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Running Head: RESPONSE REDIRECTION

A systematic review and evaluation of response redirection as a treatment for challenging
behavior in individuals with developmental disabilities

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Abstract

Response redirection is widely used in clinical practice as a treatment for repetitive behavior or stereotypy in persons with developmental disabilities. However, to date the procedure has received comparatively little empirical evaluation. The current review sought to examine the literature describing the efficacy of response redirection alone, response interruption and redirection (RIRD), and multi-element treatment packages incorporating response redirection, as interventions for challenging behavior in individuals with developmental disabilities. Additionally, the status of response redirection, and RIRD, as evidence-based practice was evaluated in accordance with Reichow's (2011) recently developed criteria. Results indicated that interventions involving response redirection or RIRD typically led to large decreases in challenging behavior but did not result in behavioral suppression. On the basis of the current literature and in accordance with Reichow's criteria, interventions incorporating response redirection do not yet constitute evidence-based practice. The implications of these findings, for both research and practice, are discussed.

Keywords: redirection, response redirection, response interruption and redirection, empirically supported treatment, evidence-based, challenging behavior, problem behavior, developmental disabilities, automatic reinforcement, stereotypy

1. A Systematic Review and Evaluation of Response Redirection as a Treatment for Challenging Behavior in Individuals with Developmental Disabilities

Challenging behaviors, such as stereotypy and self-injury, are common among individuals diagnosed with developmental disabilities with prevalence estimates as high as 82% reported in the literature (Poppes, Van der Putten, & Vlaskamp, 2010). Previous reviews have supported the use of behavioral interventions for the reduction of challenging behaviors including self-injury (Kahng, Iwata, & Lewin, 2002), stereotypy (Mulligan, Healy, & Lydon, 2013), aggression (Brosnan & Healy, 2011), and pica (McAdam, Sherman, Sheldon, & Napolitano, 2004). More specifically, reviews have found strategies such as differential reinforcement (Chowdhury & Benson, 2011), functional communication training (Kurtz, Boelter, Jarmolowicz, & Hagopian, 2011), noncontingent reinforcement (Carr, Severtson, & Lepper, 2009), self-management procedures (Harchik, Sherman, & Sheldon, 1992), the provision of choice (Shogren, Faggella-Luby, Bae, & Wehmeyer, 2004) and the use of activity schedules (Lequia, Machalicek, & Rispoli, 2012) to be effective strategies for reducing challenging behaviors.

There is clear evidence for the success of behavior analysis in treating a myriad of topographies of challenging behavior seen in developmental disabilities. However, the difficulty in treating those behaviors identified through functional analysis to be automatically reinforcing or “self-stimulatory” has been highlighted by several researchers (e.g., Cunningham & Schreibman, 2008; LeBlanc, Patel, & Carr, 2000; Vollmer, 1994). Many instances of challenging behaviors have been shown to be maintained by some form of automatic reinforcement. For example, Hanley, Iwata, & McCord (2003) found that functional analysis indicated that 61% of stereotypy cases, 24.8% of self-injury cases, and 50% of pica cases, were maintained by automatic reinforcement (see also Healy, Brett & Leader, 2013). Researchers have successfully treated automatically reinforced behaviors with

interventions incorporating differential reinforcement, noncontingent reinforcement, environmental enrichment, response blocking, competing stimuli, and punishment (Hagopian & Toole, 2009). However, interventions incorporating response blocking have been found to result in unwanted collateral behaviors, such as aggression, in several studies (Hagopian & Adelinis, 2001; Lerman, Kelley, Vorndran, & Van Camp, 2003; Rapp, Dozier, & Carr, 2001). These findings, and the emphasis on utilizing non-aversive, less restrictive interventions, have led researchers to investigate the use of response redirection during the treatment of such behaviors.

