Research in Developmental Disabilities 30 (2009) 44–57

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Review

Noncontingent reinforcement is an empirically supported treatment for problem behavior exhibited by individuals with developmental disabilities

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ARTICLE INFO

Article history:
Received 27 February 2008
Accepted 3 March 2008

Keywords:
Noncontingent reinforcement
Empirically supported treatments
Problem behavior
Developmental disabilities
Functional assessment
Fixed-time schedules

ABSTRACT

Noncontingent reinforcement (NCR) is a function-based treatment for problem behavior that has produced robust effects across a variety of response topographies and reinforcement functions among individuals with developmental disabilities. Several narrative reviews have adequately described this literature. The purpose of the present article was to quantitatively analyze and classify the empirical support for NCR using the criteria developed by The Task Force on the Promotion and Dissemination of Psychological Procedures [Task Force Promoting Dissemination of Psychological Procedures. (1995). Training in and dissemination of empirically-validated psychological treatments: Report and recommendations. *Clinical Psychology*, *48*, 3–23]. Of the 59 studies identified for analysis, 24 met the criteria to be included in treatment classification. Fixed-time reinforcer delivery (plus extinction and schedule thinning) was classified as *well established*, while fixed-time reinforcer delivery (plus extinction) and variable-time reinforcer delivery (plus extinction) were deemed *probably efficacious*.

Contents

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0891-4222/$ – see front matter
doi:10.1016/j.ridd.2008.03.002

Individuals with developmental disabilities often exhibit marked impairments in a variety of areas including communication, social behavior, self-care skills, and sensory-motor functioning. These deficits may limit an individual's ability to meet his or her basic needs, secure employment, develop friendships, engage in a variety of leisure activities, and communicate with others. The occurrence of problem behavior is also common among individuals in this population, and may further impede the development of appropriate behavioral repertoires (Bodfish, Crawford, Powell, Golden, & Lewis, 1995; Bodfish, Symons, Parker, & Lewis, 2000). For example, individuals with severe mental retardation who display aggressive or self-injurious behavior (SIB) display more impaired social skills than those who do not engage in such behavior (Duncan, Matson, Bamburg, Cherry, & Buckley, 1999). Some topographies of problem behavior can even be life threatening. Pica, the ingestion of inedible objects, for example, is common among institutionalized or severely impaired individuals and poses a serious health risk (Matson & Bamburg, 1999).

It is well recognized that many problem behaviors of individuals with developmental disabilities are products of operant conditioning (Carr, 1977). Hanley, Iwata, and McCord (2003) conducted a review of 277 studies employing functional analysis of problem behavior and identified three common operant functions: social-negative reinforcement (89.2% of studies), social-positive reinforcement (85.6%), and automatic reinforcement (59.6%). Research has shown that matching the reductive treatment to the function (e.g., attention, escape from instruction) rather than the topography (e.g., aggression, SIB) of problem behavior results in superior outcomes (e.g., Iwata, Pace, Cowdery, & Miltenberger, 1994). As such, the use of functional assessment prior to selecting reductive treatments has become the standard of care for reducing problem behavior of individuals with developmental disabilities (National Institutes of Health, 1989).

Noncontingent reinforcement (NCR) is a function-based treatment for problem behavior with a large body of research supporting its use with individuals with developmental disabilities (Carr et al., 2000; Carr & LeBlanc, 2006). The implementation of NCR involves identifying the reinforcer maintaining problem behavior and delivering that reinforcer independent of the occurrence of the behavior. During NCR, individuals receive free access to reinforcers that were once delivered contingent on problem behavior, which often results in a rapid and robust treatment effect (e.g., Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Noncontingent reinforcement has been used to treat problem behavior maintained by various reinforcement functions, including escape from instructional demands (O'Callaghan, Allen, Powell, & Salama, 2006), attention (Hanley, Piazza, & Fisher, 1997), access to tangibles (Hagopian, Wilson, & Wilder, 2001), and automatic reinforcement (Roane, Kelly, & Fisher, 2003), as well as problem behavior with multiple reinforcement functions (Kodak, Miltenberger, & Romaniuk, 2003). Additionally, NCR has also been demonstrated to be efficacious across various response topographies including SIB (Vollmer et al., 1993), aggression (Lalli, Casey, & Kates, 1997), stereotypy (Britton, Carr, Landaburu, & Romick, 2002), pica (Piazza et al., 1998), elopement (Piazza et al., 1997), disruption (Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996), and bizarre speech (Lancaster et al., 2004). When included in treatment packages, NCR has also bolstered the efficacy of other treatments, such as extinction (Vollmer et al., 1998), functional communication training (FCT) (Hagopian et al., 2001), and response cost (Falcomata, Roane, Hovanetz, Kettering, & Keeney, 2004).

