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NONCONTINGENT REINFORCEMENT FOR THE TREATMENT OF SEVERE PROBLEM BEHAVIOR: AN ANALYSIS OF 27 CONSECUTIVE APPLICATIONS

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Abstract

Noncontingent reinforcement (NCR) is a commonly used treatment for severe problem behavior displayed by individuals with intellectual and developmental disabilities. The current study sought to extend the literature by reporting outcomes achieved with 27 consecutive applications of NCR as the primary treatment for severe problem behavior. All applications of NCR were included regardless of treatment outcome to minimize selection bias favoring successful cases. Participants ranged in age from 5 to 33 years. We analyzed the results across behavioral function and with regard to the use of functional versus alternative reinforcers. NCR effectively treated problem behavior maintained by social reinforcement in 14 of 15 applications, using either the functional reinforcer or alternative reinforcers. When we implemented NCR to treat problem behavior maintained by automatic reinforcement, we often had to add other treatment components to produce clinically significant effects (five of nine applications). Results provide information on the effectiveness and limitations of NCR as treatment for severe problem behavior.

Keywords

consecutive case series; intellectual disabilities; noncontingent reinforcement; problem behavior

Noncontingent Reinforcement (NCR; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993) is commonly used to treat problem behavior displayed by individuals with intellectual and developmental disabilities (Carr, Severtson, & Lepper, 2009). NCR involves providing

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access to reinforcement independent of behavior on a fixed- or variable-time schedule. Typically, NCR is used in combination with extinction for problem behavior and is initiated using dense schedules of reinforcement that are gradually leaned (e.g., Hagopian, Fisher & Legacy, 1994; Marcus & Vollmer, 1996; Tucker, Sigafoos, & Bushell, 1998; Vollmer et al., 1993). The reductive effects of NCR (with extinction) are believed to result from the attenuation of the motivating operation for problem behavior when the schedules of NCR are dense and via extinction as the schedules of NCR are leaned (Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000; Kahng, Iwata, Thompson, & Hanley, 2000; Wallace, Iwata, Hanley, Thompson, & Roscoe, 2012). It has also been suggested that the behavior targeted for reduction by NCR may be simply replaced by alternative responses already in the individual's repertoire that participate in ongoing contingencies (Virues-Ortega, Iwata, Fahmie, & Harper, 2013). NCR has been used to treat several types of problem behaviors (e.g., aggression, disruption, self-injury, pica) with several functions (Carr et al., 2009).

When used to treat socially maintained problem behavior, NCR typically involves delivering the same reinforcer responsible for maintaining problem behavior (Vollmer et al., 1993). This includes behavior maintained by access to attention (e.g., Hagopian et al., 1994), escape (e.g., Vollmer, Marcus, & Ringdahl, 1995), and tangible items (e.g., Kahng, Iwata, DeLeon, & Wallace, 2000). Although NCR might be appropriately described as a function-based treatment only when it is used to treat socially maintained problem behavior with the maintaining reinforcer, NCR has also been used to describe response-independent delivery of alternative reinforcers for behavior maintained by both social-negative and social-positive reinforcement (e.g., Lomas, Fisher, & Kelly, 2010; and Fischer, Iwata, & Mazaleski, 1997, respectively), and for behavior maintained by automatic reinforcement (e.g., Piazza, Adelinis, Hanley, Goh, & Delia, 2000). These alternative reinforcers are sometimes termed "arbitrary" because they are not the reinforcer responsible for maintaining problem behavior. However, as in Hanley, Piazza, and Fisher (1997), we prefer referring to them as "alternative" rather than "arbitrary" because the items are typically selected using empirical methods. For example, researchers have often used empirical assessments to select alternative reinforcers for the treatment of problem behavior maintained by automatic reinforcement (e.g., Piazza et al., 1998).

For treatment of problem behavior maintained by automatic reinforcement, the methods used to select the alternative reinforcer have evolved over time. Early researchers selected stimuli based on structural properties that were logically assumed to produce the same type of reinforcement that problem behavior was hypothesized to produce (e.g., food items to treat pica; Favell, McGimsey, & Schell, 1982). Subsequently, researchers selected stimuli based on the results of a systematic preference assessment (e.g., Vollmer, Marcus, & LeBlanc, 1994). Currently, researchers typically select alternative stimuli using a *competing stimulus assessment*, which involves selecting stimuli based on the extent to which problem behavior is reduced when the stimulus is made freely available—which is presumed to occur as a function of reinforcer competition (e.g., Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Piazza et al., 2000; Piazza et al., 1998; Roscoe, Iwata, & Goh, 1998; Shore, Iwata, DeLeon, Kahng, & Smith, 1997).

Advantages of NCR include its ease of implementation (i.e., no monitoring of behavior is required because reinforcement is delivered on a time-based schedule; Vollmer et al., 1993) and minimal risk of low- or no-reinforcement periods (which can occur with differential reinforcement of alternative behavior, DRA, and differential reinforcement of other behavior, DRO, procedures when response requirements are not met; Vollmer et al., 1995). Some potential disadvantages of NCR have been suggested (DeLeon, Williams, Gregory, & Hagopian, 2005), but many of these potential problems have not been borne out. For example, adventitious reinforcement of problem behavior is possible if scheduled reinforcer deliveries happen to occur shortly after problem behavior. Nevertheless, researchers have rarely reported such adventitious reinforcement effects, and when they have, those effects reversed quickly after they imposed an omission contingency wherein the delivery of the scheduled reinforcer was suspended if problem behavior occurred during the preceding few seconds (Britton, Carr, Kellum, Dozier, & Weil, 2000; Lalli, Mace, Livezey, & Kates, 1998; Vollmer, Ringdahl, Roane, & Marcus 1997). Researchers have noted several other potential limitations of NCR that warrant additional study (e.g., Clement, Feltus, Kaiser, & Zentall, 2000; DeLeon, et al., 2005), but few such limitations have been observed. The literature demonstrating the utility and efficacy of NCR for reducing problem behavior is over-whelmingly positive (see Carr et al., 2009).

At least three reviews of the literature on NCR have been published to date—each of which concluded that NCR is an effective treatment for problem behavior among individuals with intellectual disabilities (ID). Carr et al. (2000) examined the various uses of NCR in the behavior analytic literature, starting with basic research and progressing towards the use of NCR as a function-based treatment for problem behavior maintained by social reinforcement. In the latter case, this review of prior research suggested that NCR was an effective treatment. The authors concluded with suggestions for practitioners regarding procedural aspects of NCR to maximize treatment efficacy, including methods for schedule thinning and the relative need for adjunct procedures.

In a subsequent systematic review, Carr et al. (2009) showed that a sufficient number of experimentally rigorous studies (24 studies describing 53 applications of NCR) had been conducted on NCR and extinction to characterize it as a “well-established” treatment for socially maintained problem behavior based on American Psychological Association (APA) Division 12 criteria for empirically supported treatments (Chambless & Hollon, 1998). However, they restricted their analyses to studies in which investigators delivered the functional reinforcer, as identified by a functional analysis, on a time-based schedule. That is, Carr et al. (2009) excluded studies that evaluated NCR with alternative reinforcers for problem behavior maintained by either social or automatic reinforcement. Thus, it remains unknown whether NCR meets the criteria for empirical support when it is conducted with alternative reinforcers or for behavior maintained by automatic reinforcement.

A recent meta-analysis of 55 NCR treatment studies (reporting on 91 applications of NCR) provided additional support for the effectiveness of NCR for problem behavior maintained by social and automatic reinforcement, with both functional and alternative reinforcers (Richman, Barnard-Brak, Grubb, Bosch, & Abby, 2015). Richman et al. analyzed the relative treatment effects of NCR via hierarchical linear modeling and reported that

NCR with functional reinforcers was slightly more effective than NCR with alternative reinforcers. However, Richman et al. did not conduct a similar comparison of behavior maintained by social versus automatic reinforcement. Because researchers have consistently used alternative reinforcers when treating automatically reinforced behavior but have more often used functional reinforcers when treating socially reinforced behavior, it is possible that the differences Richman et al. attributed to reinforcer type (alternative vs. functional) may have been due to behavioral function (automatically reinforced vs. socially reinforced problem behavior).

