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Systematic Review of Differential Reinforcement of Alternative Behavior Without Extinction for Individuals With Autism

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Abstract

The purpose of this article is to review the literature on differential reinforcement of alternative behavior procedures without extinction for individuals with autism. Using predetermined inclusion criteria, a total of 10 studies were included and summarized in terms of the following: (a) participant characteristics (e.g., sex, age, and diagnosis), (b) treatment setting, (c) problem behavior, (d) function, (e) alternative behavior, (f) intervention, (g) outcomes, and (h) conclusiveness of evidence. Of the 10 studies, nine demonstrated positive effects and one mixed effects. Five studies successfully reduced problem behavior by manipulating different reinforcement parameters (magnitude, immediacy, and quality) and four manipulated the schedule of reinforcement. One study had mixed results with two of the three participants requiring extinction. The findings of this review suggest that variations of differential reinforcement of alternative behavior interventions without an extinction component may be considered promising practices for the treatment of challenging behavior in individuals with autism.

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Individuals with limited verbal repertoires, such as children with autism and developmental disabilities, may engage in problem behavior (e.g., aggression, property destruction, self-injurious behavior; Horner, Carr, Strain, Todd, & Reed, 2002) that limits their access to social communication opportunities and impairs their health and safety. To treat problem behavior, an interventionist must first identify why a behavior is happening (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). Certain environmental variables may maintain behavior and reinforce its occurrence. One method of determining which environmental variables are maintaining variables is through the use of a functional analysis (FA; Hanley, Iwata, & McCord, 2003). FA is an assessment procedure used to identify variables maintaining problem behavior (Beavers, Iwata, & Lerman, 2013). An interventionist conducts an FA by manipulating one environmental variable at a time to identify what evokes the target problem behavior. Once the maintaining variable, or the function, is identified then researchers and practitioners are able to develop a function-based intervention that is individualized to the needs of the participant.

Function-based interventions are the most reliable and effective way to reduce challenging behavior (Arndorfer & Miltenberger, 1993). One of the most common interventions used to treat problem behavior is differential reinforcement of alternative behavior (DRA [differential reinforcement of alternative behavior]; Cooper, Heron, & Heward, 2007). DRA is a procedure in which a functionally equivalent targeted behavior, other than the targeted behavior, is reinforced while reinforcement for problem behavior is withheld (i.e., extinction), minimized, or reinforced on a different schedule. DRA interventions have been demonstrated to be effective with a wide range of diagnoses, topographies, and functions of problem behavior (Lennox, Miltenberger, Spengler, & Erfanian, 1988).

DRA procedures are often used in combination with other interventions (Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997). One such intervention is extinction. Extinction (EXT), combined with a differential reinforcement procedure, involves reinforcement of a behavior other than the target behavior while concurrently removing reinforcement for the target problem behavior (Vollmer & Iwata, 1992). For example, in Lalli, Casey, and Kates' (1995) study, researchers reduced escape-maintained problem behavior by programming reinforcement only after the individual emitted the appropriate communication response (e.g., handing therapist a "BREAK" card) while all problem behavior resulted in continued placement of demands and prompting to complete

the task (i.e., escape extinction). However, sometimes extinction may not be ethical or feasible as it relies on optimal treatment integrity (Fisher, Piazza, Cataldo, & Harrell, 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998) across all contexts and implementers.

Previous research has identified many negative impacts of extinction treatment integrity failures on behavioral outcomes (e.g., Lerman, Iwata, & Wallace, 1999; Northup, Fisher, Kahng, Harrell, & Kurtz, 1997; St. Peter Pipkin, Vollmer, & Sloman, 2010; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). For example, St. Peter Pipkin et al. (2010) examined the effects of two types of treatment integrity failures: failure to reinforce appropriate behavior (e.g., omission) and reinforcing problem behavior (e.g., commission). Researchers found that commission errors in isolation and omission and commission errors in combination resulted in increased problem behavior and decreased appropriate behavior. In addition, a literature review by Lerman and colleagues (1999) investigated two adverse side effects of extinction: an increase in the frequency of the target response (extinction burst) and an increase in aggression (extinction-induced aggression). Researchers examined 41 data sets for individuals treated for self-injurious behavior and found that extinction bursts or increases in aggression occurred in nearly one half of the cases. Treatment integrity becomes especially important when working in a school or home environment as caregivers or educators are often responsible for implementing intervention procedures (Northup et al., 1997). In certain contexts such as a school setting, extinction poses ethical considerations for certain topographies of behavior. For example, if a student engages in severe self-injurious behavior in the classroom and a teacher ignores it, administration and other school personnel are likely to express concern and demand that an intervention other than extinction be put in place.

Current literature is beginning to investigate the use of DRA interventions without extinction. For example, Athens and Vollmer (2010) manipulated different parameters of reinforcement (i.e., immediacy, magnitude, and quality) and programmed reinforcement to favor the alternative behavior while still reinforcing problem behavior. Similarly Marcus and Vollmer (1996) manipulated the schedule of reinforcement where they evaluated noncontingent reinforcement on a fixed time schedule plus DRA without extinction and found positive results. These interventions hold promise and could potentially inform differential reinforcement without extinction interventions for situations when extinction may not be recommended. Therefore, the purpose of this review is to synthesize the recent literature (i.e., last 20 years) regarding differential reinforcement interventions without an extinction component for individuals with autism. A review of this nature is

intended to inform future research and provide guidance for practitioners considering this intervention package.

Method

Search Procedures

Four electronic databases were searched to identify potential studies for this review: ERIC (EBSCO), PsycINFO, PubMed, and SpringerLink. Only articles from the last 20 years (e.g., 1997-2017) were included in this review. Results were limited to English language and peer-reviewed research. Boolean terms included phrases to describe intervention procedures with a differential reinforcement component and without extinction. Search terms included "DRA without extinction," "differential reinforcement of alternative behavior" AND "without extinction," "differential reinforcement" AND "without extinction," and "functional communication training" AND "without extinction." No acronyms were used in the search terms. These search procedures were conducted in September 2016 and yielded a total of 102 articles (see Figure 1). In addition, one article that was known to the authors was included (Kunnavatana, Bloom, Samaha, Slocum, & Clay, in press). The title and abstracts of the 103 articles were screened based on titles and abstracts to identify articles for potential inclusion in this review. During the title–abstract screening, articles were excluded if they (a) mentioned nonhuman subjects, (b) the title indicated that the articles are a literature review or are nonexperimental in nature ("An analysis/review of . . ."), and (c) were completely off topic to the study of interest (e.g., having to do with rocks, etc.). A resulting 66 articles were identified for further review.