Response redirection involves the prompting of an alternative appropriate response contingent on the occurrence of the target behavior (Giles, St. Peter, Pence, & Gibson, 2012). For example, response redirection to target stereotypy may involve the delivery of prompts to the individual to engage in an alternative response each time they emit the target behavior. Ahearn et al. (2007) provide an example of the mechanism of response redirection to reduce vocal stereotypy in four participants with autism. Specifically, contingent on the occurrence of the target behavior, participants were required to respond to a series of social questions or vocal imitations until they successfully fulfilled a response requirement of three consecutive correct responses without engaging in the target behavior. Response redirection has been combined with a variety of other interventions such as response blocking, noncontingent reinforcement, the provision of competing or preferred stimuli, and differential reinforcement, in multi-element treatment packages. It has also been used in conjunction with response interruption, an intervention referred to as response interruption and redirection (RIRD), to treat vocal stereotypy, a behavior which is not amenable to response blocking or physical intervention. When RIRD is in place, the emission of the target behavior is interrupted, typically using a verbal interruption to capture the individual's attention, and an alternative behavior, such as appropriate language, is prompted. Most commonly, vocal

demands are issued contingent on an occurrence of vocal stereotypy and are continuously presented until the individual has produced three successful consecutive responses in the absence of stereotypy (Ahearn, Clark, & MacDonald, 2007; Liu-Gitz, & Banda, 2010). In addition to decreasing stereotypy, RIRD has been shown to produce concomitant increases in appropriate vocalizations in many studies (Dickman, Bright, Montgomery, & Miguel, 2012). The mechanism through which RIRD achieves its effects has been questioned (Hagopian, González, Rivet, Triggs, & Clark) with some suggesting that the redirection component functions to punish the targeted behavior (Dickman et al., 2012).

The present review sought to critically examine the extant literature on the utility of response redirection as an intervention for challenging behavior among individuals with developmental disabilities. A quantitative analysis of treatment outcomes and an evaluation of the empirical support for the procedure were also undertaken.

2. Method

2.1. Literature Search

Systematic searches were carried out using the following databases: Scopus, Psychology and Behavioral Sciences Collection, PsycInfo, ERIC, MedLine, and Web of Science. In all databases, searches were conducted by inputting “response interruption AND redirection” as a sole search term, and inputting the terms “response blocking”, “response interruption”, and “redirection” in combination with the following keywords: applied behavior analysis, treatment, behavioral intervention, functional analysis, behavior modification, intellectual disability, developmental disability, autism, self-injurious behavior, self-injury, and stereotypy. All abstracts returned during the electronic searches were reviewed to determine their suitability for inclusion. The reference lists of all included studies were also reviewed to identify additional studies suitable for inclusion.

2.2. Inclusion Criteria

The criteria for inclusion in this review were: a) application of either response redirection, RIRD, or either of these techniques used in combination with other strategies, to reduce a specified challenging behavior (e.g., stereotypy, pica, self-injury), b) a diagnosis of a development disability for all participants, c) utilization of a single-subject experimental design, and d) publication in an English language, peer-reviewed journal.

2.3. Categorization of Treatment Type

A total of 18 studies met the inclusion criteria and were categorized as using either response redirection or RIRD.

2.4. Treatment Efficacy Calculations

The purpose of the present review was to quantitatively analyze and classify the empirical support for response redirection as an intervention for challenging behavior in developmental disabilities. In order to quantify effective treatment outcomes two measures of effect size were calculated for each study. These included: 1) Percentage reduction from baseline (PRB) to treatment outlined by Kahng, Iwata, and Lewin (2002) to determine behavior reduction; 2) Percentage of zero data (PZD; Scotti, Evans, Meyer, & Walker, 1991) calculated to determine the degree to which a treatment eliminated the target behavior (Scotti et al., 1991). PZD has been found to be a stringent measure of effect size (Campbell, 2003) and although behavior reduction is an indication of treatment success, determining the degree of behavior suppression in autism spectrum disorder intervention, is an important indicator of successful treatment approaches (Scotti et al., 1991).

Furthermore, the evaluative method outlined by Reichow (2011) was used to determine whether redirection and RIRD constituted evidence-based practice (EBP). This

method was selected because it was designed to evaluate research involving specific interventions. It is best suited to evaluating empirical research on interventions for individuals with autism spectrum disorders that employed either, group research designs or single-subject experimental designs, which often rely on visual analysis and demonstration of experimental control (Reichow, 2011).

2.4.1. Percentage reduction from baseline (PRB). PRB was calculated firstly, by computing the mean value of the last five data points (or the maximum number of data points available if less than five are presented) in the final baseline phase. Secondly, the mean value of the last five data points of the final treatment phase (or an equal number of data points to those used during baseline calculations) was computed. Thirdly, the percentage reduction from baseline to treatment was calculated by subtracting the mean treatment value from the mean baseline value, dividing this sum by the mean baseline value, and multiplying by 100%. To ensure the accuracy of data point estimations, and subsequent calculations, a second rater independently reviewed all articles. Interobserver agreement was calculated between the two raters across all studies within the review. An agreement was defined as both raters recording the same percentage reduction and was determined by the following formula:

$$\# \text{ of agreements} / [\# \text{ of agreements} + \text{disagreements}] * 100 = \%$$

Mean interobserver agreement for the calculation of PRB was found to be 95.6% (range 72.22-100%).