Although the overall evidence seems to over-whelmingly support NCR as an effective treatment for problem behavior in individuals with ID, it is possible that the published data do not represent the full picture. For example, the published literature on NCR may be biased toward positive treatment effects, a phenomenon referred to as publication bias or the file-drawer effect. Publication bias refers to the likelihood that authors will submit and editors will publish articles with positive findings more than those with negative findings (e.g., Easterbrook, Gopalan, Berlin, & Matthews, 1991). Publication bias is a well-documented and reliably occurring phenomenon in studies employing group designs, including randomized clinical trials (for a comprehensive review, see Dwan, Gamble, Wiliamson, & Kirkham, 2013). Recently, Sham and Smith (2014) examined the presence of publication bias in behavior analytic research by comparing the data sets in published studies and unpublished dissertations on pivotal response training. Sham and Smith found significant differences in the effect sizes of the published and unpublished studies, as indicated by the percentage of nonoverlapping data points (PND), despite the two types of studies being of similar methodological level. Additional research is needed to better understand the extent to which publication bias is present in the behavior analytic literature.

It is certainly possible that a similar publication bias might skew the meta-analyses of NCR described above. Richman et al. (2015) suggested that their analysis might be free of this bias because they did not exclude publications in which additional treatment components were evaluated when NCR was found ineffective. They therefore included some number of nonresponders in their datasets. However, that does not preclude the possibility that authors elected not to submit or editors elected not to publish manuscripts with a high percentage of NCR nonresponders. That is, there is no way to know if publication bias could have resulted in an underrepresentation of nonresponders in the literature; which would impact results of any meta-analysis.

Consecutive controlled case-series designs address concerns about publication bias by describing a series of all cases encountered (e.g., Rooker, Jessel, Kurtz, & Hagopian, 2013). Because a single-case experimental design is used in each case, these studies have high internal validity and have stronger external validity relative to studies describing fewer cases. Consecutive controlled case-series studies of late have examined functional communication training (Rooker et al., 2013), schedule thinning during functional communication training (Greer, Fisher, Saini, Owen, & Jones, 2016), and functional analysis and treatment implemented by caregivers (Kurtz, Fodstad, Huete, & Hagopian, 2013). The current study employed a consecutive controlled case-series design to extend the literature on NCR. We report on outcomes achieved with 27 applications in which NCR was the primary treatment for severe problem behavior across 21 consecutively treated cases. All applications of NCR meeting inclusion criteria were included regardless of treatment outcome to minimize selection bias favoring successful cases. In addition to examining the effects of NCR on each individual case, the current study also examined the relative effectiveness of NCR across problem behavior maintained by social versus automatic reinforcement and using the functional reinforcer versus alternative reinforcers (for socially maintained problem behavior).

METHOD

Participants and Setting

Participants, aged 5 to 33 years, were admitted to an inpatient hospital unit for the assessment and treatment of severe problem behavior. All had intellectual and developmental disabilities (see Table 1 for demographic information). Inclusion criteria for this case series were: (a) we conducted a functional analysis (FA) using a design that allowed for the demonstration of functional control; (b) we evaluated NCR (with or without extinction or response blocking) in isolation of other treatment components (thus, we did not include treatment analyses in which we added NCR as an additional component to an existing treatment package); (c) we evaluated NCR effects using a single-case experimental design that allowed for demonstration of functional control; and (d) we collected interobserver-agreement (IOA) scores for at least 25% of sessions with average coefficients equal to or exceeding 80%. We did not exclude data sets based on the presence of response blocking during NCR due to the nature and severity of the types of problem behaviors exhibited by the participants.

A total of 27 applications of NCR implemented across 21 participants met criteria for inclusion. The number of applications exceeded the number of participants because we implemented NCR in separate treatment applications (e.g., targeting different functions) for five of the participants. We have not previously published any of the NCR data sets summarized in this study. Our initial search criteria consisted of any treatment evaluation that included the term “non-contingent”. This led to a larger pool of cases, some of which did not meet our inclusion criteria. We excluded 47 cases from the analysis for the following reasons: for 9 cases, NCR was only evaluated as part of a multicomponent treatment package; 2 had no functional analysis (FA); 23 had insufficient IOA data; 5 showed insufficient data (i.e., were lacking a baseline or no behavior occurred throughout the assessment); and 10 lacked a demonstration of experimental control.

We evaluated the 10 applications lacking experimental control separately to determine if it would be possible to make some judgment about the effectiveness of NCR (and thus ensure that we did not exclude cases because the initial application of NCR was ineffective). NCR was associated with visually significant decreases from baseline in eight applications, but were excluded from the current study because we used an AB design. In one case, NCR produced apparent reductions from baseline, but baseline rates were not recovered during the reversal. Thus, for these nine applications, NCR appeared effective, but because experimental control was not demonstrated it was impossible to rule out the possibility that some variable other than NCR was responsible for the initial treatment effects. Finally, NCR did not reduce problem behavior in one application, but because we implemented a different treatment after the initial exposure to NCR, there was no experimentally controlled analysis of NCR in that case. Thus, overall, it did not appear that excluding these cases for which the treatment analysis of NCR lacked experimental control biased the results toward more positive outcomes for NCR.

We typically conducted the sessions in a padded session room (3 m by 3 m), but in some cases we conducted sessions in a bedroom or common area of the inpatient living area. Functional analysis and treatment sessions lasted 5 or 10 min. Trained behavior therapists conducted the sessions under the supervision of masters- or doctoral-level behavior analysts.

Response Definitions

We targeted one or more of the following topographies of problem behavior for each participant (see Table 1): self-injurious behavior (SIB), aggression, disruption, or some other problem behavior that limited social or academic participation or posed risks to self or others (e.g., dangerous acts, elopement, spitting, inappropriate vocalizations, dropping, and inappropriate sexual behavior). The most common forms of problem behavior were SIB, aggression, and disruption. SIB included responses such as hitting one's own body with an open or closed hand or hard objects, hitting one's body into a wall or hard surface, self-biting, self-pinching, and self-scratching. Aggression included attempts or successes at hitting others with an open or closed fist, pinching, scratching, pushing or pulling on another person's extremities and/or clothing, pulling another person's hair, biting others, and throwing items within 2 ft (.61 m) of or at a person. Disruption included ripping, dumping, swiping, breaking, hitting, knocking over, or writing on objects; and throwing objects not within 2 ft (.61 m) of a person. 'Other' included dangerous acts (e.g., climbing on furniture), elopement, spitting, inappropriate vocalizations, dropping, and inappropriate sexual behavior.

Data Collection and Reliability

Trained observers collected data on laptop computers using specialized software developed for collecting and analyzing direct-observation measures. A second independent observer collected data on 27% to 63% of the total sessions across participants. We calculated exact interobserver agreement (IOA) coefficients by dividing each session into consecutive 10-s intervals, then scoring each interval as an agreement or disagreement. We defined an agreement as both observers recording the same number of responses in an interval and a disagreement as the observers recording differing numbers of responses. We then divided the number of agreements by the total number of intervals in a session and converting the resulting quotient to a percentage. Across participants, mean IOA coefficients ranged from 86% to 100% for SIB, 86% to 100% for aggression, 88% to 100% for disruption, and 94% to 99% for other behaviors.

We calculated the percentage reduction in problem behavior in treatment using the mean of the final five baseline data points and the final five treatment data points. If there were less than five data points in a condition, we calculated the mean using all of the data in that condition.

Experimental Design

We evaluated the effects of NCR using a reversal design in 24 applications, a multielement design in 2 applications, and a multiple-baseline design in 1 application. Similar to Rooker et al. (2013), this study represents a consecutive controlled case-series analysis wherein we included all participants who met the inclusion criteria regardless of outcome. The use of a single-case experimental design allows for demonstration of functional control for each application. The inclusion of all participants enhances external validity by eliminating selection bias that might favor inclusion of only successful cases.

Procedure

Functional analysis (FA).—We conducted an FA with each participant. The functional analyses typically consisted of three or more test conditions (e.g., attention, demand, tangible, alone or no interaction) and one control (i.e., play) condition. We conducted the FAs using a multielement (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994), pairwise (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994), or reversal (Vollmer et al.,1993) design.

Preference assessments.—We used a paired-stimulus preference assessment (Fisher et. al., 1992) or a single-stimulus engagement preference assessment (Hagopian, Rush, Lewin, & Long, 2001) to identify stimuli to be delivered for applications of NCR targeting socially maintained problem behavior (except Applications 17 and 18, in which we conducted a competing-stimulus assessment). We selected stimuli based on the extent to which free access was associated with reductions in problem behavior, high levels of engagement, and ease of use. For NCR targeting problem behavior maintained by automatic reinforcement, we used a competing-stimulus assessment (Piazza et al., 1996) to identity alternative stimuli in 10 applications. In Applications 19, 22, and 23, we identified alternative stimuli based on a paired-stimulus preference assessment.