In addition to its generality and apparently robust effects, NCR offers a number of other benefits. First, NCR reduces the likelihood of extinction-induced side effects (e.g., extinction bursts) compared to other effective procedures such as differential reinforcement of zero rates of behavior (DRO; Vollmer et al., 1993) and extinction (Vollmer et al., 1998). The decreased probability of these effects under NCR is noteworthy because NCR disrupts the response–reinforcer relation, similar to extinction. Second, NCR may be easier to implement than some other reductive procedures such as DRO (Vollmer et al., 1993), although this has yet to be confirmed empirically. Third, NCR has been associated with increases in appropriate behavior (Coleman & Holmes, 1998; Kodak et al., 2003; Roane, Fisher, & Sgro, 2001). The evidence supporting the general efficacy of NCR in the functional treatment of diverse behavior problems, along with its other advantages make it an ostensibly useful clinical intervention.

In recent years, there has been a movement in clinical psychology towards the use of empirically supported treatments (ESTs), defined by Chambless and Hollon (1998), as "clearly specified psychological treatments shown to be efficacious in controlled research with a delineated population" (p. 7). This movement has been designed to: (a) improve clinical practice, (b) influence graduate training, and (c) inform policy makers (Chambless & Ollendick, 2001). The Task Force on the Promotion and Dissemination of Psychological Procedures (1995) of Division 12 of the American Psychological Association (henceforth referred to as the Division 12 Task Force) developed criteria for determining whether a body of literature supports the use of particular psychological interventions with specific populations, and identified three categories of treatment based on supporting evidence: (a) well established, (b) probably efficacious, and (c) experimental (Chambless & Hollon, 1998; Chambless & Ollendick, 2001). Although the Division 12 Task Force outlined specific criteria for acceptable group and single-case experimental designs, all of the NCR studies reviewed in this article utilized single-case experimental designs; therefore, only criteria relevant to these designs are described in this article.

Treatments with the highest level of evidence are deemed *well established*. These treatments are supported by a large body of evidence (9 or more studies) demonstrating efficacy when the treatment is found superior compared to another treatment or no treatment via an accepted experimental design (e.g., reversal, multiple baseline). In addition to these criteria, researchers must utilize manualized treatments or clearly operationally define independent variables and adequately describe the characteristics of their samples. Effects in a single-case experimental design are determined visually through graphic analysis, and therefore a careful examination of visually depicted data is required to determine whether substantial differences exist between conditions. Finally, successful treatment effects must be replicated by at least two independent investigators or teams (Chambless & Hollon, 1998; Chambless & Ollendick, 2001).

Treatments classified as *probably efficacious* have less supporting evidence than treatments that are considered well established. In order for a treatment to be considered probably efficacious, the Division 12 Task Force requires 3–8 studies that meet all of the criteria for well-established treatments. A treatment that is classified as probably efficacious may later be classified as well established if more evidence becomes available. If a treatment has yet to acquire a body of research that meets criteria for classification as well established or probably efficacious, it is considered *experimental* (Chambless & Ollendick, 2001).

Using the Division 12 Task Force criteria, Chambless and Ollendick (2001) generated a list of treatments that have been deemed well established, including cognitive behavior therapy to treat adults with agoraphobia, exposure and response prevention to treat adults with obsessive-compulsive disorder, and behavioral parent training to treat attention-deficit/hyperactivity disorder (ADHD) in children. Although clearly useful, this list of empirically supported treatments is not exhaustive, and several authors have begun to review other literatures to identify additional well-established or probably efficacious treatments. For example, Kerwin (1999) identified two well-established treatments for children with severe feeding problems. Positive reinforcement of independent and appropriate feeding responses combined with ignoring inappropriate response or refusals (i.e., differential attention) was classified as well established for most feeding problems. Differential reinforcement plus manual guidance was classified as well established for total food refusal, while escape extinction and swallow induction were found to be probably efficacious. Mindell (1999) conducted a similar review of treatments for bedtime refusal and night wakings in children and classified two treatments, extinction and parent education on sleep hygiene, as well established, while two other treatments, graduated extinction and scheduled wakings, were classified as probably efficacious.

Although three narrative literature reviews report that NCR produces reliable and robust reductions in problem behavior of individuals with developmental disabilities (Carr et al., 2000; Carr & LeBlanc, 2006; Tucker, Sigafoos, & Bushell, 1998), an analysis of the NCR literature using Division 12 Task Force criteria has not yet been conducted. Therefore, the purpose of the present article was to quantitatively analyze and classify the empirical support for NCR to better inform practitioners and policy makers involved in selecting or approving treatments for individuals with developmental disabilities.