Inclusion Criteria

The 66 articles were then downloaded and evaluated based on the preset inclusion criteria. Studies were included if (a) they included at least one participant with an autism diagnosis, (b) it was peer-reviewed and published in English, (c) utilized a DRA intervention with an explanation of how the researchers determined behavioral function(s), (d) measured and reported outcomes for at least one dependent variable pertaining to challenging behavior, and (e) indicated that extinction was not used. Studies satisfied the criterion of having at least one participant with an autism diagnosis if the participant's descriptions stated a specific diagnosis of autism (e.g., autism spectrum disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and Asperger syndrome). The remaining participants from

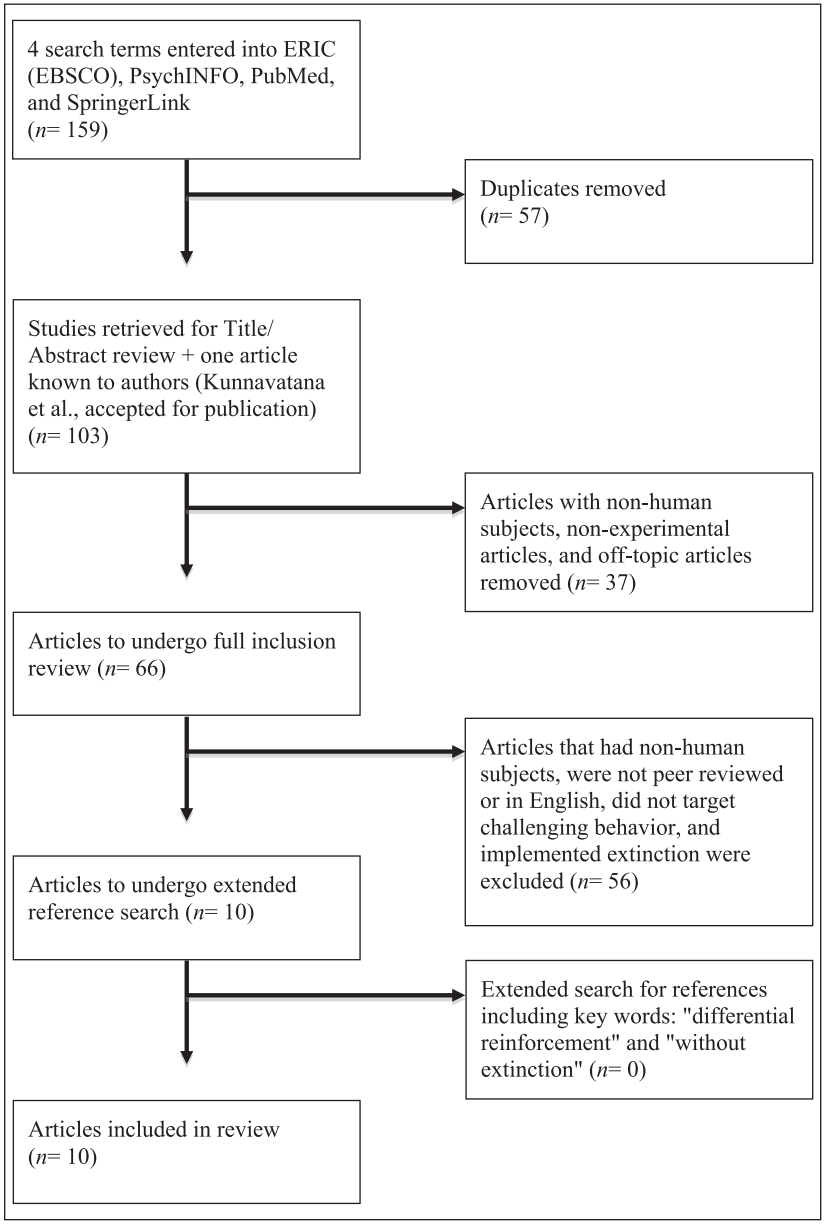

Figure 1. Search procedures.

articles with at least one participant diagnosis of autism were included regardless of diagnosis. Articles were limited to those with at least one participant with autism because there is currently an extensive amount of literature supporting the use of applied behavior analysis to improve and maintain socially significant behaviors in individuals diagnosed with autism spectrum disorder. Studies were determined to have satisfied the criterion of determining behavioral function if the researchers provided results from a functional analysis or indicated a behavioral function based on a functional analysis. Articles that completed a functional behavior assessment without explicit functional analysis results were excluded due to existing research suggesting validity issues with indirect and direct assessments (e.g., Tarbox et al., 2009). After application of these criteria, a total of 10 studies met inclusion criteria and were included in this review. An extended search was conducted including a reference search and resulted in no additional articles.

Descriptive Synthesis

Included studies were reviewed and summarized based on the following categories: (a) participant characteristics (e.g., sex, age, and diagnosis), (b) treatment setting, (c) problem behavior, (d) function, (e) alternative behavior, (f) intervention, (g) outcomes, and (h) conclusiveness of evidence. Participant characteristics included the number of participants, age of participants, and reported diagnosis. Diagnoses were reported based on independent participant diagnoses (e.g., autism only, intellectual disability only, etc.), while participants having more than one diagnosis were coded as having "comorbid diagnoses." Treatment settings were coded as clinic, hospital, or school based on setting description. Target behaviors and alternative behaviors were coded according to the topographies provided in each article, and behavioral functions for each participant were coded according to reported results from the functional analysis. If a participant's target behavior was multiply maintained, it is stated in the table as such. Types of differential reinforcement interventions were coded according to the type of differential reinforcement intervention implemented and any modifications that were made (e.g., DRA + NCR [non-contingent reinforcement] or which parameter of reinforcement was manipulated [schedule, quality, magnitude, immediacy]). Schedule of reinforcement pertains to the rate of which each concurrent schedule contacts reinforcement. Quality of reinforcement is when two concurrent schedules are reinforced with different qualities of reinforcement (e.g., high-preferred item vs. a low-preferred item). When the magnitude of reinforcement is manipulated, each schedule of reinforcement varies depending on how much reinforcement is provided (e.g., 5 s of

attention vs. 30 s of attention). While the immediacy of reinforcement means that the delay to reinforcement is manipulated (e.g., the participant is either reinforced immediately or contacts reinforcement after a certain delay of time).