Treatment evaluation.—We defined NCR as the time-based delivery of either: (a) the maintaining reinforcer or (b) an alternative reinforcer, empirically demonstrated to be reinforcing via a functional analysis, preference assessment, or competing-stimulus assessment. We implemented NCR using alternative reinforcers in every application targeting problem behavior maintained by automatic reinforcement. When we implemented NCR for behavior maintained by social reinforcement, we used the functional reinforcer in five applications, an alternative reinforcer in seven applications, and a combination of both functional and alternative reinforcers in four applications. The clinical team determined whether to use a functional or alternative reinforcer for socially maintained problem behavior on a case-by-case basis, and they based their decision, in part, on considerations regarding the logistics of delivering the functional reinforcer in all relevant contexts. For example, providing a break (i.e., the functional reinforcer) on a time-based schedule for escape-maintained problem behavior may result in completing less work than if an edible reinforcer (i.e., an alternative reinforcer) is delivered on an equivalent schedule. For another example, it may not be possible for a parent to deliver attention at all times, but provision of a competing stimulus on a time-based schedule might be an effective deterrent to attention-maintained problem behavior during periods when attention is unavailable. We considered NCR to be effective if it resulted in at least an 80% reduction from baseline levels. We considered NCR to be *highly effective* if it resulted in a 90% or higher reduction from baseline.

Baseline.—In nearly every case, the relevant test condition from the FA (e.g., the attention condition if the FA found that attention reinforced problem behavior) served as baseline condition against which we compared the effects of NCR. In three cases, the FA produced inconclusive results or suggested that multiple reinforcers maintained problem behavior. For the two inconclusive applications (5 and 23), we used specific contexts as the baseline conditions, ones on the living unit involving demands that frequently evoked problem behavior (i.e., demands to wake up from a nap or to brush teeth, respectively). For Application 15, in which the functional analysis indicated that both automatic and social reinforcement maintained problem behavior, we used the attention condition of the FA as the baseline. We selected the attention condition because it resulted in consistently elevated rates of problem behavior. We then implemented NCR with or without extinction (for socially maintained problem behavior) or with response blocking (for both socially and automatically maintained problem behavior) after baseline.

Initial NCR treatments.—For all 27 applications, the initial NCR treatment involved one or more of the following: (a) NCR without extinction, (b) NCR with extinction, or (c) NCR with response blocking. We included applications that included response blocking because of the inherent difficulties of implementing extinction when the reinforcer is unknown or cannot be withheld.

NCR without extinction (NCR w/o EXT).—During NCR w/o EXT, we delivered reinforcement according to a time-based schedule and problem behavior continued to produce reinforcement (for Application 1, we delivered the reinforcer on a variable schedule that corresponded with the presentation of instructional demands). We implemented NCR w/o EXT in 3 of the 15 socially maintained applications. In two of these applications (Applications 1 and 2), we did not include extinction, in part, to isolate the effects of an alternative reinforcer intended to attenuate the motivating operation for escape in a demand context. In another (Application 11), we determined that escape extinction was not feasible due to the severity of the problem behavior. In one application in which the FA was inconclusive (Application 5), we did not implement extinction as the form of reinforcement was unknown. NCR with response blocking (NCR + RB) data are analyzed with the NCR w/o EXT data because preventing the response from occurring would also prevent it from contacting extinction contingencies. In NCR + RB, we delivered reinforcement on a response-independent schedule and physically interrupted or prevented the completion of the target response(s). We used NCR + RB in nine applications (six with problem behavior maintained by automatic reinforcement in which the reinforcer for problem behavior was unknown, two with problem behavior maintained by social reinforcement, one with both social and automatic functions, and one in which the FA was inconclusive).

NCR with extinction (NCR + EXT).—In NCR + EXT, we delivered reinforcement on a response-independent schedule and withheld the maintaining reinforcer following problem behavior. We implemented NCR + EXT for 12 of the 15 applications with socially maintained problem behavior. For two cases in which the clinical teams defined the procedures as NCR + EXT, response blocking was also included due to the severity of the problem behavior (Applications 17 and 18, both maintained by attention). Although the precise function of blocking is unknown in these two cases, all other forms of attention were withheld.

Additional treatment components.—We implemented additional treatment components based on ongoing data analysis indicating NCR was either ineffective (e.g., Application 7) or partially effective but failed to reduce behavior to clinically acceptable levels (e.g., Application 16), or when problem behavior increased during schedule thinning (e.g., Application 4). We also based our decisions on the least-restrictive treatment philosophy and consideration of factors, such as: (a) the severity of the problem behavior and associated risks of injury to self or others; (b) the acceptability of the treatment as reported by the care providers, or as inferred by the therapist based on previous caregiver discussions; (c) the need to target appropriate skills (e.g., functional communication) once problem behavior was under control; and (d) the need to facilitate schedule thinning. Additional treatment components included either: (a) alternative reinforcement-based components, (b) punishment-based components, (c) NCR schedule thinning, or (d) other components (described below).

Alternative reinforcement components (ALT).—For Applications 7 and 20, we added DRO. In these applications, we delivered an edible reinforcer on a predetermined schedule for the absence of problem behavior concurrently with NCR. In Applications 4 and 25, we added DRA. For these applications, an edible or attention was delivered contingent on an appropriate communicative response.

Punishment components (PUN).—We added punishment components to NCR in five applications when clinically indicated. We implemented the punishment procedure for 30 s contingent on problem behavior. Punishment procedures included: response cost (Application 7), hands down (Application 7 and 16), contingent arm restraints (Application 13), facial screen with basket-hold (Applications 12 and 16), time-out (Application 15), or contingent demands (Application 12). For applications in which multiple punishment procedures were implemented, we selected the most efficacious for the terminal treatment in two applications (Application 7 and 16), and selected both procedures for the remaining one application (Application 12). In Application 12, the two punishment procedures were implemented in a randomized order.

Schedule thinning (ST).—Schedule thinning involved decreasing the density of reinforcement and was performed by increasing the length of the FT interval of NCR, resulting in longer time intervals between periods of reinforcement (Applications 8, 13, 20, 25, and 26), or by increasing the number of demands presented between periods when noncontingent escape was provided (Applications 3 and 4). In the remaining 20 applications, we conducted schedule thinning after treatment was extended to longer durations and applied in the context of the individual's daily routine. For example, for Application 6, we used a structured schedule in which continuous noncontingent attention was available for 5 of every 15 min. Thus, we implemented NCR with continuous reinforcement across the participant's daily routine as one component of an alternating multiple schedule that also included a DRA component for compliance during instructional times. This molar method of schedule thinning is comparable to the use of multiple schedules with functional communication training wherein schedule thinning is achieved by decreasing the component duration of the FR1 schedule for mands, while increasing the component duration of extinction (Hanley, Iwata, & Thompson, 2001).

Other components.—We included additional treatment components when problem behavior increased during schedule thinning or failed to reach clinically significant reductions with NCR alone. Additional components included redirection to interact with toys contingent on target behavior (Application 13), the use of a multiple schedule of EXT and NCR (Application 25), and noncontingent arm splints for severe SIB, followed by restraint-fading (Application 25).

RESULTS

Functional Analysis

Table 2 lists the average rate of problem behavior in the control and relevant test condition of the FA and the function of problem behavior for each participant. In cases in which SIB was maintained by automatic reinforcement, we retrospectively applied criteria for subtyping automatically reinforced SIB, as described by Hagopian, Rooker, and Zarcone (2015). Briefly, Subtype 1 SIB is characterized by a high level of differentiation between the *play* and *alone* or *no interaction* condition in the FA, Subtype 2 SIB is characterized by low levels of differentiation, and Subtype 3 is characterized by the presence of self-restraint. Sub-typing was conducted based on the results of Hagopian et al. (2015) indicating that Subtype 1 SIB appears highly responsive to treatment, whereas with Subtypes 2 and 3, SIB is generally less responsive to treatment. We were able to determine a subtype of automatically reinforced SIB for five of the eight individuals. In two cases (9 and 18) extreme variability in the FA data, including shifting forms of behavior and patterns of responding over time, precluded definitive subtype classification. In the third case (15) where a subtype of SIB was not determined, a series of alone sessions confirmed the presence of automatic reinforcement, but there was no comparative control condition to allow subtype classification.