1. Method

1.1. Article identification

A search of the literature was conducted to identify articles in which NCR was implemented as a treatment for problem behavior exhibited by individuals with developmental disabilities. The PsycINFO, ERIC, Medline, and *Journal of Applied Behavior Analysis*[1] databases were searched using the following descriptors: noncontingent reinforcement, fixed time, variable time, problem behavior, autism, and developmental disabilities. In addition, ancestral searches of recent literature reviews of NCR (Carr et al., 2000; Carr & LeBlanc, 2006) were conducted. From these initial searches, 325 articles were identified. Articles were excluded if (a) NCR was not used as a treatment for problem behavior (e.g., NCR was used as a control procedure), (b) participants were not diagnosed with a developmental disability, or (c) NCR was implemented as part of a treatment package with an intervention other than extinction (e.g., NCR + response blocking). Fifty-nine articles remained for coding.

1.2. Coding categories

Each of the 59 articles was coded using the following categories. Some of the categories were applied to each participant within a study (e.g., age, sex, diagnosis) whereas other categories were applied to the study as a whole (e.g., interobserver agreement).

1.2.1. Participant characteristics

The participant pseudonym or code number, age, sex, and diagnosis were recorded for each study. When multiple diagnoses were provided, only the first three were coded. These variables were coded for each participant.

1.2.2. Setting

The study's setting was coded as home, residential facility, school, outpatient treatment program, or inpatient treatment program. This variable was coded for each participant.

[1] *Journal of Applied Behavior Analysis* was included in the search because previous literature reviews have shown that the majority of research on NCR has been published there.

1.2.3. Dependent measures

Based on the descriptions of the *treated* behaviors in each article, problem behaviors were assigned to the following topographical categories: stereotypic behavior, SIB, aggression, property destruction, disruptive behavior, object mouthing, inappropriate vocalizations, and noncompliance. This variable was coded for each participant.

1.2.4. Interobserver agreement

Interobserver agreement (IOA) was deemed acceptable if average agreement between two individual observers was at least 80% (Hartmann, 1997; Page & Iwata, 1986) across at least 20% of sessions (Cooper, Heron, & Heward, 1987). This variable was coded for each participant.

1.2.5. Functional analysis

The presence of a functional analysis was coded if the author(s) stated that an experimental functional analysis was conducted for a participant and the function of the behavior was reported, even if quantitative results were omitted. No functional analysis was coded if a functional analysis was not conducted or if another functional assessment method (e.g., descriptive assessment) was used. This variable was coded for each participant.

1.2.6. Behavioral function

If a functional analysis was conducted, the identified function(s) of each *treated* problem behavior was coded as attention, escape, tangible, or automatic reinforcement. This variable was coded for each participant.

1.2.7. Functionality of treatment

Each treatment was coded as functional if it matched the identified function of behavior. For example, if a functional analysis indicated that a problem behavior was maintained by attention, then the fixed-time delivery of attention would be considered a functional treatment, whereas the fixed-time delivery of tangible items would not. This variable was coded for each participant.

1.2.8. Experimental design

The experimental design used to evaluate each NCR implementation was coded as an alternating treatments design (ATD), a reversal design, or a multiple baseline design (across participants, settings, or behaviors). If two designs were used in combination (e.g., an ATD embedded in a reversal design), then both were coded. Each treatment-evaluation graph was visually inspected to determine whether functional control was demonstrated based on the requirements of the experimental design. These variables were coded for each participant.

1.2.9. Comparison condition

A brief description of the condition against which NCR was compared was coded for each participant (e.g., tangible condition from functional analysis).

1.2.10. NCR treatment

Each NCR treatment was coded as one of the following: fixed time (FT), fixed time with schedule thinning (FTST), fixed time plus extinction (FT + EXT), fixed time with schedule thinning plus extinction (FTST + EXT), variable time (VT), variable time with schedule thinning (VTST), variable time plus extinction (VT + EXT), and variable time with schedule thinning plus extinction (VTST + EXT). Treatments that utilized yoked schedules of reinforcer delivery were coded as VT schedules.

1.2.11. Schedule thinning

The method used to thin NCR schedules was coded, and the initial and terminal values were noted. When schedule thinning was not conducted, the sole value of the reinforcement schedule was noted (e.g., FT 20 s). This variable was coded for each participant.

1.2.12. Treatment effect

The treatment effect was analyzed by visually inspecting each graph. If the implementation of treatment resulted in a clear decrease in problem behavior relative to the comparison condition, the treatment was coded as effective. This variable was coded for each participant.