Although the main purpose of this review is to synthesize the literature, a preliminary review of the quality of the studies was conducted. All the resulting studies utilized single-case research designs. Intervention outcomes were summarized and coded as negative, mixed, or positive based on visual analysis criteria (Kennedy, 2005). The criteria from Kennedy (2005) were chosen to evaluate the single-case research designs over other criteria (such as the What Works Clearinghouse criteria) as the quality ratings are meant to provide initial evidence on the quality of the literature. However, since this literature base is emerging and the focus of this review is to conduct a systematic literature review, a more comprehensive evaluation may be warranted as the literature base develops. According to Kennedy (2005), a study was coded as having negative results if no reduction of baseline problem behavior was observed. Studies were coded as having mixed results if some, but not all, of the participants demonstrated a reduction in problem behavior during the intervention phase relative to the baseline phase. Studies were coded as having positive results if all participants' problem behavior decreased during the intervention phase as compared with the baseline phase. For interventions that implemented a reversal design, the baseline phase was compared with the consecutive intervention phase and the second treatment phase was compared with the second baseline phase. The study's capacity to provide a certainty of evidence was rated as suggestive, preponderant, or conclusive, with conclusive being the highest rating (Schlosser, 2009; Simeonsson & Bailey, 1991; Smith, 1981). Studies that had (a) an experimental design capable of establishing experimental control (e.g., ABAB, multiple-baseline design, alternating treatments design), (b) sufficient interobserver agreement (IOA) collected on the observed behaviors (i.e., agreement coefficients above 80% and IOA collected for a minimum of 20% of the sessions), (c) intervention procedures detailed enough to promote replication of the procedures, (d) operationalized definitions of the dependent variable, and (e) demonstrated positive effects of the intervention for every participant (i.e., received a rating of positive results) were coded as conclusive. A study was coded as preponderant if it met all the criteria for a conclusive study, but results demonstrated mixed effects for some of participants. Any study that (a) lacked an experimental design capable of establishing experimental control, (b) did not meet the minimum IOA criterion, (c) did not operationally define the intervention procedures, (d) or did not operationally define the dependent variable was coded as suggestive.

Effect Size Analysis

Tau-U effect size without baseline trend correction was calculated using reverse rank-ordered data (e.g., highest data point ranked as one and rank order increases as the data values decrease). Data were extracted by hand for each A-B contrast (e.g., baseline vs. intervention). To obtain relevant rank orders for each data point, a straight line was drawn through the center of each data point and each point was ranked from top to bottom. The data point at the highest point on the graph was ranked as Number 1. The next highest data point was ranked as Number 2. Each successive data point followed the same method. If two data points fell at the same level on the graph, they were given the same rank number. The data were entered into the single-case research Tau-U calculator (Vannest, Parker, Gonen, & Adiguzel, 2016). If there were multiple A-B contrasts for a single intervention within a study, these were combined into an omnibus Tau-U using the calculator. Tau-U effect sizes can be interpreted based on the size of their effect (i.e., small effect = 0 to .62, medium effect = .63 to .92, large effect = .93 to 1.00; Parker, Vannest, & Davis, 2011).

Interrater Agreement (IRA)

To ensure accurate application of the inclusion criteria, two raters reviewed all the 66 articles during the inclusion review. IRA was calculated using percent agreement by dividing the total number of agreements by the sum of the agreements and disagreements and multiplying by 100 to convert to a percentage. Resulting IRA was 100%, indicating that agreement was reached on whether or not to include a study for all of the studies.

To establish IRA for the data summaries, two independent raters coded 5 of the 10 included articles (50%). IRA was calculated based on whether the two raters agreed on the extracted data. There were a total of 50 items in which there could be agreement or disagreement (i.e., five studies with 10 data categories each). The 10 data categories include participant's name, age, diagnoses, treatment setting, problem behavior, function, alternative behavior, intervention, results, and conclusiveness of evidence. IRA was calculated using percent agreement by dividing the total number of agreements by the sum of the agreements and disagreements and multiplying by 100 to convert to a percentage. Initial agreement for coding of studies was 92%. In instances of disagreement, the raters discussed until 100% agreement was reached.

To obtain IRA for data extraction and calculation of effect size, two raters independently assigned a rank to each data point for each participant graph in 30% of the articles. Interrater reliability (IRR) was calculated based on agreement of data extraction for each participant graph. As a result, agreement rates ranged from 0.85 to 0.88.

Results

Table 1 summarizes and displays each study according to the following: (a) participant characteristics (e.g., sex, age, and diagnosis), (b) treatment setting, (c) problem behavior, (d) function, (e) alternative behavior, (f) intervention, (g) outcomes, and (h) conclusiveness of evidence.

Participant Characteristics

The 10 studies included a total of 29 participants. All the studies reported the participants' ages. The average age of participants was 10 years (range = 4-31 years) across studies. The participants in these studies were diagnosed with various types of disabilities including autism (n = 11; 38%), intellectual disability (n = 2; 7%), attention deficit hyperactivity disorder (n = 1; 3%), Down syndrome (n = 1; 3%), developmental delay (n = 1; 3%), and comorbid diagnoses (n = 13; 46%). The most common singular diagnosis (n = 11; 38%) was autism.

Treatment Setting

All studies reported information regarding the setting where the intervention took place. The settings included in-patient hospitals, schools, and clinics. Of the 10 studies, three took place in an in-patient hospital (Adelinis, Piazza, & Goh, 2001; Ingvarsson, Kahng, & Hausman, 2008; Kahng, Hendrickson, & Vu, 2000), three took place in either a public school or school for individuals with severe emotional/behavioral disorders (Davis, Fredrick, Alberto, & Gama, 2012; Kelley, Lerman, & Van Camp, 2002; Marcus & Vollmer, 1996), three took place in a day clinic setting (Kunnavatana et al., in press; Roane, Fisher, Sgro, Falcomata, & Pabico, 2004; Slocum & Vollmer, 2015), and one took place in either a clinic or a school (Athens & Vollmer, 2010). For the two participants whose interventions took place at a school, no other children were in the room during the analysis except for the final experimental condition assessing generality. In

Table 1. Synthesis of Articles.

