Treatment Option

NCR has been used to eliminate a wide variety of problem behavior including but not limited to aggression, disruption, self-injury, problematic speech, stereotypy, finger sucking, and food refusal. In NCR treatments, the topography of the behavior problem to be targeted is subsidiary to its functional properties. In fact, topography is virtually incidental in the process. In a typical preparation, analyses are conducted initially to determine critical functional properties of the target behavior such as whether it is maintained by access to a stimulus event (i.e., positive reinforcement), avoidance or escape from a stimulus event (i.e., negative reinforcement) and whether the related stimulus event or item is delivered by the environment (i.e., social reinforcement) or generated automatically by the behaving individual (Iwata et al., 1982/1994). Following a functional analysis, NCR investigators extend the preparation by delivering reinforcers identified in it according to a time based schedule (i.e., independent of target responses). Typical classes of reinforcers used in NCR interventions include social-positive (SP) consequences (e.g., delivery of social attention), social-negative (SN) consequences (e.g., withdrawal of social demands), and automatic (A) consequences (e.g., stimulation produced by item engagement).

One of the first studies to blend functional analyses with NCR for treatment purposes compared the effects of NCR with a differential reinforcement of other behavior procedure (DRO) on the self-injury exhibited by three developmentally disabled individuals (Vollmer, Iwata, Zarcone, Smith, & Masaleski, 1993). The functional analyses indicated that the self-injurious behavior (SIB) of all three was maintained by social attention. During the DRO condition, attention was delivered after specified intervals during which self-injury was not exhibited. During the NCR condition attention was delivered according to a time-based schedule, initially a 10-s fixed time (FT) schedule that was gradually thinned to a 5-min FT schedule. The results indicated that both procedures were highly effective in reducing self-injury. Noteworthy with respect to this paper and the reason for the study is the fact that both procedures were extinction-based. One of the primary reasons for the study was to test a reinforcement based alternative to DRO because the periods of extinction typically programmed in it yield initial increases in the target behavior as well as collateral emotional behavior and aggression. These side effects are caused by terminating contact between a person's problem behavior and its functional consequences, and they are especially problematic when the target behavior is self-injurious. Because an initially rich NCR schedule guarantees the target person's access to the functional consequences of their problem behavior, even though the functional relation between them has been disestablished, these increases ('extinction bursts') were thought to be much less likely. As predicted by the authors, the results of the NCR intervention were achieved with far fewer extinction type increases in problem behavior. Nonetheless, the procedure as evaluated was an extinction based one and its

effects indicate that one of the mechanisms operating in NCR for behavior maintained by social positive reinforcement is extinction.

But what about NCR with respect to behavior maintained by social negative reinforcement? As indicated previously, NCR procedures also use social-negative consequences and there are many published studies demonstrating their success (e.g., Hagopian, Wilson, & Wilder, 2001; Kahng, Iwata, DeLeon, & Worsdell, 1997; Kodak, Miltenberger, & Romaniuk, 2003; Piazza, Contrucci, Hanley, & Fisher, 1997; Vollmer et al., 1998; Wilder & Carr, 1998). Rather than through delivering social consequences (i.e., attention) as in the Vollmer et al. (1993) study, NCR-SN achieves its effects through the cessation of an aversive social event such as an instruction or an ongoing effortful task. As with NCR-SP, NCR-SN arranges for delivery of consequences in accordance with time and independent of the target behavior.

Like with NCR-SP, the agenda setting inaugural study was conducted by Vollmer and colleagues (Vollmer, Marcus, & Ringdahl, 1995). Following a functional analysis which identified escape from demands as the maintaining consequence for self-injury in two boys with developmental disabilities, the authors began scheduling breaks on a continuous fixed schedule that was thinned by 10-s increments until it reached FT 2.5-min for one boy and FT 10-min for the other. As with the Vollmer et al. (1993) study, this study also included a DRO procedure for one boy in order to compare the effects of NCR-SN with DRO utilizing negative reinforcement. Results showed that NCR and the DRO were highly effective in reducing escape-maintained self-injury for both boys. Because NCR treatments are generally easier to implement and are associated with fewer side effects than DRO, and the similar levels of reduced self-injury achieved for both in this study (as with the 1993 study), this study expanded the data-based case for preferring NCR over DRO. Additionally, by including DRO and thus virtually by definition including an extinction procedure, this study underscored the importance of determining the mechanism underlying the effects of NCR.