2.4.2. Percentage of zero data (PZD). PZD was calculated by identifying the first data point to reach zero during the treatment phase and determining the percentage of subsequent data points which remained at zero. Wendt's (2009) guidelines for the interpretation of PZD scores were used. These guidelines suggest that PZD scores of <18% are indicative of "ineffectiveness", scores of 18-54% reflect "questionable effectiveness",

scores of 55-80% are suggestive of “fair effectiveness”, and scores of >80% indicate “high effectiveness”. Interobserver agreement for PZD was also assessed between two raters across all studies with an agreement defined as both raters recording the same percentage of data points at zero. The same formula outlined above was used. Mean interobserver agreement for the calculation of PZD scores was 100%.

2.4.3. Evidence-based Practice (EBP). The evaluative method outlined by Reichow (2011) involved a comprehensive protocol implemented across three stages. First, an assessment of the quality of each study was conducted using what Reichow (2011) describes as primary quality indicators (participant characteristics, independent variables, dependent variables, baseline conditions, visual analyses, experimental control) and secondary quality indicators (interobserver agreement, kappa, blind raters, fidelity, generalization or maintenance, and social validity). Each indicator was rated as either “high quality” (H), “acceptable quality” (A) or “unacceptable quality” (U). Second, ratings of quality indicators were synthesized using a scoring criterion with studies receiving a categorization of: “strong”; “adequate”; or “weak. Third, studies were aggregated based on the number of participants who received effective treatment in studies categorized as “strong” or “adequate” using the following categories: group research designs earning a “strong” rating (Group_s); group research designs earning an “adequate” rating (Group_A); single subject experimental designs earning a “strong” rating (SSED_s) and single subject experimental designs earning an “adequate” rating (SSED_A). The formula used for determining EBP status was:

$$\begin{aligned} &(\text{Group}_s * 30) + (\text{Group}_A * 15) + \\ &(\text{SSED}_s * 4) + (\text{SSED}_A * 2) = Z \end{aligned}$$

Finally, a Z score indicating the total number of points for an intervention was employed with ≤ 60 points indicating “established EBP” and >30 points indicating “probable EBP”

(see Reichow, 2011). Interobserver agreement of EBP was calculated to assess agreement between coders. Agreement was assessed across all ratings for primary quality indicators, secondary quality indicators, and research strength ratings, for all included studies, using the same formula outlined above. A mean interobserver agreement for the calculation of strength rating scores for each study was 92.6% (range 83.33-100).

3. Results

Eight studies were categorized as using response redirection either alone or within a multi-element treatment package. Table 1 summarizes the sample characteristics, target behaviors, assessments utilized, behavioral functions identified, experimental design, treatments implemented, treatment outcomes, treatment efficacy, and strength rating (strong/adequate/weak) for each of these studies. Ten studies were categorized as evaluating the use of RIRD either alone or within a mixed treatment package. Table 2 summarizes the same characteristics of these studies.

Insert Table 1 about here

Insert Table 2 about here

3.1. Participants

In total, 38 participants were included across the 18 studies. The mean age of participants was 13.4 years (range 3-66). Thirteen studies (72.22%) involved children (<18

years), four studies (22.22%) included adults, and one study (5.55%) included both children and adults. Autism was the most common diagnosis among participants (60.52%), followed by autism and a co-morbid intellectual disability (15.79%), and intellectual disabilities (7.89%). Other diagnoses, either primary or co-morbid, included bipolar disorder, cerebral palsy, microcephaly, pervasive developmental disorder not otherwise specified, fetal hydantoin syndrome, seizure disorder, and ADHD (See Tables 1 & 2). Only three studies (Duker & Schaapveld, 1996; McEntee et al., 1996; Turner et al., 1996) provided information on the methods used to diagnose participants with intellectual disability or autism. The remaining studies did not specify the diagnostic instruments used in classifying participants' developmental delay.

3.2. Target Behaviors

The majority of studies (n=13; 72.22%) targeted either motor or vocal stereotypy (see Tables 1 & 2). Two studies (11.11%) targeted self-injurious behavior, two studies (11.11%) targeted pica, and one study (5.55%) targeted breath-holding.