Article	Participant characteristics	Treatment setting	Problem behavior	Function	Alternative behavior	Intervention	Outcomes	Conclusiveness of evidence
Adelinis, Piazza, and Goh (2001)	*n* = 1; 12 years; AU, ADHD, ID	Hospital	Aggression	Attention/ escape	Picture exchange	Functional reinforcer for PB and edible reinforcer for alternative behavior	Positive Tau-U = 1 (large) CI = 0.559<>1	Conclusive
Athens and Vollmer (2010)	*n* = 7; 4, 6, 7, 8, 9, 10, and 12 years; ADHD, AU	Clinic/ School	Aggression	Escape, tangible, attention	Compliance, picture exchange, vocal request, sign	Investigated manipulation of reinforcement parameters to favor alternative behavior while still reinforcing PB (e.g., high quality vs. low quality, long duration vs. short duration, short latency to reinforcement vs. long latency, and a combined parameters condition)	Positive Tau-U for combined parameters condition = 0.8401 (medium) CI = 0.578<>1	Conclusive
Davis, Fredrick, Alberto, and Gama (2012)	*n* = 4; 8, 12, 17, and 18 years; ID, AU, SEBD, CP, Feeding disorder	School	Aggression, skin picking, elopement, noncompliance, property destruction, wringing hands	Escape	Picture exchange	FCT with alternating treatments of escape and escape + preferred activity (parameters)	Positive Tau-U = 1 (large) CI = 0.709<>1	Conclusive
Ingvarsson, Kahng, and Hausman (2008)	*n* = 1; 8 years; AU, CP, ID, OCD	Hospital	Aggression, disruption, SIB	Tangible/ escape	Compliance	High-density NCR, low-density NCR, and DRA (concurrent schedules)	Positive HD NCR: Tau-U = 0.8119 (medium) CI = 0.412<>1 HD NCR: Tau-U = 0.8413 (medium) CI = 0.348<>1	Conclusive
Kahng, Hendrickson, and Vu (2000)	*n* = 1; 7 years; ID, AU	Hospital	SIB, aggression, property destruction	Tangible	Picture exchange with vocal response	FCT without EXT—two FCT conditions where he either said (a) "I want treats"; single or (b) "I want (specific item); multiple (parameters)	Positive FCT single: Tau-U = 0.0496 (small) CI = −0.364<>0.464 FCT multiple: Tau-U = 1 (large) CI = 0.606<>1	Conclusive

(continued)

Table 1. (continued)

Article	Participant characteristics	Treatment setting	Problem behavior	Function	Alternative behavior	Intervention	Outcomes	Conclusiveness of evidence
Kelley, Lerman, and Van Camp (2002)	*n* = 3; 9, 10, and 10 years; ID, AU	School	Aggression, disruption	Tangible, escape, multiply maintained	Card touching, Hand clapping	FCT without EXT (VR 8 for PB and FR 1 for AB)	Mixed Without EXT: Tau-U = 0.4006 (small) CI = 0.167<>0.635 With EXT: Tau-U = 0.7054 (medium) CI = 0.190<>1	Suggestive
Kunnavatana, Bloom, Samaha, Slocum, & Clay, (in press)	*n* = 3; 10, 24, and 31 years; AU, CP, VI, PTSD, psychotic disorder NOS	Clinic	Aggression, property destruction, inappropriate vocalizations	Escape/ tangible	Picture exchange, vocal request	FCT without EXT—Parameter sensitivity manipulations (parameters and concurrent schedules)	Positive Duration: Tau-U = 0.9710 (large) CI = 0.543<>1 Quality: Tau-U = 1 (large) CI = 0.480<>1	Conclusive
Marcus and Vollmer (1996)	*n* = 3; 4, 5, and 5 years; Down Syndrome, ID, AU	School	SIB, aggression, disruption	Tangible	Vocal request, touching response card	NCR + DRA, DRO, DRA, NCR	Positive NCR + DRA: Tau-U = 0.9627 (large) CI = 00.495<>1 DRO: Tau-U = −1 (small) CI = −1<>–0.343 NCR: Tau-U = 0.828 (medium) CI = 0.487<>1	Conclusive

(continued)

Table 1. (continued)

Article	Participant characteristics	Treatment setting	Problem behavior	Function	Alternative behavior	Intervention	Outcomes	Conclusiveness of evidence
Roane, Fisher, Sgro, Falcomata, and Pabico (2004)	*n* = 1; 7 years; AU, ID	Clinic	Aggression	Attention	Response card	DRA vs. DRA + noncontingent toys with alternative response restriction	Positive DRA: Tau-U = 1 (large) CI = 0.288<>1 DRA + NCT with alternative. response restriction: Tau-U = 0.3704 (small) CI = −0.087<>0.827	Conclusive
Slocum and Vollmer (2015)	*n* = 5; 4, 4, 7, 7, and 8 years; AU, ADHD, ODD, PDD-NOS, Developmental delay	Clinic	Aggression, vocal protests	Escape	Compliance	Function (SR−; escape) vs. nonfunction (SR+; edibles)	Positive SR+: Tau-U = 0.7871 (medium) CI = 0.627<>0.948 SR−: Tau-U = 0.2106 (small) CI = 0.050<>0.372	Conclusive

Note. Only participants with differential reinforcement without extinction interventions were included. AU = autism; ADHD = attention deficit hyperactive disorder; ID = intellectual disability; CI = confidence interval; SEBD = severe emotional or behavioral disorder; CP = cerebral palsy; FCT = functional communication training; OCD = obsessive compulsive disorder; DRA = differential reinforcement of alternative behavior; HD = high density; LD = low density; EXT = extinction; VI = visual impairment; PTSD = posttraumatic stress disorder; NOS = not otherwise specified; NCT = noncontingent access to toys; ODD = oppositional defiant disorder; PB = problem behavior; PDD = pervasive developmental disorder; SIB = self-injurious behavior; NCR = non-contingent reinforcement; EXT = extinction; DRO = differential reinforcement of other behavior; FR = fixed ratio; SR = reinforcement; AB = appropriate behavior. <> signifies the confidence interval= 90%.

Roane et al. (2004) and Davis et al.'s (2012) studies, interventions were conducted either in a hospital waiting room (Roane et al., 2004) with other individuals present or in a regular classroom with other students present in the classroom (Davis et al., 2012). All other studies implemented their interventions in a private setting with no other individuals other than the participant and therapist(s).

Problem Behavior

Target behaviors included aggression, self-injurious behavior (n = 5; 17%), elopement (n = 2; 7%), vocal protests/inappropriate vocalizations/disruptions (n = 8; 27%), and property destruction (n = 3; 10%). For some participants, multiple topographies of behaviors were targeted. The most common target behavior for participants was aggression with 93% of participants (n = 28) exhibiting this topography. Three out of 10 studies focused solely on reducing aggression (Adelinis et al., 2001; Athens & Vollmer, 2010; Roane et al., 2004). All other studies targeted multiple topographies of behavior.

Function

All the studies conducted a traditional functional analysis based on the Iwata et al. (1982/1994) procedures. One study also included a pairwise functional analysis following the traditional model (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). All functional analysis identified a maintaining consequence. Of the 29 functional analyses conducted, 11% (n = 3) of analysis identified an attention function of the target behavior, 41% (n = 12) identified an escape function, 28% (n = 8) identified a tangible function, and 20% (n = 6) identified multiple functions that maintained the target behavior.