Treatment Selection

We used NCR to treat behavior maintained by social reinforcement in 15 applications and to treat problem behavior maintained by automatic reinforcement in 9 applications. We also used NCR to treat problem behavior in two cases in which the FA was inconclusive (Applications 5 and 23) and one in which behavior was maintained by both automatic and social reinforcement (Application 15).

Initial NCR treatment outcomes.—The initial NCR treatment involved either NCR w/o EXT, or NCR w/ EXT. Outcomes obtained with all applications are listed in Table 3; data in Table 3 for NCR with RB are depicted in the NCR w/o EXT column. The initial NCR treatment produced a 90% or greater reduction in problem behavior relative to baseline in 70.4% (19 of 27) of applications (*M* = 97.8%, range 91.8% to 100%); and at least an 80% reduction in 74.1% (20 of 27) of applications (*M* = 97.0%, range 81.6% to 100%). NCR reduced problem behavior by a lesser degree in an additional six applications (*M* = 54.0%, range: 26.3% to 74.9%). In one application (Application 7), NCR resulted in an increase in problem behavior when compared to baseline. Overall, NCR was effective or highly effective in almost three quarters of the total applications.

Outcomes of NCR with additional treatment components.—We implemented at least one additional treatment component with NCR in eight applications. When we combined NCR + ALT SR, it was highly effective for three of four applications (75% of applications, *M* = 99.5%, range 99.2% to 100% reduction). When we combined NCR + PUN, it was highly effective in five of five applications (*M* = 94.9%, range 90.6% to 96.9%). In the two applications in which we added NCR + Other, only one resulted in a 90% or better reduction in problem behavior (Application 25, three-component multiple schedule of DRA, NCR, and EXT with noncontingent arm splints followed by restraint fading). For the other application (Application 13; redirection), we achieved a greater than 90% reduction only after we added the punishment component.

Schedule thinning.—We implemented reinforcement schedule thinning after the initial implementation of NCR in five applications before we extended the treatment for longer periods of time and across contexts. We initiated schedule thinning after achieving at least a 90% reduction in problem behavior (except in Application 3, in which we initiated schedule thinning following a 74.5% reduction). We achieved a greater than 90% reduction in problem behavior with the addition of schedule thinning in four of these five applications (*M* = 95.45%, range 90.7% to 100%). For Application 4, problem behavior increased slightly with schedule thinning, but decreased further when we overlaid an alternative reinforcement schedule on NCR.

We conducted schedule thinning in four applications after the addition of NCR + ALT SR (three applications) or NCR + PUN (one application). For two of the three applications in which we added NCR + ALT, problem behavior remained low or reduced further as we thinned the schedules of reinforcement. For the application in which we added NCR + PUN, problem behavior was further reduced. Table 4 depicts the types of schedule-thinning procedures used as well as the terminal schedules achieved for applications for which we collected IOA. For the 20 applications in which we conducted schedule thinning after we applied the treatment across settings and over extended periods of time, results are not reported because we did not collect IOA during these times.

NCR for social versus automatic functions.—The outcomes of NCR across functions are summarized in Table 5. We observed notable differences in treatment effects with the initial NCR treatment for behavior maintained by social versus automatic reinforcement. NCR produced an 80% or greater reduction in problem behavior in all but one application to socially maintained problem behavior. Specifically, when we applied the initial NCR treatment to socially maintained behavior (NCR with or without EXT), problem behavior decreased by 90% or more in 13 of 15 applications (86.7% of applications; *M* = 98.3%, range 91.8% to 100% reduction), and by 80% in 14 of 15 applications (93.3% of applications; *M* = 97.06%, range 81.6% to 100% reduction). For the one remaining application of NCR to socially maintained problem (Application 3), problem behavior reduced by 74.9%. Treatment effects for socially maintained problem behavior were similar regardless of extinction being implemented (*M* = 94.8%, range 74.9% to 100%) or withheld (*M* = 98.6%, range 95.9% to 100%). By contrast, when we applied the initial NCR treatment to problem behavior maintained by automatic reinforcement (NCR with or without RB), problem behavior decreased by 90% or more in only four of nine applications (44.4% of applications; *M* = 96.8%, range 93.4% to 100% reduction). NCR produced an effective reduction in problem behavior for four applications (Applications 6, 19, 21, and 24), and a moderately effective reduction in problem behavior (73.9%) in one application (Application 14). It proved relatively ineffective for three applications (Applications 12, 13, & 16) and NCR significantly increased problem behavior in one application (Application 7). Treatment effects for the initial application of NCR for automatically maintained problem behavior varied significantly between when response blocking was being implemented (*M* = 53.9%, range −119.6% to 100%) and withheld (*M* = 94.9%, range 93.4% to 96.4%). However, it is possible that the severity of the problem behavior accounts for both the need to use response blocking and the relative difference in efficacy of the initial NCR treatments, thus the comparison data should be interpreted with caution.

We calculated a Yate’s chi-square statistic to determine whether the observed difference in the proportion of applications in which we achieved an 80% or greater reduction in problem behavior for social versus automatically reinforced problem behavior reached statistical significance, which it did ($X^2 = 4.8$, $p = .028$).

NCR with functional versus alternative reinforcers.—In some cases with socially maintained problem behavior, we implemented NCR using the functional reinforcer as determined by the FA. However, in other cases we used an alternative reinforcer or a combination of the functional and alternative reinforcer. All variations proved to be about equally effective. For the four applications in which we used the functional reinforcer, NCR reduced problem behavior by a mean of 98.7% (range 96.6% to 100%). For the seven applications in which we used alternative reinforcers, NCR reduced problem behavior by a mean of 97.4% (range 91.1% to 100%). For the four applications in which we combined the functional reinforcer with an alternative reinforcer, NCR reduced problem behavior by a mean of 93.2% (range 81.6% to 100%).

NCR for treatment of automatically reinforced SIB, Subtypes 1 and 2.—Automatically reinforced SIB met criteria as Subtype 1 in Applications 6, 12, and 19; and as Subtype 2 in Applications 7 and 16. Although this is a limited sample, the extent to which NCR reduced each subtype of SIB paralleled reports by Hagopian et al. (2015). For Subtype-1 SIB, NCR + RB alone produced a clinically significant outcome (90% or greater reduction in SIB) in two of three applications. In the application in which NCR was found to be ineffective, the individual began to engage in SIB using the competing stimulus (i.e., toy-to-head SIB), and we therefore added a punishment component. For applications in which we targeted Subtype-2 SIB, NCR did not reduce problem behavior by more than 80% in either case, necessitating the use of punishment.

DISCUSSION

Findings from the current study show that NCR applied in accordance with an individualized, response-guided approach, reduced severe problem behavior that warranted inpatient hospitalization by at least 80% in 20 of 27 applications across 21 individuals, and by 90% in 19 of 27 applications. With and without supplemental procedures, NCR reduced problem behavior by at least 80% in 26 of 27 applications, and by 90% in 25 of 27 applications. Participants included a diverse group of individuals with intellectual and developmental disabilities ranging in age from 5 to 33 years, with a variety of diagnoses and conditions, and displaying problem behavior maintained by social or automatic reinforcement.

Although the literature on NCR spans decades and provides strong empirical support for its effectiveness (Carr et al., 2009), most studies on NCR report on one to three individuals. In addition to the limited external validity of any individual small-n study, there is also the potential that published studies are more likely to include cases in which NCR was effective. However, the analysis of the data from Carr’s et al. (2009) systematic review of the literature is remarkably consistent with that of the current case series. Specifically, Carr et al. (2009) summarized data on the effectiveness of NCR with FT schedules and EXT (the same type used in this study), as well as NCR with schedule thinning for the treatment of socially reinforced problem behavior. Using the same criterion for efficacy (i.e., an 80% or greater reduction from baseline rates) as in the current paper to allow for direct comparison, the authors found that prior to schedule thinning, this form of NCR was effective in 19 of 28 published cases (68%) and with schedule thinning, this form of NCR was effective in 18 of 25 (72%) of published cases. These results are very similar to the overall results reported in the current study with respect to NCR, which was effective in 20 of 27 cases (74.1%). However, our results included applications of NCR using alternative reinforcers for both socially and automatically reinforced problem behavior. For the four applications in which we implemented NCR with the functional reinforcer for socially reinforced problem behavior, we observed a 90% or greater reduction in problem behavior in every case. Similarly, we found NCR with schedule thinning to be only slightly more effective in the current study (five of five cases) relative to the published cases summarized by Carr et al. (2009). Although no firm conclusions can be made, these comparable findings show no evidence of publication bias in the NCR literature as it relates to the treatment of socially reinforced problem behavior.