One variable unique to interventions designed to eliminate negatively reinforced behavior, is the collateral affects of the intervention on compliance. Because compliance with demands becomes a collateral behavior of interest when attempting to decrease problem behavior maintained by getting out of a demand (i.e., escape from tasks), demonstrations of increases in compliance as well as understanding what circumstances lead to such increases becomes of utmost importance. In fact, several studies have shown such increases in compliance as problem behaviors decreases (e.g., Coleman & Holmes, 1998; Kodak et al., 2003; Roane, Fisher, & Sgro, 2001); however, the reasons or conditions under which such increases occur or not have not been determined. Although experimental manipulations have not been conducted to determine the cause of these collateral increases in compliance, some hypotheses have been put forward to explain such increases during NCR such as: a) compliant behavior may have contacted reinforcement inadvertently during the intervention (adventitious reinforcement), b) the establishing operation for escape may have been weakened as the response-independent breaks alleviated the aversive property of the task, and, c) the praise provided for compliance with the task may become an effective reinforcer after escape behavior is reduced. Thus, with respect to utilizing NCR as an intervention for behavior maintained by negative reinforcement it is not only important to determine the behavioral mechanism responsible for behavioral suppression (i.e., eliminating the problem behavior), but also for behavioral increases and maintenance (i.e., increasing compliance).

Unlike NCR-SP and NCR-NP, when implementing NCR-A the reinforcer maintaining the behavior is difficult to manipulate (i.e., deliver noncontingently or withhold), thus procedurally NCR-A is somewhat different. Basically, NCR-A requires the identification of a preferred item that competes with the on-going problem behavior and that item is available noncontingently. In a recent example in which the reinforcement contingencies for automatically maintained problem behavior were manipulated, Roscoe, Iwata, and Goh (1998) compared the effects of NCR-A to those of protective equipment (sensory extinction) on the self-injury of three individuals with developmental disabilities. After a functional

analysis indicated that all participants engaged in SIB to obtain the automatic reinforcement produced by the response, the authors then conducted a) leisure probes to identify an item that would compete effectively with self-injury (i.e., the sensory stimulation produced by interacting with the item would compete with the sensory stimulation produce by engaging in the self-injury), and b) equipment probes to determine the least intrusive form of protective equipment that would effectively eliminate the reinforcement contingency between the response and the sensory stimulation that it produced. These items were subsequently compared with respect to their suppressive effects on SIB. Results indicate that the procedures were equally effective in decreasing self-injury. Given that "extinction" was not implemented during the NCR condition, extinction cannot be the mechanism responsible for behavioral reduction when NCR effectively reduces behavior maintained by automatic reinforcement. Thus, the behavioral mechanism responsible for behavioral reduction during NCR-A is either different (i.e., satiation) than that assumed to be partially responsible for socially reinforced behavior (i.e., extinction) or satiation may be somewhat responsible for behavioral reduction during NCR-SP and NCR-NP as well. Moreover, regardless of whether satiation is a factor in the reduction of problem behavior in NCR-SP or NCR-NP, research is needed to understand the longevity of this satiation effect in NCR overall. Specifically to NCR-A, how long will the reinforcement produced by interacting with the competing stimulus abolish the establishing operation (EO) for the problem behavior?

Current Debate on the Mechanism(s) Responsible for Behavioral Suppression

Given that NCR has been successfully utilized to decrease aberrant behavior maintained by social positive, social negative, as well as automatic reinforcement, one question that remains is, what are the behavioral mechanisms responsible for these reductions in problem behavior? Identifying the behavioral mechanism(s) involved in response suppression during NCR is important for multiple reasons. First, it is of theoretical importance to identify the mechanisms responsible for behavior change, so as to be able to predict and control behavior (Skinner, 1953) as well as to understand the use of reinforcement in general. Second, on the methodological front, it is imperative to understand what mechanism(s) may be responsible for behavior change as the specific procedures one would implement may be different depending on the necessity of a particular component (e.g., extinction). Finally, of practical importance, if satiation is effective at decreasing the behaviors of interest, then it may make extinction unnecessary, whereas if extinction is found to be important, it will be necessary to program that consequence, or another if extinction is not possible. Taken together, this information may lead to some standard guidelines on when and how to implement NCR.