Alternative Behavior

Of the 10 studies included in this review, all identified an alternative behavior and all reported information regarding the specific desired alternative behavior for each participant. Alternative behaviors included picture exchange (n = 12; 40%), a vocal response (n = 6; 20%), picture exchange + vocal response (n = 2; 7%), manual sign (n = 2; 7%), and compliance (n = 7; 23%). The most common alternative behavior was picture exchange (n = 12; 40%). For example, in Davis et al.'s (2012) study, participants were taught to place a card with a picture indicating break time in the hand of the instructor.

Intervention

All studies reported the type of DRA intervention used in their study. Of the 10 studies, five studies manipulated different reinforcement parameters (magnitude, immediacy, and quality) while five manipulated the schedule of reinforcement (e.g., DRA + NCR or Fixed Ratio (FR) 1 vs. Intermittent). In regard to parameter manipulations, the five studies that implemented this type of intervention differed in the concurrent schedules of reinforcement based on the quality, magnitude, or immediacy of reinforcement to favor the alternative behavior while still reinforcing problem behavior. For example, if manipulating quality, a DRA intervention could reinforce alternative behavior with a high-quality reinforcer while problem behavior is reinforced with a low-quality reinforcer. If manipulating immediacy, the alternative behavior could be reinforced immediately (after no delay) while problem behavior is reinforced after a certain amount of time (delay). For magnitude, alternative behavior could contact 30 s of a reinforcer while problem behavior only contacts 5 s of reinforcement. In specific, Kahng et al. (2000) evaluated whether a functional communication training (FCT)-single response (e.g., "I want treats"), to obtain one of six items delivered randomly, or a FCT-multiple response (e.g., "I want [specific item]"), to obtain the specified reinforce, was more effective in reducing problem behavior. The single-FCT response resulted in an item being delivered at random with a one in six chance to be the item the participant desired, which produced an intermittent schedule of reinforcement, whereas the FCT-multiple response provided the specific desired item every time (FR 1), therefore manipulating the quality of reinforcement. The authors found that participants emitted specific mands at a higher frequency than general mands suggesting that the participants were sensitive to the quality of reinforcement. The DRA without extinction procedure was effective when it allowed for access to high-quality reinforcement. Problem behavior was also reduced in frequency when the FCT-multiple response was emitted. Similarly, Davis et al. (2012) manipulated quality of reinforcement with concurrent schedules of reinforcement by programming problem behavior to contact 30-s escape while alternative behavior contacted 30-s of escape + a preferred activity. As this intervention was implemented in a classroom setting, authors found that students allocated responding to the alternative behavior while reduced rates of problem behavior were observed. In addition, participants spent more time on task. Adelinis et al. (2001) and Slocum and Vollmer (2015) also manipulated the quality of reinforcement using a nonfunctional reinforcer (edibles) for alternative behavior and a functional reinforcer (escape/attention) for problem behavior. The participant demonstrated a reduced rate of aggression compared with baseline rates when edibles were contingent on appropriate behavior and escape was provided for multiply-maintained problem behavior.

In terms of manipulating schedules of reinforcement, the five articles that implemented this type of intervention manipulated the schedule of reinforcement to favor the alternative behavior. Specifically, Roane et al. (2004) compared DRA without EXT with DRA without EXT + noncontingent access to toys (NCT) followed by increasing alternative response restriction. In the DRA without EXT condition, Juan's problem behavior was reinforced with a brief verbal reprimand. Contingent on emitting the alternative response, Juan received 20 s of high-quality attention (e.g., praise and tickling). During the DRA without EXT + NCT phase, the intervention remained the same as previously described, but Juan also had NCT access to highly preferred toys. Researchers then systematically restricted the response card that enabled Juan to emit the alternative response and measured the rates of problem behavior. Juan's problem behavior remained at least 80% lower than the baseline mean and researchers were able to reach the terminal schedule of response restriction for 320 s. Similarly, Marcus and Vollmer (1996) implemented NCR on a fixed time schedule + DRA without EXT by superimposing a DRA schedule on a previously existing NCR schedule. For one participant, DRA and NCR interventions were introduced simultaneously and then the NCR schedule was thinned. For the other participant, NCR was introduced first, the schedule was thinned, and then DRA was superimposed on the previously existing NCR schedule. Both participants demonstrated reduced rates of problem behavior and an increase in alternative behavior; however, the participant who had DRA and NCR interventions introduced simultaneously followed by thinning, demonstrated more rapid suppression of problem behavior. Also using NCR, Ingvarsson et al. (2008) compared NCR with DRA without extinction by noncontingently providing nonfunctional reinforcers (i.e., edibles) before placing demands either on a high-density schedule (every demand) or a low-density schedule (every four demands). Results from this study demonstrate reduced rates of problem behavior and increased rates of compliance when both high-density and low-density NCR were implemented Also, both NCR and DRA without extinction were found to be equally effective when each treatment was compared with each other. Finally, Kelley et al. (2002) evaluated FCT without extinction by setting problem behavior to contact reinforcement on a variable ratio 8 (VR 8) schedule while alternative behavior contacted reinforcement continuously (FR 1) for one participant while the remaining two participant's interventions included an extinction component. The participant who had positive outcomes displayed high rates of alternative responding and low rates of aggression.

Outcomes

Nine of the nine studies included in this review indicated positive outcomes for the differential reinforcement without extinction intervention (Adelinis

et al., 2001; Athens & Vollmer, 2010; Davis et al., 2012; Ingvarsson et al., 2008; Kahng et al., 2000; Kelley et al., 2002; Kunnavatana et al., in press; Marcus & Vollmer, 1996; Slocum & Vollmer, 2015). One of the studies, Kelley et al. (2002), had only one out of three participants achieve positive results with the differential reinforcement (e.g., FCT) intervention without an extinction component. The remaining two participants required FCT with extinction to achieve positive results. For the one participant, whose behavior was successfully reduced using FCT without extinction, problem behavior contacted reinforcement on a VR 8, while alternative behavior was reinforced on a FR 1 schedule. Reinforcement for problem behavior for the two participants that were not sensitive to the concurrent reinforcement rates alone was set on either a VR 8 or VR 6 schedule of reinforcement.

Results for the effect sizes are categorized as having a small effect if the Tau-U ranges from 0 to .62, a medium effect if Tau-U ranges from .63 to .92, and a large effect if the Tau-U ranges from .93 to 1.00 per criteria from Parker et al. (2011). Interventions that compared a functional versus nonfunctional reinforcer (Adelinis et al., 2001; Davis et al., 2012; Slocum & Vollmer, 2015), that included multiple alternative responses (e.g., both specific and general alternative responses; Kahng et al., 2000), that manipulated parameters of reinforcement (Athens & Vollmer, 2010; Ingvarsson et al., 2008; Kunnavatana et al., in press; Marcus & Vollmer, 1996), or that combined noncontingent reinforcement plus DRA (Marcus & Vollmer, 1996; Roane et al., 2004) demonstrated medium to large effects on problem behavior.