The meta-analysis of NCR conducted by Richman et al. (2015) provides a broad quantitative analysis of the literature on NCR, further supporting its effectiveness, but the findings may still be impacted by potential publication bias. That is, although Richman et al. suggested that the reported data sets might be relatively free of publication bias because they included cases in which NCR proved unsuccessful (approximately 34% of their sample), we do not know the extent to which other unsuccessful cases were excluded from the published research. It should be noted that Richman et al. judged NCR to be ineffective if the original investigators added other components to the treatment. In the present study, we judged the success of NCR based on the reduction from baseline in the initial application of NCR. This makes direct comparisons of the results of these analyses difficult. Regardless, the current consecutive controlled case-series analysis mitigates publication bias by including all applications of NCR without consideration of treatment outcomes. Outcomes obtained during the initial application of NCR in isolation (with only extinction and/or response blocking) were not successful in reducing problem behavior by at least 80% in 7 of 27 applications (26%), illustrating that a range of outcomes were observed. In these cases, additional treatment components were needed to supplement NCR, which represents standard clinical practice whereby the individual's response to treatment guides modifications on an ongoing basis.

Another advantage of consecutive controlled case-series analyses (as well as meta-analyses) is that it enables additional comparisons not otherwise possible when examining individual datasets. For example, the current study allows for some comparison of outcomes of NCR for both socially reinforced and automatically reinforced problem behavior. We found problem behavior maintained by social contingencies (escape, attention, and access to tangibles) to be responsive to the initial NCR treatment relative to problem behavior maintained by automatic reinforcement. For socially reinforced problem behavior, the initial NCR treatment (NCR + EXT, NCR w/o EXT) effectively reduced problem behavior by 80% in all but one application. In contrast, the initial NCR treatment targeting problem behavior maintained by automatic reinforcement (NCR, NCR + RB) was effective in less than half of applications. However, a 90% reduction was eventually achieved in all but one application when we supplemented NCR with additional treatment components.

Comparisons between the effects of NCR for treatment of socially versus automatically reinforced problem behavior should be made with some caution for two reasons. First, we used different procedures for socially versus automatically reinforced problem behavior (i.e., NCR + EXT versus NCR + RB, respectively). A perfectly equivalent comparison across these functional classes is not possible; whereas we can implement extinction for socially reinforced problem behavior, we typically cannot withhold reinforcement for automatically reinforced behavior. Although published studies have evaluated NCR without response blocking for automatically reinforced problem behavior (e.g., Roscoe et al., 1998), we chose to use NCR + RB (in all but two applications) because it approximates extinction for automatically reinforced problem behavior in that it prevents the sensory stimulation hypothesized to reinforce problem behavior. This limitation is mitigated somewhat by the fact that the observed differences in effectiveness of NCR for socially versus automatically reinforced problem behavior would likely have been greater had we used NCR without response blocking for automatically reinforced problem behavior. In light of these issues, and variable outcomes that response blocking can produce (Hagopian & Adelinas, 2001; Lerman & Iwata, 1996), additional research is needed to examine the effectiveness of NCR with and without response blocking in the treatment of automatically reinforced problem behavior.

The second caveat with regard to comparing the effects of NCR across social versus automatic functional classes is that when using NCR for socially reinforced problem behavior, the functional reinforcer can be delivered on the response-independent schedule, whereas only alternative reinforcers can be used when treating automatically reinforced self-injurious problem behavior. Interestingly however, we found that NCR reduced socially reinforced problem behavior regardless of whether we used the functional reinforcer or an alternative reinforcer. This result differed from the findings of Richman et al. (2015), who found functional reinforcers to be slightly more effective than alternative reinforcers. However, this discrepancy might be accounted for by the different methods used in each study to examine the impact of this variable. Richman and colleagues looked at functional and alternative reinforcement regardless of behavioral function, whereas in the present study, we excluded cases in which we determined behavior to be maintained by automatic reinforcement from this part of the analysis (given that the exact source of automatic reinforcement was unknown). Therefore, it is possible that the differences between functional versus alternative reinforcers identified by Richman and colleagues might be attributable, at least in part, to differences in behavioral function.

Another possible reason NCR may be more effective for treating socially reinforced problem behavior is that it may be more difficult to identify reinforcers that compete with automatic reinforcement relative to social reinforcement. The challenges of treating automatically reinforced behavior have been long noted (e.g., Vollmer, 1994). Recent empirical findings identifying subtypes of SIB maintained by automatic reinforcement suggest that some subtypes (Subtypes 2 & 3) are more resistant to treatment relative to other subtypes (Subtype 1) and relative to SIB maintained by social contingencies (Hagopian et al., 2015). Results from the current study are consistent with those findings in demonstrating that NCR needs to be supplemented with more treatment components when used to treat automatically reinforced Subtype-2 SIB relative to Subtype-1 SIB and problem behavior maintained by social reinforcement.

However, with the addition of other treatment components (most commonly an additional reinforcement schedule or punishment contingency), we eventually achieved a 90% reduction in all but one application of NCR for automatically reinforced problem behavior. It is possible that the inclusion of an additional reinforcement schedule enhanced NCR by providing yet another source of reinforcement that competed with reinforcement maintaining problem behavior. Another possibility is that a 30-s punishment procedure enhanced treatment by weakening the target behavior directly (via punishment), and/or because it was more effective than response blocking in interrupting the response for a longer period of time, and thus was more effective in limiting the reinforcing consequences that problem behavior produced. These hypotheses remain somewhat speculative at this time because the design of the current study did not allow us to determine how these additional components enhanced NCR.

In addition to being a highly effective treatment, NCR is also easier to implement than many alternative treatments (e.g., DRO, DRA). A common critique of NCR, however, is that it does not establish any replacement behavior. Although NCR does not explicitly target adaptive behavior for increase, it seems likely that overall reductions in problem behavior might enhance opportunities for learning. That is, it is possible that in the case of severe, high rate problem behavior, the first course of action should be to reduce the behavior such that the individual has the opportunity to engage in alternative responses that can be reinforced. Although Goh, Iwata, and DeLeon (2000) demonstrated the potential for dense schedules of NCR to impede the acquisition of alternative behavior, they did not investigate the potential effects of combining NCR with other reinforcement-based procedures. Furthermore, Lomas, Fisher, and Kelley (2010) demonstrated that for one of three participants, implementing variable-time (VT) delivery of a preferred food and praise (i.e., NCR) in the context of demands both reduced problem behavior and resulted in an increase in compliance, despite the fact that there was no contingency in place for compliance. In a follow-up to this study, Mevers, Fisher, Kelley, and Fredrick (2014) directly compared VT food delivery and food delivery contingent on compliance in a demand context. Although compliance increased more with contingent reinforcement than with NCR, compliance increased with NCR for three of four subjects. This suggests that even in isolation, NCR may increase untargeted appropriate behavior.

It should also be noted that studies have demonstrated that when given a choice between NCR and DRA, subjects will select DRA (e.g., Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Luczynski & Hanley, 2009, 2010). This work seems to suggest that the contingency itself is responsible for this preference. The preference was demonstrated with both children with ID who engaged in problem behavior using the functional reinforcer (i.e., Hanley, Piazza, Fisher, Contrucci, et al., 1997) and typically developing children using an alternative reinforcer (e.g., Luczynski & Hanley, 2009). Gabor, Fritz, Roath, Rothe, and Gourley (2016) also recently showed that after implementing reinforcement-based interventions for their children who engaged in problem behavior, four of five caregivers preferred differential over noncontingent reinforcement (one caregiver was indifferent). Additional research is needed to examine the generality of this apparent preference for differential reinforcement and the implications of this preference with respect to longer term outcomes.