For example, if NCR schedules reduce the occurrence of problem behavior through satiation, the use of extinction may be unnecessary. This may prove to be helpful information when trying to develop treatments for parents or caregivers to implement to reduce severe self-injurious behavior (SIB), which sometimes cannot be ignored (i.e., extinction for attention maintained behavior). On the other hand, if the goal is to reduce problem behavior that is deemed to be less severe, then if NCR is effective via extinction, it would be an appropriate intervention not only because it reduces problem behavior, but also by allowing for some reinforcement to be provided so as not to increase the deprivation from the maintaining reinforcer that can be encountered with differential reinforcement procedures (Vollmer et al., 1993) or extinction alone. Moreover, if extinction is the mechanism responsible for response suppression but the delivery of the reinforcer sporadically throughout the session is an extra procedure, one could determine whether the response effort involved with implementing that component is worthwhile. For example, it may be that the delivery of reinforcement noncontingently reduces the chances of extinction induced side effects (Lerman, Iwata, & Wallace, 1999), thus making the added effort involved in its implementation worthwhile.

Within the last five years the identification of the mechanism(s) responsible for behavioral suppression under NCR, has become a focus of

research. More specifically, researchers have attributed NCR's effectiveness to satiation, extinction, a combination of both, or responding as choice behavior (Carr et al., 2000; Fisher et al., 1999; Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000; Vollmer et al., 1993; Wilder, Fisher, Anders, Cercone, & Neidert, 2001).

Satiation could affect behavior, in that frequent access to reinforcers may reduce an individual's motivation to engage in problem behavior through alteration of an EO (Michael, 1982). Fisher et al. (1999) indicate that, "if the satiation hypothesis is more accurate, then the reductive effects of NCR should increase over the course of a session,…and should occur during both NCR delivery and the NCR inter-reinforcement interval" (p. 411). By contrast, reductions in response rate may be a result of the disruption of the response-reinforcer relationship (extinction), which should occur during NCR due to the elimination of the contingent relationship between problem behavior and its reinforcing consequence. If a combination of the two mechanisms is responsible for behavioral reductions, satiation is seen as the operative mechanism during implementation of dense schedules of NCR and, as the schedule is thinned, the behavior may come in contact with extinction. Finally, responding as choice behavior may serve as the mechanism for behavioral change in NCR situations. That is, the individual chooses between not responding when NCR is available and responding when contingent access is in effect (during inter-reinforcement intervals). Reductions in behavior are seen as, "participants choosing not to access contingent reinforcement when NCR is delivered and only minimally due to reinforcer satiation" (Fisher et al., 1999, p. 411). To date, the notion that the suppression in responding is due to the choice behavior hypothesis has received little attention and as such, the following description of potential mechanisms involved in NCR will be limited to satiation, extinction, and a combination of the two.

Satiation Hypothesis

Support for the satiation hypothesis can be found in a study conducted by Lalli, Casey, and Kates (1997) that reduced the SIB of one participant by implementing NCR without extinction (i.e., they continued to reinforce problem behavior every time it occurred), thus ruling out extinction as a source of influence. The authors first conducted a functional analysis and demonstrated that the participant's SIB was maintained by access to preferred items. During baseline, every occurrence of SIB resulted in 20 s access to the preferred object. During the subsequent NCR condition, 30-s access to the preferred object was provided according to an FT schedule (NCR), as well as contingent on SIB. Results showed a gradual decrease in the rate of SIB to near-zero levels. The authors concluded that the response suppression observed during the NCR condition was due to satiation because extinction was not included in the treatment procedure.