Interventions that included only one type of alternative response (e.g., specific or general but not both; Kahng et al., 2000), DRA without extinction (Kelley et al., 2002), differential reinforcement of other behavior (DRO) alone (Marcus & Vollmer, 1996), DRA + noncontingent reinforcement with alternative response restriction (Roane et al., 2004), and function-based negative reinforcement (Slocum & Vollmer, 2015) demonstrated small effects.

Conclusiveness of Evidence

Of the 10 studies included in this review, nine articles were coded as being conclusive as they met all the identified quality indicators. However, both raters did note that more detail would have been preferred regarding descriptions of the dependent variable for three of the articles (i.e., Davis et al., 2012; Kahng et al., 2000; Kelley et al., 2002). For example, in Slocum and Vollmer (2015), aggression included hitting, kicking, biting, scratching, spitting, hair pulling, pinching, grabbing, and pushing. For each topography of aggression, an operational definition was provided (e.g., "hitting" defined hitting as "forceful contact of the subject's hand to another person from 6 inches or more"). However, in Kahng

et al.'s (2000) study, authors described self-injury as "hitting, pinching, biting, and scratching." Additional details regarding the topography of behavior could improve the operationalized definition of behavior. One study was rated as suggestive due to mixed results for the participants (Kelley et al., 2002).

Discussion

The purpose of this review was to synthesize the literature on differential reinforcement procedures without extinction for individuals with autism. Using predetermined inclusion criteria, a total of 10 studies were included and summarized in terms of the following: (a) participant characteristics (e.g., sex, age, and diagnosis), (b) treatment setting, (c) problem behavior, (d) function, (e) alternative behavior, (f) intervention, (g) outcomes, and (h) conclusiveness of evidence. Of the 10 studies, nine demonstrated positive effects and one demonstrated mixed effects. The 10 studies indicated two general methods of successfully implementing a differential reinforcement without extinction intervention.

The first procedure included manipulation of reinforcement schedule. Four of the 10 studies successfully reduced problem behavior and increased alternative behavior by manipulating the reinforcement schedules. The most common intervention included concurrent DRA + NCR schedules (i.e., Ingvarsson et al., 2008; Marcus & Vollmer, 1996; Roane et al., 2004). Results of these studies extended previous research identifying NCR as an effective intervention to decrease problem behavior (e.g., Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). In particular, these results indicate that DRA + NCR could be an effective alternative to DRA + EXT with the added benefit of increasing participant contact with reinforcement (Ingvarsson et al., 2008). To note, with NCR interventions, suppression of the alternative behavior (e.g., manding) is often a concern. However, results from Marcus and Vollmer (1996) found that the addition of DRA could strengthen the alternative behavior and address this limitation of NCR. The NCR + DRA concurrent schedule may also be particularly beneficial for natural change agents due to ease of implementing NCR.

The remaining study manipulated the schedule of reinforcement without a NCR component (Kelley et al., 2002). Kelley et al.'s (2002) was the only study reporting mixed results. Kelley and colleagues scheduled the reinforcement rate to favor the alternative behavior by reinforcing the problem behavior on a VR 8 schedule and appropriate behavior on a FR 1 schedule. Although they identified positive effects for one participant, the remaining two participants required DRA + EXT or DRA + EXT + response blocking. These results suggest that reduction of the problem behavior may be difficult when a variable reinforcement schedule is used. A factor that may have resulted in

the mixed results is the density of reinforcement for the problem behavior. Perhaps a VR 8 was not thin enough to shift responding and future research may compare denser schedules of reinforcement for appropriate behavior with leaner fixed ratio schedules for problem behavior as a potential alternative to extinction. Another consideration is the time of exposure to each contingency. Participants may require additional time to discriminate between different rates of reinforcement contingent on each behavioral response. Since a VR 8 schedule requires a participant to emit the problem behavior 8 times before contacting reinforcement, a high rate of behavior must be emitted. Perhaps further exposure to the contingencies would shift behavior allocation toward the alternative response when alternative behavior contacts a denser schedule of reinforcement (FR 1).

The second procedure used involved manipulating other reinforcement parameters besides rate (e.g., magnitude, immediacy, and quality; Adelinis et al., 2001; Athens & Vollmer, 2010; Davis et al., 2012; Kahng et al., 2000; Kunnavatana et al., in press; Slocum & Vollmer, 2015). Of the six articles that manipulated different reinforcement parameters, three manipulated quality (Adelinis et al., 2001; Kahng et al., 2000; Slocum & Vollmer, 2015), one manipulated magnitude (Davis et al., 2012), and two manipulated quality, magnitude, and the immediacy of reinforcement (Athens & Vollmer, 2010; Kunnavatana et al., in press). In regard to quality, one of the studies differentially reinforced general versus specific mands with general versus specific reinforcement (Kahng et al., 2000). Results from the other two studies (Adelinis et al., 2001; Slocum & Vollmer, 2015) support the use of primary reinforcers (e.g., edibles) as competing reinforcement for escape-maintained and multiply-maintained problem behavior. Both studies delivered the nonfunctional primary reinforcement on a FR 1 schedule and delivered a functional reinforcer for problem behavior on an FR 1 schedule. Although the mechanism of change is unclear, the contingent delivery of primary reinforcers may function as an abolishing operation for escape. Alternatively, the primary reinforcer may have been preferred over the identified functional reinforcer.

The only study that manipulated solely the magnitude of reinforcement was Davis et al.'s (2012). This study extends research on differential reinforcement without extinction by training teachers to implement the intervention and conducting sessions in a classroom setting with other peers and adults present. Researchers manipulated the magnitude of reinforcement by programming alternative behavior (i.e., mands) to contact escape + a preferred activity and problem behavior to contact escape only. The concurrent schedules increased task completion and decreased escape-maintained behavior. These results have implications for the use of differential

reinforcement interventions without an extinction component in the classroom, but further replication needs to be conducted.