A limitation of the current study is that we drew the sample from a population of individuals who were receiving treatment for severe problem behavior in a specialized inpatient unit with intensive assessment and treatment resources. Because admission to this program is reserved for individuals with highly treatment-resistant problem behavior, the sample may not be representative of the broader population of individuals with problem behavior. Thus, although the consecutive controlled case series design addresses possible publication bias, its external validity can be limited if the setting in which the study is conducted provides treatment to individuals who are not a representative sample. Furthermore, NCR was assessed in relatively brief sessions, by highly trained staff, and in a highly controlled environment that is not representative of typical settings in which NCR would be applied to address problem behavior, also potentially limiting the generality of our findings. It is possible that the treatment effects demonstrated in these evaluations would not be maintained under more natural conditions or for longer periods of time. Future research should evaluate the efficacy of NCR in isolation over longer time periods and when implemented by caregivers in typical contexts.

One additional limitation of this and other consecutive, controlled case-series analyses (e.g., Rooker et al., 2013) that report on individuals receiving clinical treatment (as opposed to participants enrolled in a research protocol) is that there tend to be variations in how the treatment is applied across participants. Although such variations decrease experimental control, they mirror actual practice and may have advantages over a rigid, predetermined protocol. An ideal middle ground would involve the use of treatment algorithms to structure how treatment components are sequenced while still preserving the response-guided approach that is the hallmark of good clinical practice in applied behavior analysis.

REFERENCES

Britton LN, Carr JE, Kellum KK, Dozier CL, & Weil TM (2000). A variation of noncontingent reinforcement in the treatment of aberrant behavior. Research in Developmental Disabilities, 21(6), 425–435. doi:10.1016/S0891-4222(00)00056-1 [PubMed: 11153827]

Carr JE, Coriaty S, Wilder DA, Gaunt BT, Dozier CL, Britton LN … Reed CL (2000). A review of “noncontingent” reinforcement as treatment for the aberrant behavior of individuals with developmental disabilities. Research in Developmental Disabilities, 21(5), 377–391. 10.1016/S0891-4222(00)00050-0 [PubMed: 11100801]

Carr JE, Severtson JM, & Lepper TL (2009). Noncontingent reinforcement is an empirically supported treatment for problem behavior exhibited by individuals with developmental disabilities. Research in Developmental Disabilities, 30(1), 44–57. doi:10.1016/j.ridd.2008.03.002 [PubMed: 18467073]

Chambless DL, & Hollon SD (1998). Defining empirically supported therapies. Journal of Consulting and Clinical Psychology, 66(1), 7. [PubMed: 9489259]

Clement TS, Feltus JR, Kaiser DH, & Zentall TR (2000). “Work ethic” in pigeons: Reward value is directly related to the effort or time required to obtain the reward. Psychonomic Bulletin & Review, 7(1), 100–106. Retrieved from http://link.springer.com/article/10.3758/BF03210727 [PubMed: 10780022]

DeLeon IG, Williams D, Gregory MK, & Hagopian LP (2005). Unexamined potential effects of the noncontingent delivery of reinforcers. European Journal of Behavior Analysis, 6(1), 57. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/15021149.2005.11434250

Dwan K, Gamble C, Williamson PR, & Kirkham JJ (2013). Systematic review of the empirical evidence of study publication bias and outcome reporting bias—an updated review. PloS one, 8(7), e66844. [PubMed: 23861749]

Easterbrook PJ, Gopalan R, Berlin JA, & Matthews DR (1991). Publication bias in clinical research. Lancet, 337, 867–872. doi:10.1016/0140-6736(91)90201-Y [PubMed: 1672966]

Favell JE, McGimsey JF, & Schell RM (1982). Treatment of self-injury by providing alternate sensory activities. Analysis and Intervention in Developmental Disabilities, 2(1), 83–104. doi:10.1016/0270-4684(82)90007-6

Fischer SM, Iwata BA, & Mazaleski JL (1997). Noncontingent delivery of arbitrary reinforcers as treatment for self-injurious behavior. Journal of Applied Behavior Analysis, 30, 239–249. doi:10.1901/jaba.1997.30-239 [PubMed: 9210304]

Fisher W, Piazza CC, Bowman LG, Hagopian LP, Owens JC, & Slevin I (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. Journal of Applied Behavior Analysis, 25, 491–498. doi:10.1901/jaba.1992.25-491 [PubMed: 1634435]

Gabor AM, Fritz JN, Roath CT, Rothe BR & Gourley DA (2016). Caregiver preference for reinforcement-based interventions for problem behavior maintained by positive reinforcement. Journal of Applied Behavior Analysis, 49, 215–227. doi:10.1002/jaba.286 [PubMed: 26792408]

Goh HL, Iwata BA, & DeLeon IG (2000). Competition between noncontingent and contingent reinforcement schedules during response acquisition. Journal of Applied Behavior Analysis, 33, 195–205. doi:10.1901/jaba.2000.33-195 [PubMed: 10885527]

Greer BD, Fisher WW, Saini V, Owen TM, & Jones JK (2016). Improving functional communication training during reinforcement schedule thinning: An analysis of 25 applications. Journal of Applied Behavior Analysis, 49, 105–121. doi:10.1002/jaba.265 [PubMed: 26482103]

Hagopian LP, & Adelinas JD (2001). Response blocking with and without redirection for the treatment of pica. Journal of Applied Behavior Analysis, 34, 527–530. doi:10.1901/jaba.2001.34-527 [PubMed: 11800195]

Hagopian LP, Crockett JL, van Stone M, DeLeon IG, & Bowman LG (2000). Effects of noncontingent reinforcement on problem behavior and stimulus engagement: The role of satiation, extinction, and alternative reinforcement. Journal of Applied Behavior Analysis, 33, 433–449. doi:10.1901/jaba.2000.33-433 [PubMed: 11214021]

Hagopian LP, Fisher WW, & Legacy SM (1994). Schedule effects of noncontingent reinforcement on attention-maintained destructive behavior in identical quadruplets. Journal of Applied Behavior Analysis, 27, 317–325. doi:10.1901/jaba.1994.27-317 [PubMed: 8063630]

Hagopian LP, Rooker GW, & Zarcone JR (2015). Delineating subtypes of self-injurious behavior maintained by automatic reinforcement. Journal of Applied Behavior Analysis, 48, 523–543. doi:10.1002/jaba.236 [PubMed: 26223959]

Hagopian LP, Rush KS, Lewin AB, & Long ES (2001). Evaluating the predictive validity of a single stimulus engagement preference assessment. Journal of Applied Behavior Analysis, 34, 475–485. doi:10.1901/jaba.2001.34-475 [PubMed: 11800186]

Hanley GP, Iwata BA, & Thompson RH (2001). Reinforcement schedule thinning following treatment with functional communication training. Journal of Applied Behavior Analysis, 34, 17–38. doi:10.1901/jaba.2001.34-17 [PubMed: 11317985]

Hanley GP, Piazza CC, & Fisher WW (1997). Noncontingent presentation of attention and alternative stimuli in the treatment of attention-maintained destructive behavior. Journal of Applied Behavior Analysis, 30, 229–237. doi:10.1901/jaba.1997.30-229 [PubMed: 9210303]

Hanley GP, Piazza CC, Fisher WW, Contrucci SA, & Maglieri KA (1997). Evaluation of client preference for function-based treatment packages. Journal of Applied Behavior Analysis, 30(3), 459–473. doi:10.1901/jaba.1997.30-459 [PubMed: 9316259]

Iwata BA, Dorsey MF, Slifer KJ, Bauman KE, & Richman GS (1994). Toward a functional analysis of self-injury. Journal of Applied Behavior Analysis, 27, 197. [PubMed: 8063622]

Iwata BA, Duncan BA, Zarcone JR, Lerman DC, & Shore BA (1994). A sequential, test-control methodology for conducting functional analyses of self-injurious behavior. Behavior Modification, 18, 289–306. doi:10.1177/01454455940183003 [PubMed: 8037650]

Kahng S, Iwata BA, DeLeon IG, & Wallace MD (2000). A comparison of procedures for programming noncontingent reinforcement schedules. Journal of Applied Behavior Analysis, 33, 223–231. doi:10.1901/jaba.2000.33-223 [PubMed: 10885529]

Kahng S, Iwata BA, Thompson RT, & Hanley GP (2000). A method for identifying satiation versus extinction effects under noncontingent reinforcement schedules. Journal of Applied Behavior Analysis, 33, 419–432. [PubMed: 11214020]