Fischer, Iwata, and Mazaleski (1997) were also successful in reducing problem behavior with NCR without extinction, suggesting that behavioral reduction during NCR is due to satiation. A functional analysis indicated that two participants' SIB was maintained by social-positive reinforcement (attention and access to a tangible item). Subsequently, the authors conducted a preference assessment to identify food items (arbitrary reinforcers), which were later demonstrated to be irrelevant to behavioral function (i.e., contingent access to food did not produce increases in SIB). The authors evaluated the effectiveness of NCR without extinction in decreasing SIB by delivering the arbitrary reinforcer according to an FT 10-s schedule and delivering the maintaining reinforcer contingent on SIB. After this condition, arbitrary reinforcers were again delivered according to an FT schedule. However, the NCR schedule was progressively thinned, and occurrences of SIB were no longer reinforced (extinction). Results showed that the delivery of arbitrary reinforcers during NCR without extinction was effective in decreasing both participants' SIB.

Extinction Hypothesis

Support of the extinction hypothesis can be found in a study conducted by Marcus and Vollmer (1996). The authors examined the effects of combining differential reinforcement of an alternative behavior (DRA) with NCR on both problem behavior and the acquisition of an alternative response for two participants to determine

if satiation effects might contraindicate the use of NCR when attempting to increase appropriate behaviors with the same reinforcer maintaining the problem behavior. The authors first conducted a functional analysis and demonstrated that the participants' problem behavior was maintained by social-positive reinforcement in the form of access to preferred items. During baseline, the preferred items were delivered contingent upon each occurrence of SIB or aggression. After baseline, a training phase was conducted during which the participants were taught to emit an alternative response to receive reinforcement. After this training phase, an NCR procedure was combined with a DRA procedure. The NCR component of the intervention consisted of delivering the maintaining reinforcer according to an FT schedule. The DRA component of the intervention consisted of the delivery of the same reinforcer contingent on the occurrence of an alternative response. Results showed that the combination of NCR and DRA lead to continued suppression of problem behavior and an increase in the alternative response. Given that the participants' alternative responses increased when both NCR and DRA were in effect suggests that the individuals were not satiated because they continued to engage in the alternative response to gain the same reinforcer that was being provided by way of the NCR schedule. Typically, dense schedules of NCR result in blocking acquisition of the alternative response (Goh, Iwata, & DeLeon, 2000). Thus, the reduction in problem behavior during the NCR and DRA conditions appeared to be a result of extinction.

Satiation & Extinction Hypothesis

Another hypothesis concerning the mechanism responsible for NCR's effectiveness is that both satiation and extinction may participate in behavioral suppression. That is, initially dense NCR schedules may result in satiation to the reinforcer because the rate of reinforcement is greater than that delivered during baseline, whereas extinction may become the operative mechanism once the NCR schedule is thinned because the reduction in the density of reinforcement may increase the likelihood of contacting the extinction contingency. Support for this hypothesis can be found in a study conducted by Goh et al. (2000). In this experiment, the authors examined whether NCR would interfere with the acquisition of an alternative response being shaped using a DRA procedure.

A functional analysis demonstrated that the two participants' problem behavior was maintained by social-positive reinforcement (either attention or access to preferred items). After the functional analysis, a baseline condition was conducted during which the maintaining reinforcer was delivered contingent on each occurrence of problem behavior. After baseline, the authors implemented a NCR and DRA procedure in a multiple baseline across subjects design. During the NCR plus DRA condition, attention or access to a preferred item was delivered according to a dense NCR schedule and contingent on each emission of the alternative response. Following this, the authors thinned the NCR schedule while keeping the DRA procedure intact. When the NCR schedule was dense, problem behavior was suppressed; however, the alternative response was not acquired by either participant. When the NCR schedule was thinned, problem behavior remained suppressed and both participants started to emit the alternative response. The authors suggested that the suppressive effects on problem behavior observed under dense NCR schedules were due to satiation because the alternative response was not acquired. By contrast, because the alternative response was acquired as the NCR schedule was thinned, the authors suggested that the mechanism responsible for the observed reduction in problem behavior changed from satiation to extinction.

One difference between this study and the Marcus and Vollmer (1996) study is that Goh et al. (2000) did not conduct a separate pre-training phase, but instead attempted to train the alternative response during the NCR and DRA condition. A second difference between the two studies is the speed with which the NCR schedules were thinned: Marcus and Vollmer quickly thinned the NCR schedule, where as Goh et al. kept the initial dense NCR schedule constant for a number of sessions before thinning.