1.2.13. Effect size

To quantify effective treatment outcomes, two measures of effect size were calculated for each data set: the percentage of nonoverlapping data (PND) and mean baseline reduction (MBLR). The PND was determined by calculating the percentage of data points in a treatment condition below the lowest baseline data-point value. The MBLR was calculated by subtracting the mean of the treatment data-point values from the mean of the baseline values, dividing the difference by the baseline mean, and multiplying the quotient by 100.

A software program was used to obtain the data-point values from each graph. For reversal designs, data from the last replication of the baseline and treatment phases were used to calculate effect sizes. When an alternating treatment design was used, NCR data and the corresponding baseline data path were used to calculate the effect sizes. For a multiple-baseline design across participants, the baseline and treatment data for each participant were used to generate an effect size for each demonstration of the NCR treatment. If a multiple-baseline design across some other dimension (e.g., settings, behaviors) was utilized, the baseline and treatment data from the final panel were used to calculate effect sizes. Both PND and MBLR were calculated for each participant's data set.

1.2.14. Use of clearly defined treatments

Studies were coded for the use of a treatment manual to guide the treatment or whether a clear description of the treatment was provided.

1.2.15. Procedural fidelity

Studies were coded according to whether data were collected on the accuracy of the implementation of the independent variable. This variable was coded for each study.

1.2.16. Social validity

Studies were coded for the use of social validity assessment (i.e., treatment acceptability, meaningfulness of behavior change). This variable was coded for each study.

1.3. Efficacy classification

If schedule thinning was implemented during NCR treatment, the study was placed into one of the schedule thinning categories (e.g., FTST); however, in some instances the same treatment *without* schedule thinning (e.g., FT) had been implemented in a prior condition for the same participant. For such cases, PND and MBLR were calculated based on data from both NCR conditions (with and without schedule thinning); however, only the NCR condition that contained schedule thinning was used in the primary empirical-support analysis. Table 1 summarizes the results of the study and participant categorization by noting the formal count for each category of treatment along with parenthetical data that include the total number of implementations of a treatment, including those that were implemented prior to schedule thinning.

Some participants were counted multiple times within the same category if they were exposed to more than one treatment. For example, in some cases problem behavior was maintained by multiple functions (e.g., attention, tangibles). One treatment may have successfully reduced problem behavior by addressing one of the behavior functions (e.g., FT attention), and the same treatment addressing a different function (e.g., FT tangible) may have been equally effective. In this case, two demonstrations for the same treatment were counted, although they were implemented with the same participant. Therefore, even though data from 49 different participants were analyzed, the total number of participant data sets reflected is higher (53).

After the aforementioned coding was completed, the data were further analyzed and additional inclusionary and exclusionary criteria were applied to determine whether a data set for a given

Table 1
Number of studies and participants for each NCR treatment category

NCR category	Number of published studies	Number of participants
Fixed time (FT)	2 (3)	5 (7)
Fixed time with schedule thinning (FTST)	1	2
Fixed time + extinction (FT + EXT)	7 (12)	14 (28)
Fixed time + extinction with schedule thinning (FTST + EXT)	11	25
Variable time (VT)	0	0
Variable time with schedule thinning (VTST)	0	0
Variable time + extinction (VT + EXT)	3	7
Variable time + extinction with schedule thinning (VTST + EXT)	0	0

Note. Parenthetical data represent studies or participants for which the treatment was successfully implemented prior to schedule thinning.

participant provided empirical support for the use of NCR as a treatment for problem behavior within a particular study. NCR is most often considered a function-based treatment (Carr & LeBlanc, 2006); therefore, participant data were included when the function(s) of the treated behavior was clearly identified through the use of experimental functional analysis. Participant data were excluded when behavior function was unidentified, the treatment did not match behavioral function, or when an automatic reinforcement function was identified. Treatments based on automatic reinforcement were excluded from the analysis due to the difficulty in determining whether the stimulus delivered during NCR actually maintained problem behavior.

The Division 12 Task Force criteria require use of "good" research designs for studies to be considered supportive of treatment efficacy. Chambless and Hollon (1998) indicated that well-controlled single-case designs such as reversal designs and multiple-baseline designs across three behaviors, settings, or participants are acceptable experimental designs for demonstrating treatment efficacy. However, multiple-baseline designs (across two behaviors, settings, or participants) were also considered acceptable for the present analysis because this design variation sufficiently controls for relevant threats to internal validity (Cooper et al., 1987). In addition to the reversal and multiple-baseline designs, Horner, Carr, McGee, Odom, and Wolery (2005) advocate the use of ATDs, which also sufficiently controlled for threats to internal validity. Thus, data sets were included in the present analysis only when reversal, multiple-baseline, or ATDs were used.