Kurtz PF, Fodstad JC, Huete JM, & Hagopian LP (2013). Caregiver- and staff-conducted functional analysis outcomes: A summary of 52 cases. Journal of Applied Behavior Analysis, 46(4), 738–749. [PubMed: 24114788]

Lalli JS, Mace FC, Livezey K, & Kates K (1998). Assessment of stimulus generalization gradients in the treatment of self-injurious behavior. Journal of Applied Behavior Analysis, 31, 479–483. doi:10.1901/jaba.1998.31-479 [PubMed: 9757586]

Lerman DC, & Iwata BA (1996). A methodology for distinguishing between extinction and punishment effects associated with response blocking. Journal of Applied Behavior Analysis, 29, 231–233. doi:10.1901/jaba.1996.29-231 [PubMed: 8682737]

Lomas JE, Fisher WW, & Kelley ME (2010). The effects of variable-time delivery of food items and praise on problem behavior reinforced by escape. Journal of Applied Behavior Analysis, 43, 425–435. doi:10.1901/jaba.2010.43-425 [PubMed: 21358903]

Luczynski KC, & Hanley GP (2009). Do children prefer contingencies? An evaluation of the efficacy of and preference for contingent versus noncontingent social reinforcement during play. Journal of Applied Behavior Analysis, 42(3), 511–525. doi:10.1901/jaba.2009.42-511 [PubMed: 20190915]

Luczynski KC, & Hanley GP (2010). Examining the generality of children’s preference for contingent reinforcement via extension to different responses, reinforcers, and schedules. Journal of Applied Behavior Analysis, 43(3), 397–409. doi:10.1901/jaba.2010. 43–397 [PubMed: 21358901]

Marcus BA, & Vollmer TR (1996). Combining noncontingent reinforcement and differential reinforcement schedules as treatment for aberrant behavior. Journal of Applied Behavior Analysis, 29, 43–51. doi:10.1901/jaba.1996.29-43 [PubMed: 8881343]

Mevers JEL, Fisher WW, Kelley ME, & Fredrick LD (2014). The effects of variable-time versus contingent reinforcement delivery on problem behavior maintained by escape. Journal of Applied Behavior Analysis, 47(2), 277–292. doi:10.1002/jaba.110 [PubMed: 24764205]

Piazza CC, Adelinis JD, Hanley GP, Goh HL, & Delia MD (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. Journal of Applied Behavior Analysis, 33, 13–27. doi:10.1901/jaba.2000.33-13 [PubMed: 10738949]

Piazza CC, Fisher WW, Hanley GP, Hilker K, & Derby KM (1996). A preliminary procedure for predicting the positive and negative effects of reinforcement-based procedures. Journal of Applied Behavior Analysis, 29, 136–146.

Piazza CC, Fisher WW, Hanley GP, LeBlanc LA, Worsdell AS, Lindauer SE, & Keeney KM (1998). Treatment of pica through multiple analyses of its reinforcing functions. Journal of Applied Behavior Analysis, 31, 165–189. doi:10.1901/jaba.1998.31-165 [PubMed: 9652098]

Richman DM, Barnard-Brak L, Grubb L, Bosch A, & Abby L (2015). Meta-analysis of non-contingent reinforcement effects on problem behavior. Journal of Applied Behavior Analysis, 48, 131–152. doi:10.1002/jaba.189 [PubMed: 25754894]

Rooker GW, Jessel J, Kurtz PF, & Hagopian LP (2013). Functional communication training with and without alternative reinforcement and punishment: An analysis of 58 applications. Journal of Applied Behavior Analysis, 46, 708–722. doi:10.1002/jaba.76 [PubMed: 24114463]

Roscoe EM, Iwata BA, & Goh HL (1998). A comparison of noncontingent reinforcement and sensory extinction as treatments for self-injurious behavior. Journal of Applied Behavior Analysis, 31, 635–646. doi:10.1901/jaba.1998.31-635 [PubMed: 9891399]

Sham E, & Smith T (2014). Publication bias in studies of an applied behavior-analytic intervention: An initial analysis. Journal of Applied Behavior Analysis, 47, 663–678. doi:10.1002/jaba.146 [PubMed: 24990802]

Shore BA, Iwata BA, DeLeon IG, Kahng S, & Smith RG (1997). An analysis of reinforcer substitutability using object manipulation and self-injury as competing responses. Journal of Applied Behavior Analysis, 30, 21–41. doi:10.1901/jaba.1997.30-21 [PubMed: 9103985]

Tucker M, Sigafoos J, & Bushell H (1998). Use of noncontingent reinforcement in the treatment of challenging behavior: a review and clinical guide. Behavior Modification, 22(4), 529–547. doi:10.1177/01454455980224005 [PubMed: 9755650]

Virues-Ortega J, Iwata BA, Fahmie TA, & Harper JM (2013). Effects of alternative responses on behavior exposed to noncontingent reinforcement. Journal of Applied Behavior Analysis, 46, 603–612. doi:10.1002/jaba.61 [PubMed: 24114223]

Vollmer TR (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. Research in Developmental Disabilities, 15(3), 187–207. doi:10.1016/0891-4222(94)90011-6 [PubMed: 7938787]

Vollmer TR, Iwata BA, Zarcone JR, Smith RG, & Mazaleski JL (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. doi:10.1901/jaba.1993.26-9 [PubMed: 8473262]

Vollmer TR, Marcus BA, & LeBlanc L (1994). Treatment of self-injury and hand mouthing following inconclusive functional analyses. Journal of Applied Behavior Analysis, 27(2), 331–344. doi:10.1901/jaba.1994.27-331 [PubMed: 8063632]

Vollmer TR, Marcus BA, & Ringdahl JE (1995). Noncontingent escape as treatment for self-injurious behavior maintained by negative reinforcement. Journal of Applied Behavior Analysis, 28, 15–26. doi:10.1901/jaba.1995.28-15 [PubMed: 7706146]

Vollmer TR, Ringdahl JE, Roane HS, & Marcus BA (1997). Negative side effects of non-contingent reinforcement. Journal of Applied Behavior Analysis, 30(1), 161–164. doi: 10.1901/jaba.1997. 30–161 [PubMed: 9157097]

Wallace MD, Iwata BA, Hanley GP, Thompson RH, & Roscoe EM (2012). Non-contingent reinforcement: a further examination of schedule effects during treatment. Journal of Applied Behavior Analysis, 45, 709–719. doi:10.1901/jaba.2012.45-709 [PubMed: 23322927]

Table 1

Demographic Information

Case	Application	Age (years)	Gender	ASD	Other Diagnoses	Level of ID	Target Behaviors
1	1	8	F	Y	Mild CP, SMD w/SIB	Moderate	SIB, Agg, Dis
1	2	-	-	-	-	-	-
2	3	16	M	Y	Cornelia de Lange Syndrome, SMD w/SIB	Moderate	SIB, Agg, Dis
2	4	-	-	-	-	-	-
3	5	14	M	Y	ADHD, Adjustment Disorder, Bipolar Disorder, PTSD, Unspecified Genetic Syndrome w/ Microcephaly	Moderate	SIB, Agg, Dis
4	6	7	F	N	CP, Kyphoscoliosis, Optic Nerve Hypoplasia, SMD w/ SIB	Severe	SIB, Agg, Dis
5	7	12	M	Y	None	Severe	SIB, Agg, Dis
6	8	7	M	N	CP	Profound	Agg
7	9	33	F	N	Intermittent-Explosive Disorder	Severe	SIB, Agg, Dis
7	10	-	-	-	-	-	-
7	11	-	-	-	-	-	-
8	12	15	M	N	Anxiety Disorder NOS	Profound	SIB, Agg, Dis
9	13	6	M	Y	Bardet Bidel Syndrome, Exostosis, SMD w/ SIB, Syndactyly	Moderate	SIB, Agg
9	14	-	-	-	-		-
10	15	7	M	Y	DBD NOS, SMD w/ SIB	Moderate	SIB, Agg, Dis, Other
11	16	13	F	Y	DBD NOS, Mood Disorder NOS, SMD w/ SIB	Profound	SIB, Agg, Dis
12	17	14	M	N	r/o Mood Disorder NOS, SMD w/ SIB, Tuberous Sclerosis, UDC	Moderate	SIB, Agg, Dis
12	18	-	-	-	-	-	-
13	19	14	F	Y	SMD w/ SIB, UDC	Moderate	SIB, Agg, Dis
14	20	13	F	Y	Seckel Syndrome	Moderate	SIB, Agg, Dis
15	21	10	M	Y	SMD w/SIB, UDC	Moderate	Other
16	22	7	M	Y	Bipolar Disorder, UDC	Not specified	Agg, Dis
17	23	11	M	Y	DBD NOS, SMD w/ SIB	Moderate	SIB, Agg, Dis
18	24	13	M	Y	Seizure Disorder, SMD w/ SIB, UDC	None	SIB, Agg
19	25	5	F	N	DBD NOS, Partial Trisomy 13, Plagiocephaly, SMD w/ SIB, Spina Bifida, Torticollis	Severe	SIB, Agg, Dis
20	26	17	M	Y	DBD NOS, Mood Disorder NOS	Not specified	SIB, Agg, Dis, Other
21	27	9	M	Y	DBD, Mood Disorder NOS, SMD w/ SIB	Not specified	SIB, Agg, Dis