The final two studies that manipulated parameters of reinforcement are of Athens and Vollmer (2010) and Kunnavatana et al. (in press). Both studies manipulated immediacy, quality, and magnitude of reinforcement or a combination of all three. Athens and Vollmer (2010) manipulated parameters to favor appropriate behavior while still reinforcing problem behavior on a variable interval schedule. In Experiment 1, researchers manipulated the duration of reinforcement. For two participants, alternative behavior contacted 30 s of reinforcement while problem behavior contacted 10 s of reinforcement. Authors stated that a variable interval schedule was used to mimic the natural environment and rule out reinforcement rate as the reason for response allocation. Similarly Kunnavatana et al. (in press) reinforced both problem and alternative behavior on the same reinforcement schedule (FR 1) but first assessed for individual parameter sensitivity to only manipulate one parameter of reinforcement during the FCT without extinction phase. According to the results of the parameter sensitivity assessment, authors then programmed the most sensitive parameter of reinforcement to favor alternative behavior. For example, one participant was most sensitive to quality of reinforcement. During the FCT treatment phase, problem behavior contacted low-quality reinforcement for 30 s while alternative behavior contacted 30 s of high-quality reinforcement. These two studies suggest that it is possible to achieve positive results by reinforcing problem behavior and alternative behavior on the same schedule of reinforcement, but favoring reinforcement for alternative behavior in terms of immediacy, magnitude, or quality of reinforcement.

Limitations and Implications for Future Research

In addition to the identified suggestions above, there are several areas of future research identified by this review. First, there is a need to further investigate the mechanism underlying the effectiveness of the investigated interventions. For example, with the use of NCR + DRA procedures, it is possible that NCR may eliminate the functional relationship between the behavior and the reinforcing consequence. NCR may also be effective due to participant satiation on the functional reinforcer (Marcus & Vollmer, 1996). Other articles also identified the abolishing operation as a potential mechanism for behavioral change (Adelinis et al., 2001). Future research may manipulate motivating operations in combination with differential reinforcement to further investigate this phenomenon. In addition, many of the studies investigated multiple schedule components with overall positive results. However, the mixed results from Kelley et al. (2002) identified a need to evaluate the density of

the competing schedules to identify effective schedules that may compete effectively with problem behavior. In addition, future research may consider conducting a quality parameter evaluation to further investigate these potential mechanisms. The only study to conduct parameter evaluations was of Kunnavatana et al. (in press). Kunnavatana and colleagues used arbitrary switches to assess individual parameter sensitivities to reinforcement and then use the results to develop a FCT without extinction intervention. The use of arbitrary switches allowed for assessment of parameter sensitivities without occasioning the occurrence of problem behavior. This assessment procedure also holds promise as it can allow researchers and practioners to identify the reinforcement parameters that are valued by the participant. This could lead to individualized treatments and specific evaluations of when reinforcement procedures are not effective (e.g., a reinforcement procedure may not be effective as the individual is sensitive to quality of reinforcement rather than immediacy of reinforcement). Further research is needed to replicate the findings of this study.

A substantial area of future research is to investigate the generality and validity of these interventions in applied settings with natural change agents. One of the potential benefits of DRA without extinction interventions is the ease of implementation for natural change agents. However, the validity and generality of these interventions has not been evaluated extensively. Therefore, future research should continue this line of research to ensure that these interventions are feasible for natural change agents. In particular, implementation of multiple component schedules may be complex and lead to reduced implementation fidelity. It is also unknown the effects of DRA without extinction interventions on the maintenance and generalization of the behavior change. These issues should be further evaluated by future research.

There are also a number of notable limitations in our review that may be addressed with future research. The first is that this review focused solely on articles that included at least one participant with an autism diagnosis. Future reviews might look at expanding beyond autism to other diagnoses, as there were positive results indicated for the other participants in these studies with various disabilities. In addition, only articles that were published within the last 20 years were included in this review. Authors applied this delimiter due to ensure relevance of the resulting articles and to control for quality of research. As this review has a relatively small amount of articles included, future research might include all articles and conduct a quality evaluation of the research designs to assist in the interpretation of the results. Finally, future research should include the comparison between DRA with and without extinction to account for possible publication bias. It is important to compare a new intervention with previously established interventions to compare the efficacy of each intervention.

Implications for Practitioners

Although there are promising results for the use of DRA without extinction interventions, the evidence is limited and practitioners should implement with caution. In particular, practitioners should continue to rely on evidence-based practices (such as DRA with EXT). In the event that extinction is counter-therapeutic, practitioners may consider the use of NCR + DRA or manipulation of parameters of reinforcement plus DRA. For example, following a preference assessment, practitioners may choose to manipulate parameters of reinforcement within a DRA intervention by choosing to reinforce the appropriate behavior with a high-quality reinforcer and deliver a moderate- or low-preferred reinforcer for problem behavior. This is only a general example of how one might begin to implement one of the methods outlined in this review. However, practitioners should employ best practices when using these methods and monitor the progress of the intervention and individual's behavior to make data-based decisions.

Conclusion

Overall, the articles in this review successfully reduced problem behavior and increased alternative responding by manipulating the schedules of reinforcement or by manipulating other parameters of reinforcement. DRA interventions is effective when combined with extinction. In instances where extinction is not ethical or feasible, there are variations of DRA interventions that may be considered promising practices for the treatment of problem behavior. However, further research is needed to investigate other variations of these interventions and replicate results of the existing literature base.

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References

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*Adelinis, J. D., Piazza, C. C., & Goh, H. L. (2001). Treatment of multiply controlled destructive behavior with food reinforcement. *Journal of Applied Behavior Analysis*, *34*, 97-100. doi:10.1901/jaba.2001.34-97

Arndorfer, R. E., & Miltenberger, R. G. (1993). Functional assessment and treatment of challenging behavior: A review with implications for early childhood. *Topics in Early Childhood Special Education*, *13*, 82-105. doi:10.1177/027112149301300109

*Athens, E. S., & Vollmer, T. R. (2010). An investigation of differential reinforcement of alternative behavior without extinction. *Journal of Applied Behavior Analysis*, *43*, 569-589. doi:10.1901/jaba.2010.43-569

Beavers, G. A., Iwata, B. A., & Lerman, D. C. (2013). Thirty years of research on the functional analysis of problem behavior. *Journal of Applied Behavior Analysis*, *46*, 1-21. doi:10.1002/jaba.30

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson.

*Davis, D. H., Fredrick, L. D., Alberto, P. A., & Gama, R. (2012). Functional communication training without extinction using concurrent schedules of differing magnitudes of reinforcement in classrooms. *Journal of Positive Behavior Interventions*, *14*, 162-172. doi:10.1177/1098300711429597

Fisher, W., Piazza, C., Cataldo, M., & Harrell, R. (1993). Functional communication training with and without extinction and punishment. *Journal of Applied Behavior Analysis*, *26*, 23-36.