After the aforementioned criteria had been applied to each study, 24 studies in which at least one participant's evaluation met our standards remained for efficacy classification. Treatments were classified as *well established* when they were supported by at least 9 studies containing at least one demonstration of treatment efficacy, while treatments supported in the same manner by 3–8 studies were classified as *probably efficacious*. Treatments that lacked the evidence necessary to be included in the above categories were classified as *experimental*.

1.4. Inter-coder agreement

Point-by-point agreement (# of agreements/[# of agreements + disagreements]) was calculated to assess agreement between coders. An agreement was defined as both coders recording the same feature (e.g., diagnosis) for a study. Agreement was assessed for 30 (50.8%) of the 59 studies and was 99.4%. All discrepancies were examined and resolved before final codes were applied.

2. Results

Forty-nine participants out of 58 (84.5%) who engaged in problem behavior were successfully treated with at least one of the NCR treatments. The number of participants treated with each type of NCR treatment is depicted in Table 1. The other nine participants (15.5%) who engaged in problem behavior were treated with a treatment other than NCR. Unless otherwise noted, the following results are based on the 49 participants who were treated using NCR.

The mean age of the participants was 18.1 years (range 3–56); 42.9% of participants were female and 57.1% were male. Most participants (81.6%) were diagnosed with mental retardation, and 32.7%

Table 2
Studies that evaluated fixed-time (FT) schedules

Study	Participant	Topography	Function	Treatment	MBLR	PND
Fisher et al. (1999)	Lynn	Aggression, property destruction, SIB	Attention	FT (lean)[a]	32.2	14.3
Fisher et al. (1999)	Lynn	Aggression, property destruction, SIB	Attention	FT (dense)[a]	88.6	71.4
Fisher et al. (1999)	Matt	Aggression	Attention	FT (lean)[a]	65.5	100
Fisher et al. (1999)	Matt	Aggression	Attention	FT (dense)[a]	90.0	100
Hagopian, Crockett, et al. (2000) and Hagopian, LeBlanc, et al. (2000)	Jack	Aggression	Tangible	FT[b]	100	100
Hagopian, Crockett, et al. (2000) and Hagopian, LeBlanc, et al. (2000)	Rex	Aggression	Tangible	FT[b]	100	100
Piazza et al. (1997)	Owen	Elopement	Tangible	FT	100	100

[a] Two different treatments were implemented for the same participant within the same study (e.g., dense FT vs. lean FT).

[b] The treatment, with and without schedule thinning, was efficacious for a given participant.

Table 3
One study that evaluated fixed-time schedules plus schedule thinning (FTST)

Study	Participant	Topography	Function	MBLR	PND
Hagopian, Crockett, et al. (2000) and Hagopian, LeBlanc, et al. (2000)	Jack	Aggression	Tangible	69.2	85
Hagopian, Crockett, et al. (2000) and Hagopian, LeBlanc, et al. (2000)	Rex	Aggression	Tangible	85.2	100

were diagnosed with autism or pervasive developmental disorder (PDD). The most commonly treated topographies of problem behavior were SIB (55.1% of participants) and aggression (51.0%), followed by disruptive behavior (20.4%), property destruction (10.2%), and inappropriate vocalizations (6.2%). The most common behavioral functions were attention (59.2%), tangible (34.7%), and escape (16.3%). Sessions were most often conducted in an inpatient (51.0%), outpatient (32.7%), or school setting (16.3%). The reversal design was the most frequently used experimental design (32.7%), followed by the multiple-baseline design (28.6%), and the reversal design with an embedded ATD (24.5%). Sufficient IOA was reported for each of the 24 studies, whereas treatment integrity was only reported in 20.8% of studies. None of the studies reported social validity assessment.

Thirteen (54.1%) of the 24 studies implemented schedule thinning, with a mean initial value of FT 34.8 s (range 10–120 s) and a mean terminal value of FT 292.2 s (range 45–720 s). The results of the effect size calculations for each treatment are reported in Tables 2–6, along with the treatment category, behavioral function, and topography of the behaviour for each participant. Some participants are listed more than once due to multiple successful demonstrations of an NCR treatment for the same participant, and the specific MBLR and PND indices are presented for each demonstration.

2.1. *Efficacy classification*

The FTST + EXT treatment was deemed *well established*, with 11 studies demonstrating its efficacy with 25 participants (see Table 5). The mean initial schedule value of these treatments was FT 33.4 s (range 10–120 s) and the mean terminal value was FT 311.7 s (range 60–720 s). The mean PND and MBLR values for FTST + EXT treatments were 70.7 (S.D. = 38.1) and 85.1 (S.D. = 16.2), respectively. No studies were identified that employed VTST + EXT treatments; however, given the procedural and functional similarities between VTST + EXT and FTST + EXT treatments (Carr, Kellum, & Chong, 2001; Van Camp, Lerman, Kelley, Contrucci, & Vorndran, 2000), there is reason to believe that VTST + EXT is an efficacious treatment for problem behavior of individuals with developmental disabilities.