Note. F = Female; M = Male; Y = Yes; N = No; ADHD = Attention Deficit Hyperactivity Disorder; CP = Cerebral Palsy; DBD = Disruptive Behavior Disorder; NOS = Not Otherwise Specified; PTSD = Posttraumatic Stress Disorder; r/o = rule out; SMD = Stereotypic Movement Disorder; UDC = Unspecified Disturbance of Conduct; Agg = Aggression; Dis = Disruption; and SIB = Self-Injurious Behavior.

Table 2

Functional Analysis Results

Case	Application	Test	Control	Function
1	1	1.1	0.2	Escape
1	2	1.1	0.2	Escape
2	3	0.9	0.5	Escape
2	4	0.9	0.5	Escape
3	5	0.2	0.1	Inconclusive
4	6	48.3	10.5	Automatic; S1
5	7	4.2	2.2	Automatic; S2
6	8	1.1	0.1	Tangible
7	9	1	0.2	Attention
7	10	1	0.2	Attention
7	11	1.2	0.2	Escape
8	12	1.1	1.8	Automatic; S1
9	13	1.3	0.1	Automatic
9	14	1.3	0.1	Automatic
10	15	0.1	0	Social/Auto
11	16	10.9	6.1	Automatic; S2
12	17	11.4	0.4	Attention
12	18	11.4	0.4	Attention
13	19	54	0	Automatic; S1
14	20	36.1	2.5	Attention
15	21	2.07	-	Automatic
16	22	1.4	0.4	Escape
17	23	0.9	0	Inconclusive
18	24	1.9	0	Automatic
19	25	10.4	0.2	Attention
20	26	0.8	0	Tangible
21	27	4.7	0.4	Tangible

Note. Results reported as responses per min. The test condition represents the relevant condition as indicated in the final column. S1 and S2 indicate automatically maintained SIB Subtypes 1 and 2, respectively in cases for which subtype was identified.

Table 3

NCR Treatment Analysis Results for All Applications

			NCR Treatment Analysis								
Case	Application	Function	Design	NCR w/ EXT	NCR w/o EXT	NCR+ST	NCR+Alt SR	NCR+Alt SR + ST	NCR+PUN	NCR+PUN + ST	NCR+OTHER
1	1	Escape	ABAB	-	100	-	-	-	-	-	-
1	2	Escape	ABAB	-	95.9	-	-	-	-	-	-
	3	Escape	ABABAB	74.9	-	91.1[*]	-	-	-	-	-
2	4	Escape	ABABABCBC	95.6	-	84.3	99.3	94[*]	-	-	-
3	5	Inconclusive	ABAB	-	100	-	-	-	-	-	-
4	6	Automatic	ABAB	-	97.3[^]	-	-	-	-	-	-
5	7	Automatic	ABCDBD	-	−119.6[^]	-	−93.8	-	94.8[*]	-	-
6	8	Tangible	ABAB	100	-	100[*]	-	-	-	-	-
7	9	Attention	ABAB	100	-	-	-	-	-	-	-
7	10	Attention	ABAB	100	-	-	-	-	-	-	-
7	11	Escape	ABAB	-	100	-	-	-	-	-	-
8	12	Automatic	Multiple BL	-	26.3[^]	-	-	-	90.6[*]	-	-
9	13	Automatic	ABABEBDBD	-	30.6[^]	-	-	-	95.9	97.1[*]	77.7
9	14	Automatic	ABAB	-	73.9[^]	-	-	-	-	-	-
10	15	Social/Auto	ABABDAD	-	68.6[^]	-	-	-	96.9[*]	-	-
11	16	Automatic	ABABDAD	-	49.5[^]	-	-	-	96.2[*]	-	-
12	17	Attention	ABAB	91.8[^]	-	-	-	-	-	-	-
12	18	Attention	ABAB	81.6[^]	-	-	-	-	-	-	-
13	19	Automatic	BAB	-	100[^]	-	-	-	-	-	-
14	20	Attention	ABABCAC	96.6	-	90.7	99.2	100[*]	-	-	-
15	21	Automatic	ABAB	-	93.4[+]	-	-	-	-	-	-
16	22	Escape	ABAB	100	-	-	-	-	-	-	-
17	23	Inconclusive	ABAB	-	93.1[^]	-	-	-	-	-	-
18	24	Automatic	Multielement	-	96.4[+]	-	-	-	-	-	-

			NCR Treatment Analysis								
Case	Application	Function	Design	NCR w/ EXT	NCR w/o EXT	NCR+ST	NCR+Alt SR	NCR+Alt SR + ST	NCR+PUN	NCR+PUN + ST	NCR+OTHER
19	25	Attention	ABABCE	99.1	-	-	100	67.9	-	-	95.8*
20	26	Tangible	ABAB	100	-	100*	-	-	-	-	-
21	27	Tangible	BABAB	98.2	-	-	-	-	-	-	-

Note. A = Baseline; B = NCR with or without EXT; C = Alt SR; D = PUN; R = OTHER. All reported outcomes represent the percentage reduction in problem behavior during treatment relative to baseline. For cases with automatically maintained SIB, NCR with and without RB data are included in the NCR w/ EXT column due to the inability to identify the reinforcer of problem behavior. *ST* = schedule thinning; *Alt SR* = another reinforcement schedule; *PUN* = punishment; *OTHER* = some other treatment component (see text);

* indicates the final treatment package;

^ indicates NCR w/ RB;

+ indicates NCR w/o RB.

Table 4

Summary of Procedures for Applications in Which Schedule Thinning Was Implemented

Application	Initial Condition	ST Method	Terminal Schedule	Additional Components	ST Method	Terminal Schedule
3	NCR	Demand Fading	20 demands	-	-	-
4	NCR	Demand Fading	20 demands	Alt SR	Concurrent	20 demands FR2 DRA
8	NCR	Increasing FT	7 minutes	-	-	-
13	NCR + PUN	Increasing FT	5 minutes	-	-	-
20	NCR	Increasing FT	3 minutes	Alt SR	Increasing FT	10 minutes
25	NCR + Alt SR	Increasing FT	1.5 minutes	-	-	-
26	NCR	Increasing FT	2 minutes	-	-	-

Note. Initial Condition indicates the treatment in place when schedule thinning (ST) was first attempted; Demand Fading = increasing the number of prompts given prior to reinforcement; Increasing FT = increasing the amount of time between reinforcer deliveries; Concurrent = introducing a multiple schedule.

Table 5

Summary of Outcomes by Operant Function

Function	*n*	Application	NCR w/ EXT	NCR w/o EXT	NCR+ ST	NCR+ Alt SR	NCR+ Alt SR+ ST	NCR+ PUN	NCR+ PUN + ST	NCR+ OTHER
Automatic	9	6, 7, 12–14, 16, 19, 21, 24	-	63.0*	-	-	-	94.4	97.1	77.7
All Social	15	1–4, 8–11, 17, 18 20, 22, 25–27	94.8*	98.6	93.2	99.5	87.3	-	-	95.8
Escape	6	1–4, 11, 22	90.2	98.6	87.7	99.3	94	-	-	-
Tangible	4	8, 26, 27	99.6	-	100	97.3	96.3	90.4	90.4	66.4
Attention	6	9, 10, 17, 18, 20, 25	94.9	-	90.7	99.6	84	-	-	95.8
Inconclusive/Both	3	5, 15, 23	99.4	100	-	-	-	-	-	-

Note. All reported outcomes represent the percentage reduction in problem behavior during treatment relative to baseline.