Due to the combination of multiple treatments in previous investigations, future researcher

attempted to isolate the behavioral mechanism responsible for behavioral changes during NCR without confounds of other procedures (i.e., differential reinforcement procedures). For example, Kahng, Iwata, Thomson, and Hanley (2000) attempted to isolate the satiation and extinction components of NCR by examining behavioral patterns during NCR sessions and post-NCR sessions. Functional analyses demonstrated that all participants' problem behaviors were maintained by social-positive reinforcement. During baseline, the maintaining reinforcer was delivered contingent on each occurrence of problem behavior. During the NCR sessions, the maintaining reinforcer was delivered on an FT schedule and problem behavior was ignored (dense NCR schedules were implemented initially, and were thinned in later sessions). Subsequently, a 20-min post-NCR session was conducted after each NCR session. During the post-NCR sessions, no reinforcers were delivered and problem behavior was ignored.

The authors examined the within-session patterns during and immediately after each NCR session to identify the mechanism responsible for NCR's suppressive effects. Results for one participant were consistent with a satiation interpretation (a temporary increase in responding during the post-NCR sessions). Results for another participant were consistent with an extinction interpretation (no increase in responding during the post-NCR sessions). Finally, results for the remaining two participants suggested that the mechanism changed from satiation to extinction as the NCR schedules were thinned.

In a subsequent attempt to conduct a component analysis of NCR, Wallace (2001) compared NCR with and without extinction with respect to their suppressive effects on problem behavior maintained by social-positive reinforcement for three participants while the NCR schedule was thinned. Results demonstrated that both treatments initially suppressed responding of two of the participants. However, as the reinforcement schedule was thinned, NCR without extinction lost its suppressive effects and responding increased to near baseline levels for both individuals. Results for the third participant indicated that only NCR with extinction was effective in reducing problem behavior.

In conclusion, when taken together with other research investigating the thinning of NCR schedules (e.g., Wallace, 2001), it is reasonable to conclude that NCR treatments produce reductions in undesirable behaviors, first as a function of satiation due to the density of initial schedules, and then second, to extinction (whether present from the start of treatment, or implemented during schedule thinning). However, these conclusions should be tempered in that to date all of the investigations attempting to isolate the mechanisms responsible for behavioral reduction during NCR have all focused on behavior that is maintained by the delivery of a positive reinforcer (i.e., SP), thus whether the same mechanisms are responsible during NCR-SN as well as the longevity of the effects during NCR-A need to be addressed.

Another purpose for identifying the behavioral mechanisms responsible for response suppression during NCR is that it may shed some insight on both the short- and long-term efficacy of NCR. For example, satiation effects may wean across time and extinction might produce bursting initially but may be beneficial in the long run. Moreover, extinction can also have effects long-term that may be detrimental (e.g., spontaneous recover) and should be considered when implementing behavioral interventions. Regardless of the potential outcomes based on the specific mechanism involved during NCR, it may be beneficial to summarize the current literature with respect to known short- and long-term effects.

Treatment Efficacy

In summarizing the literature, one can cogently concluded that NCR is an effective treatment for behavior problems maintained by social positive, social negative, and automatic reinforcement. Moreover, numerous replications and extensions of the efficacy of NCR have been conducted (see Carr et al., 2000 for a review). Specifically, replications and extensions of the efficacy of NCR have: compared NCR to extinction with respect to treatment efficacy (O'Reilly, Lancioni,

& Taylor., 1999); examined acquisition rates of appropriate behavior during noncontingent schedules (Goh et al., 2000); noted the effects of NCR on collateral (i.e., non-targeted) behavior (Roane et al., 2001); demonstrated the efficacy of utilizing peer attention to decrease disruptive behavior in a classroom (Jones, Drew, & Weber, 2000); demonstrated the utility of VT schedules in comparison to FT schedules during NCR (Carr, Kellum, & Chong, 2001; Van Camp et al., 2000); evaluated the efficacy of utilizing a stimulus delay procedure during NCR (Britton, Carr, Landaburu, & Romick, 2000); demonstrated the application of NCR to produce response maintenance (Dozier et al., 2001; Ringdahl, Vollmer, Borrero, & Connell, 2001), evaluated the effects of reinforcer magnitude on behavior change (Carr et al., 1998; Roscoe, Iwata, & Rand, 2003), compared various strategies for programming and thinning FT schedules (Kahng, Iwata, DeLeon, & Wallace, 2000), as well as demonstrated the use of NCR as a control procedure (Thompson et al., 2003).