The FT + EXT treatment was deemed *probably efficacious*, with 8 studies demonstrating its efficacy with 15 participants (see Table 4). The mean schedule value of these treatments was FT 56.5 s (range 10–300 s). The mean PND and MBLR values for FT + EXT treatments were 66.7 (S.D. = 39.3) and 78.6 (S.D. = 20.9), respectively. In addition to the 8 studies used to support FT + EXT for the efficacy classification, four studies employing FTST + EXT treatments contained successful implementations of

Table 4
Studies that evaluated fixed-time schedules plus extinction (FT + EXT)

Study	Participant	Topography	Function	Treatment	MBLR	PND
Britton, Carr, Kellum, Dozier, and Weil (2000)	Victor	Aggression	Attention	FT + EXT[a]	91.4	0
Britton et al. (2000)	Rob	Disruptive behavior	Tangible	FT + EXT[a]	55.4	42.9
Britton et al. (2000)	Todd	SIB	Attention	FT + EXT[a]	95.4	0
Fisher, DeLeon, Rodreguez-Catter, and Keeny (2004)	Carl	Aggression, SIB	Attention	FT + EXT	90.2	71.4
Fisher et al. (2004)	Jill	SIB, aggression, disruptive behavior	Attention	FT + EXT	98.0	100
Fisher et al. (2004)	Katy	SIB, aggression, disruptive behavior	Attention	FT + EXT	92.5	100
Fisher et al. (2004)	Sally	SIB, aggression, disruptive behavior	Attention	FT + EXT	100	0
Fisher et al. (1996)	Mat	Disruptive behavior, aggression	Attention	FT + EXT[a]	92.4	75
Hagopian, Fisher, and Legacy (1994)	Wanda	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (dense)	92.6	200
Hagopian et al. (1994)	Wanda	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (lean)	55.0	100
Hagopian et al. (1994)	Laurie	SIB, Aggression, disruptive behavior	Attention	FT + EXT[a,b] (dense)	94.5	100
Hagopian et al. (1994)	Laurie	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (lean)	89.1	0
Hagopian et al. (1994)	Lynn	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (dense)	98.7	100
Hagopian et al. (1994)	Lynn	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (lean)	85.7	77.8
Hagopian et al. (1994)	Glenda	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (dense)	97.9	66.7
Hagopian et al. (1994)	Glenda	SIB, aggression, disruptive behavior	Attention	FT + EXT[a,b] (lean)	40.4	18.8
Hanley, Piazza, and Fisher (1997)	Rick	Aggression, property destruction	Attention	FT + EXT[b]	86.3	66.7
Hanley, Piazza, and Fisher (1997)	Rick	Aggression, property destruction	Tangible	FT + EXT[b]	98.9	100
Hanley, Piazza, and Fisher (1997)	Hank	Aggression, SIB	Attention	FT + EXT[b]	68.1	78.9
Hanley, Piazza, and Fisher (1997)	Hank	Aggression, SIB	Tangible	FT + EXT[b]	72.7	83.3
Lalli, Mace, Livezey, and Kates (1998)	Val	SIB	Attention	FT + EXT[a]	83.7	85.7
Lancaster et al. (2004)	Participant 1	Inappropriate vocalizations	Attention	FT + EXT	73.2	100
Lancaster et al. (2004)	Participant 3	Inappropriate vocalizations	Attention	FT + EXT	85.2	100
Mace, Shapiro, and Mace (1998)	Kerry	SIB	Tangible	FT + EXT	49.7	0
Marcus and Vollmer (1996)	Rob	Aggression	Tangible	FT + EXT	70.6	83.3
O'Reilly, Lancioni, and Taylor (1999)	Rick	Aggression	Attention	FT + EXT	83.2	96.7
Van Camp et al. (2000)	Roger	Aggression	Tangible	FT + EXT[b]	66.5	85.7
Vollmer, Ringdahl, Roane, and Marcus (1997)	Emily	Aggression	Tangible	FT + EXT[a]	83.8	100

[a] The treatment, with and without schedule thinning, was efficacious for a given participant.

[b] Two different treatments were implemented for the same participant (e.g., dense FT + EXT vs. lean FT + EXT).