Hagopian, L. P., Fisher, W. W., Sullivan, M. T., Acquisto, J., & LeBlanc, L. A. (1998). Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis*, *31*, 211-235. doi:10.1901/jaba.1998.31-211

Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003). Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis*, *36*, 147-185. doi:10.1901/jaba.2003.36-147

Horner, R. H., Carr, E. G., Strain, P. S., Todd, A. W., & Reed, H. K. (2002). Problem behavior interventions for young children with autism: A research synthesis. *Journal of Autism and Developmental Disorders*, *32*, 423-446. doi:10.1023/A:1020593922901

*Ingvarsson, E. T., Kahng, S., & Hausman, N. L. (2008). Some effects of noncontingent positive reinforcement on multiply controlled problem behavior and compliance in a demand context. *Journal of Applied Behavior Analysis*, *41*, 435-440. doi:10.1901/jaba.2008.41-435

Iwata, B., Dorsey, M., Slifer, K., Bauman, K., & Richman, G. (1982/1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis.*, *27*, 197-209.

Iwata, B., Duncan, B.A., Zarcone, J. R., Lerman, D., & Shore, B.A. (1994). A sequential, test-control methodology for conducting functional analyses of self-injurious behavior. Behavior Modification, 18, 289-306. doi: 10.1177/01454455940183003

*Kahng, S., Hendrickson, D. J., & Vu, C. P. (2000). Comparison of single and multiple functional communication training responses for the treatment of problem behavior. *Journal of Applied Behavior Analysis*, *33*, 321-324.

*Kelley, M. E., Lerman, D. C., & Van Camp, C. M. (2002). The effects of competing reinforcement schedules on the acquisition of functional communication. *Journal of Applied Behavior Analysis*, *35*, 59-63. doi:10.1901/jaba.2002.35-59

Kennedy, C. H. (2005). *Single-case designs for educational research*. Boston, MA: Allyn & Bacon.

*Kunnavatana, S. S., Bloom, S. E., Samaha, A. L., Slocum, T. A., & Clay, C. J. (in press). Manipulating parameters of reinforcement to reduce problem behavior without extinction. *Journal of Applied Behavior Analysis*.

Lalli, J. S., Casey, S., & Kates, K. (1995). Reducing escape behavior and increasing task completion with functional communication training, extinction, and response chaining. *Journal of Applied Behavior Analysis*, *28*, 261-268. doi:10.1901/jaba.1995.28-261

Lennox, D. B., Miltenberger, R. G., Spengler, P., & Erfanian, N. (1988). Decelerative treatment practices with persons who have mental retardation: A review of five years of the literature. *American Journal on Mental Retardation*, *92*, 492-501.

Lerman, D. C., Iwata, B. A., & Wallace, M. D. (1999). Side effects of extinction: Prevalence of bursting and aggression during the treatment of self-injurious behavior. *Journal of Applied Behavior Analysis*, *32*(1), 1-8.

*Marcus, B. A., & Vollmer, T. R. (1996). Combining noncontingent reinforcement and differential reinforcement schedules as treatment for aberrant behavior. *Journal of Applied Behavior Analysis*, *29*, 43-51. doi:10.1901/jaba.1996.29-43

Northup, J., Fisher, W., Kahng, S. W., Harrell, R., & Kurtz, P. (1997). An assessment of the necessary strength of behavioral treatments for severe behavior problems. *Journal of Developmental and Physical Disabilities*, *9*, 1-16.

Parker, R. I., Vannest, K. J., & Davis, J. L. (2011). Effect size in single-case research: A review of nine nonoverlap techniques. *Behavior Modification*, *35*, 303-322. doi:10.1177/0145445511399147

*Roane, H. S., Fisher, W. W., Sgro, G. M., Falcomata, T. S., & Pabico, R. R. (2004). An alternative method of thinning reinforcer delivery during differential reinforcement. *Journal of Applied Behavior Analysis*, *37*, 213-218. doi:10.1901/jaba.2004.37-213

Schlosser, R. (May, 2009). *The role of evidence-based journals as evidence based information sources*. Applied Behavior Analysis International Annual Convention (Conference), Phoenix, AZ.

Shirley, M. J., Iwata, B. A., Kahng, S., Mazaleski, J. L., & Lerman, D. C. (1997). Does functional communication training compete with ongoing contingencies of reinforcement? An analysis during response acquisition and maintenance. *Journal of Applied Behavior Analysis*, *30*, 93-104. doi:10.1901/jaba.1997.30-93

Simeonsson, R., & Bailey, D. (1991). Evaluating programme impact: Levels of certainty. In D. Mitchell & R. Brown (Eds.), *Early intervention studies for young children with special needs*. New York, NY: Chapman & Hall. 280-296

*Slocum, S. K., & Vollmer, T. R. (2015). A comparison of positive and negative reinforcement for compliance to treat problem behavior maintained by escape. *Journal of Applied Behavior Analysis*, *48*, 563-574. doi:10.1002/jaba.216

Smith, N. (1981). The certainty of judgments in health evaluations. *Evaluation and Program Planning*, *4*, 273-278.

St. Peter Pipkin, C., Vollmer, T. R., & Sloman, K. N. (2010). Effects of treatment integrity failures during differential reinforcement of alternative behavior: A translational model. *Journal of Applied Behavior Analysis*, *43*, 47-70. doi:10.1901/jaba.2010.43-47

Tarbox, J., Wilke, A. E., Najdowski, A. C., Findel-Pyles, R. S., Balasanyan, S., Caveney, A. C., . . .Tia, B. (2009). Comparing indirect, descriptive, and experimental functional assessments of challenging behavior in children with autism. *Journal of Developmental and Physical Disabilities*, *21*, 493-514. doi:10.1007/s10882-009-9154-8

Vannest, K. J., Parker, R. I., Gonen, O., & Adiguzel, T. (2016). *Single case research: Web based calculators for SCR analysis* (Version 2.0) [Web-based application]. College Station: Texas A&M University. Available from http://www.singlecaseresearch.org/

Volkert, V. M., Lerman, D. C., Call, N. A., & Trosclair-Lasserre, N. (2009). An evaluation of resurgence during treatment with functional communication training. *Journal of Applied Behavior Analysis*, *42*, 145-160.

Vollmer, T. R., & Iwata, B. A. (1992). Differential reinforcement as treatment for behavior disorders: Procedural and functional variations. *Research in Developmental Disabilities*, *13*, 393-417. doi:10.1016/0891-4222(92)90013-V

Vollmer, T. R., Iwata, B. A., Zarcone, J. R., Smith, R. G., & Mazaleski, J. L. (1993). The role of attention in the treatment of attention-maintained self-injurious behavior: Noncontingent reinforcement and differential reinforcement of other behavior. *Journal of Applied Behavior Analysis*, *26*, 9-21. doi:10.1901/jaba.1993.26-9

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