While the studies listed above have shown that NCR can be a viable treatment option for problem behavior and a number of variables have been examined, the most significant under-researched area is the specific efficacy of NCR with respect to long-term effects. For example, of the studies conducted on NCR, most have investigated the efficacy of NCR utilizing brief session durations (e.g., 5- to 15-min sessions) within the course of brief treatment analyses (e.g., 1- to 4- months of treatment implementation). Although, NCR has repeatedly been demonstrated to be effective with respect to reducing problem behavior in the short-term, how beneficial is NCR if treatment efficacy is not demonstrated long-term (i.e., during longer session durations as well as across time)? Given the mechanisms responsible for behavioral reduction during NCR it is plausible that the short-term effects may not maintain in the long-term or may produce side-effects long-term that have not be noted in the short-term analyses.

For example, DeLeon, Anders, Rodriguez-Catter, and Neidert (2000) examined the effects of NCR with a single stimulus available, a rotating single stimulus available, and multiple stimuli available, on SIB maintained by automatic reinforcement during 30-min sessions. Results demonstrated that the implementation of NCR utilizing a single stimulus produced only slightly lower levels of SIB when compared to baseline levels; where as implementation of NCR utilizing the rotating procedure as well as the NCR utilizing the multiple stimuli produced substantially lower levels of SIB. Within session analyses of behavior during the single stimulus sessions indicate that problem behavior started to resume at some point within the 30 min. Thus, suggesting that if one were to analyze this procedure short-term (e.g., during 10-min sessions) one would have concluded that the treatment was effective; however, upon further analysis in fact, the intervention failed to suppress problem behavior. Similar results were demonstrated by Lindberg, Iwata, Roscoe, Worsdell, and Handley (2003), when the effects of NCR were compared between 10-min and 120-min sessions, further supporting the importance of the analysis of NCR across longer session durations. However, it should be pointed out that, these two failures of NCR to be effective during extended sessions were both interventions implemented to decrease problem behavior maintained by automatic reinforcement. Moreover, to date only one study has evaluated the effects of NCR during extended session as treatment for problem behavior maintained by socially mediated reinforcement. Tarbox, Wallace, Tarbox, Landaburu, and Williams (2004) analyzed the effects of implementing NCR to suppress aggressive behavior maintained by social-positive reinforcement for two participants across 1 hr sessions and 2 hr sessions, respectively. Results demonstrated that NCR was effective in eliminating aggression during these extended sessions for both participants

Besides looking at the long-term efficacy of NCR with respect to session duration, it is also important to evaluate the efficacy of NCR with respect to maintenance of the treatment effects (e.g., during follow-up). Of all the studies conducted on NCR, four studies have taken data evaluating treatment efficacy long-term as measured during follow-up evaluations. In the first study, Mace, Shapiro, and Mace (1998) recorded the effectiveness of NCR to suppress problem behavior for 5 sessions during a 10-month fol-

low-up period. In another study, O'Reilly et al. (1999) evaluated the treatment efficacy of NCR on the reduction of one individuals attention maintained aggression at 1, 2, 3, 4, and 5 weeks post intervention. Results demonstrated a slight increase in aggression, although baseline data were not taken in the home thus evaluating the data collected in the home during follow-up to that collected during baseline in the clinic is somewhat problematic. O'Reilly, Lancioni, King, Lally, and NicDhomhnaill (2000) also collected follow-up data on the effects of NCR in the treatment of aggression for one participant at 4, 8, 16, 20, 24 weeks. Results indicated that maintenance of treatment effects were maintained for up to 6 months. Finally, Lindberg et al. (2003) also recorded treatment effects for 3 months for one participant and 12 months for another participant with respect to reductions in automatically maintained SIB. Results indicated that response reductions were maintained with NCR long-term (across time) when varied stimuli were utilized within sessions. Given the importance of lasting behavior change, it goes without question that future research is needed with respect to the long-term efficacy of NCR.