Table 5
Studies that evaluated fixed-time schedules plus extinction and schedule thinning (FTST + EXT)

Study	Participant	Topography	Function	MBLR	PND
Britton et al. (2000)	Victor	Aggression	Attention	81.4	33.3
Britton et al. (2000)	Rob	Disruptive behavior	Tangible	95.5	100
Britton et al. (2000)	Todd	SIB	Attention	89.5	100
Carr and Britton (1999)	Christian	Inappropriate vocalizations	Attention	55.1	77.8
Fisher et al. (1996)	Mat	Disruptive behavior	Attention	99.9	100
Hagopian et al. (1994)	Glenda	SIB, aggression, disruptive behavior	Attention	96.5	0
Hagopian et al. (1994)	Laurie	SIB, aggression, disruptive behavior	Attention	88.6	8.5
Hagopian et al. (1994)	Lynn	SIB, aggression, disruptive behavior	Attention	95.9	97.9
Hagopian et al. (1994)	Wanda	SIB, aggression, disruptive behavior	Attention	88.4	98.0
Hagopian, Toole, Long, Bowman, Lieving, and (2004)	Jason	Aggression, property destruction	Tangible	29.3	86.7
Kahng, Iwata, Thompson, and Hanley (2000)	Julia	SIB	Attention	99.8	100
Kahng et al. (2000)	Matt	SIB	Tangible	93.2	100
Kahng et al. (2000)	Susan	SIB, aggression	Attention	68.5	91.7
Lalli et al. (1997)	Donny	Aggression	Tangible	78.3	73.8
Lalli et al. (1997)	Harry	SIB	Tangible	73.1	0
Lalli et al. (1997)	Tony	SIB	Tangible	84.3	0
Lalli et al. (1998)	Val	SIB	Attention	95.3	100
Vollmer et al. (1993)	Bonnie	SIB	Attention	68.7	83.3
Vollmer et al. (1993)	Brenda	SIB	Attention	96.5	96.9
Vollmer et al. (1993)	Diane	SIB	Attention	84.4	85.3
Vollmer, Marcus, and Ringdahl (1995)	Kevin	SIB	Escape	75.7	73.0
Vollmer et al. (1995)	Mark	SIB	Escape	91.5	85.2
Vollmer et al. (1998)	Dana	Aggression	Escape	89.8	95.2
Vollmer et al. (1998)	Matthew	Aggression	Escape	100	0
Vollmer et al. (1998)	Alan	Disruptive behavior	Attention	93.0	93.8

FT + EXT in phases prior to schedule thinning for 13 additional participants, indicating that FT + EXT is most likely as efficacious as FTST + EXT.

The VT + EXT treatment was deemed *probably efficacious*, with three studies demonstrating its efficacy with seven participants (see Table 6). In two studies, the NCR schedule was yoked to a previous FCT condition, such that each participant received the same number of reinforcers in both the NCR and FCT conditions. In the third study, the initial NCR schedule for both participants was VT 30 s and the terminal schedule was 300 s. The mean PND and MBLR values for VT + EXT treatments were 80.9 (S.D. = 35.8) and 81.5 (S.D. = 14.8), respectively.

The FT treatment was classified as *experimental* because only two supporting studies were identified in which FT was implemented for five participants (see Table 2). The mean schedule value of these treatments was FT 100 s (range 20–300 s). The mean PND and MBLR values for FT treatments were 83.7 (S.D. = 32.4) and 82.3 (S.D. = 25.3), respectively. In a third study utilizing FTST, FT was successfully used with two participants prior to schedule thinning. These demonstrations provide

Table 6
Studies that evaluated variable-time schedules plus extinction (VT + EXT)

Study	Participant	Topography	Function	MBLR	PKD
Hanley, Piazza, Fisher, Contrucci, and Maglieri (1997)	Carla[a]	Property destruction	Attention	95.5	66.7
Hanley, Piazza, Fisher, Contrucci, et al. (1997)	Tony[a]	Property destruction	Attention	85.0	100
Kahng, Iwata, Deleon, and Worsdell (1997)	Bob[a]	SIB	Escape	54.1	4.5
Kahng et al. (1997)	Lynn	SIB	Attention	90.5	100
Kahng et al. (1997)	Todd[a]	SIB	Escape	92.7	100
Van Camp et al. (2000)	Roger	Aggression	Tangible	69.5	95.2
Van Camp et al. (2000)	Rachel	SEB, aggression	Tangible	92.7	100

[a] The NCR schedule for these participants was yoked to reinforcement schedules in a previous FCT condition to ensure that an equal number of reinforcers were delivered in each phase.

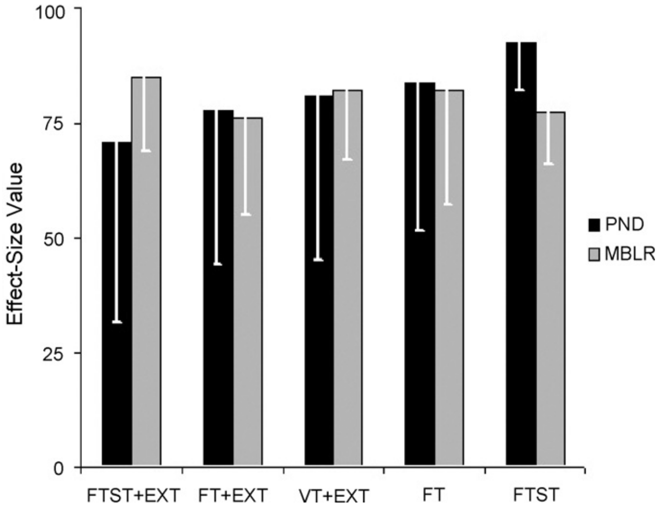

Fig. 1. Percentage of nonoverlapping data (PND) and mean baseline reduction (MBLR) values for each NCR treatment category. Each error bar represents 1 S.D.

additional evidence that would allow FT could be considered *probably efficacious*; however, for the purposes of this review, it remains classified as *experimental*.

The FTST treatment is also considered *experimental* because only one study was identified in which FTST was successfully implemented with two participants (see Table 3). The initial schedule value for both participants was FT 30 s. The terminal schedule values were FT 45 s and FT 50 s. The mean PND and MBLR values for FTST treatments were 92.5 (S.D. = 11.3) and 77.2 (S.D. = 11.3), respectively.

3. Discussion

Of the 59 NCR treatment studies that were analyzed, 24 provided support for NCR as a function-based treatment for problem behavior of individuals with developmental disabilities. Based on the Division 12 Task Force (1995) and Horner et al. (2005) guidelines, FTST + EXT can be classified as a *well-established* treatment, FT + EXT and VT + EXT can be classified as *probably efficacious*, and FT and FTST can be classified as *experimental* treatments at this time. Notably, regardless of their classification, the forms of NCR treatment that were evaluated produced consistently robust effects. Fig. 1 shows that, without exception, average PND and MBLR values were quite high across NCR categories providing evidence of the efficacy of NCR independent of the volume of research on each procedural variation.

Several interesting themes identified during the review are worth mentioning. Categories of NCR without extinction (e.g., FT) had less empirical support than those in which extinction was implemented (e.g., FTST + EXT). Although there were too few studies of NCR without extinction to justify a more supportive classification, the existing research has nonetheless shown positive effects (e.g., Hagopian, Crockett, Van Stone, DeLeon, & Bowman, 2000). This finding is promising because there are circumstances under which NCR without extinction represents an important treatment option. For example, attention-maintained elopement (Piazza et al., 1997) or false medical complaints (Hagopian, Crockett, et al., 2000; Hagopian, LeBlanc, & Maglieri, 2000) would be suitable for NCR without extinction because withholding attention following these responses might be impractical or unethical.

Schedule thinning procedures were implemented in 12 of the 24 (50%) studies after responding had been reduced following a period of continuous or near-continuous reinforcer delivery. Although FTST + EXT was the only treatment that met criteria to be deemed well established, FT + EXT appeared to be a viable treatment option as well because it was successfully implemented prior to each implementation of FTST + EXT. The primary role that schedule thinning plays in NCR treatment is to render the procedure less effortful to implement. The fact that FTST + EXT met the well-established criteria suggests that schedule thinning can accomplish this purpose without compromising the efficacy of NCR.

The present review employed rather stringent inclusion criteria that should be considered when interpreting the conclusions. For example, studies were excluded when an experimental functional analysis was not used to identify the maintaining reinforcers for problem behavior. Some of these studies used other functional assessment methods (e.g., caregiver interviews) to identify behavioral function (Coleman & Holmes, 1998; Goh, Iwata, & Kahng, 1999). These studies were excluded to ensure that the remaining research focused exclusively on *function-based* NCR treatment. The fact that these excluded studies (e.g., Coleman & Holmes, 1998) still reported robust NCR effects adds even further support for the treatment. In addition, only NCR applications for individuals with developmental disabilities were reviewed. The reason for this was not that we believe that NCR might be more or less efficacious with other populations. In fact, NCR has been used successfully with other clinical conditions such as traumatic brain injury (Persel, Persel, Ashley, & Krych, 1997) and ADHD (Jones, Drew, & Weber, 2000). However, a common practice in the EST movement has been to evaluate treatment efficacy for certain populations. One benefit of such a restriction is that it might make it easier to disseminate research syntheses to certain stakeholders (e.g., state developmental disability boards). It is our hope that by focusing the present review on NCR treatment for individuals with developmental disabilities, such dissemination might be facilitated.

Acknowledgements

We thank Clarissa Barnes and Topa Augustine for their assistance with coding.

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