Discussion

Given the number of successful examples of the use of NCR as a treatment option to decrease problem behavior, it is clear why NCR has received a multitude of attention in the research literature. In fact, it is clear that a "standard" technology for the implementation of NCR has been developed (i.e., identify the functional reinforcer, deliver the functional reinforcer on a time based schedule, eliminate the maintaining response-reinforcer contingency whenever possible, and start with a dense schedule and fade to a thinner schedule); however, much more research is needed with respect to the use of NCR in the prediction and control of behavior.

First, research focusing on the mechanisms responsible for behavioral reduction has exclusively been examined with behavior that has been reinforced by social positive reinforcement. Whether it is the delivery of attention or a tangible item to suppress problem behavior or a tangible item to suppress some arbitrary response, these investigations fall under the category of NCR-SP. Given this narrow focus and the differences between positive and negative reinforcement contingencies as well as the differences between socially mediated and automatic reinforcement contingencies, future research should evaluate the behavioral mechanisms involved during NCR when behavior is reinforced by social-negative reinforcement and automatic reinforcement (whether investigated under analog conditions or naturalistic conditions). Moreover, given the importance of increased collateral behavior when treating behavior maintained by social-negative reinforcement (i.e., escape from demands), it would be imperative to not only investigate the behavioral mechanisms involved with respect to response suppression, but also, when increases in responding (e.g., compliance) are desired. With respect to behavior maintained by automatic reinforcement, one question that needs to be addressed is whether the inclusion of an extinction component (although, be it, difficult to implement) would produce effects more inline with those observed when NCR is implemented to reduce socially mediated behaviors? Thus, although the literature has clarified the role of the behavioral mechanisms responsible for behavioral reduction during NCR-SP, much more work is needed with respect to NCR-SN and NCR-A.

Second, and maybe of more social importance, is the evaluation of NCR's effectiveness long-term. Not only long-term with respect to time, but with respect to the logistics of implementing NCR treatments in naturalistic settings. For example, the vast majority of the research on NCR to treat problem behavior to date has occurred during brief sessions in clinical environments. Although some researchers have started to look at NCR's effectiveness during longer sessions, the findings to date have been mixed (DeLeon et al., 2000; Lindberg et al., 2003; Tarbox et al., 2004). Moreover, the longest session duration investigated has only been 2 hrs. Thus, much more research is needed with respect to NCR's effectiveness over longer session durations.

Moreover, it is also important to look at what happens to responding post-NCR (i.e., when the session is over). It may be impossible or not

feasible to implement a NCR procedure 24 hrs a day for one reason or another (e.g., staff time constraints). Thus, what happens to responding during this post-session time is extremely important. Does behavior increase over baseline levels, does it remain suppressed, or does it increase gradually over time? To date this information can only be garnered via two studies, for which this was not the focus of the study, and the data are mixed (Kahng et al., 2000; Simmons, Smith, & Kliethermes, 2003). Thus, future research is needed with respect to evaluating the effects of different session duration to post-session duration ratios and the behavioral patterns observed both within and post-session in order to make clinical recommendations or create standardized procedures for the implementation of NCR.

Furthermore, given the lack of follow-up data reported in the literature, future research needs to address the efficacy of NCR long-term as well as compare its efficacy long-term with that of interventions that have already been demonstrated to have long-lasting change. It may be that in the long run, NCR is better suited for short-term (i.e., emergency) situations, and that other interventions should be either subsequently or simultaneously implemented to produce long-term effects.

In conclusion, given that the field of applied behavior analysis is derived from the experimental analysis of behavior, future research might want to expand our knowledge of NCR by first conducting an overview of the basic literature on response-independent (i.e., noncontingent) reinforcement (e.g., Staddon & Simulhag, 1971; Timberlake & Lucas, 1985). It may be that rather than re-inventing the wheel, we can gain insight on the ins and outs of utilizing noncontingent schedules to produce robust and lasting behavioral change by looking at what has already been done in the basic laboratory.

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