3.3. Assessments

The range of assessments used during the studies can be seen in Tables 1 and 2. A functional analysis (an experimental manipulation of consequences to determine maintaining variables of specific target behaviors in either analog or natural environments) was conducted to identify the function of target behaviors in twelve studies (66.67%). A further two (11.11%) studies incorporated a functional assessment of target behaviors (indirect and direct methods indicating correlations between causal factors and problem behavior). Four studies included a preference assessment (22.22%), three studies (16.67%) included a measure of social validity, and two studies (11.11%) included a competing stimulus assessment. Other

assessments included a preliminary assessment of motor directive performance, a matched stimuli assessment, and a treatment integrity assessment.

3.4. Behavioral Function

Of the 14 studies (77.78%) which assessed the function of target behaviors, 12 studies (85.71%) identified automatic reinforcement as the sole maintaining variable of target behaviors. Of the remaining two studies, Casella, Sidener, Sidener and Proger (2011) found that vocal stereotypy was maintained by automatic reinforcement for one participant, and multiply controlled by automatic reinforcement and attention for the second participant. Reed and Martens (2008) found that breath-holding was maintained by social positive reinforcement in the form of attention. Four studies did not provide a functional assessment or analysis of target behaviors.

3.5. Experimental Design

Tables 1 and 2 summarize the experimental designs employed by the studies reviewed. Reversal designs were most commonly used, appearing in 14 studies (77.78%). Two studies (11.11%) utilized a combined reversal and multi-element design. The remaining designs included a nonconcurrent multiple baseline across participants and a multi-element design.

3.6. Treatment Efficacy Calculations (PRB and PZD)

The efficacy of the treatments provided within individual studies are presented in Tables 1 and 2. Table 3 provides an overview of treatments, target behaviors and treatment efficacy calculations. Results are presented in the following order: overview of study characteristics; analysis of treatment efficacy; summary of research strength ratings and Z scores indicating EBP status. Table 3 shows that Vocal RIRD, involving verbal interruption

and redirection to an alternative vocal response, was the most frequently implemented intervention. However, although an average reduction of 77.66% in stereotypy was identified from baseline phase to intervention across studies, a PZD analysis indicated that it was an ineffective intervention for suppressing stereotypy. Vocal RIRD was combined with a variety of other interventions such as verbal operant training, the provision of matched stimulation, differential reinforcement of incompatible behavior, and medication. In all cases, the target behavior was reduced by more than 50% from baseline levels. However, PZD statistics indicated that each of these interventions was either ineffective, or showed questionable effectiveness, in suppressing target behaviors.

Insert Table 3 about here

Motor RIRD, involving verbal interruption and redirection to an alternative motor response, has been studied less commonly. In the current review, Motor RIRD alone was demonstrated to produce reductions of greater than 80% in vocal and motor stereotypy but was shown to be an ineffective method of suppressing such behaviors. Motor RIRD used in combination with differential reinforcement of alternative behavior and the provision of competing stimuli lead to a 96.8% reduction in pica. According to Wendt's (2009) guidelines for the interpretation of PZD scores this was a fairly effective method of suppressing the behavior (Hagopian et al., 2011). A variety of combined interventions incorporating response redirection were evaluated as treatments for motor and vocal stereotypy, self-injurious behavior, pica, and breath holding (see Table 3). Target behavior was redirected in a variety of ways including: redirection to a motor activity; redirection to preferred stimuli; response blocking and redirection to preferred stimuli; physical redirection; physical redirection in

combination with noncontingent reinforcement and differential reinforcement of other behaviors, RIRD to academic tasks, and response interruption. All implementations led to at least a 40% reduction in target behaviors although some treatment packages were markedly superior to others (range of PRB: 43.48-100%). However, behavior suppression (PZD) was only reported for pica demonstrating response blocking and redirection to preferred stimuli as a highly effective treatment for this behavior.

As can be seen in Tables 1 and 2, the efficacy of both redirection and RIRD interventions were variable. However, the use of functional assessment or analysis did not appear to account for differences in treatment efficacy. Function-based interventions resulted in an average PRB of 77.10 and an average PZD score of 19.9, indicative of ineffective behavioral suppression. Correspondingly, non function-based interventions resulted in an average PRB of 74.84 and an average PZD score of 1 also indicative of ineffective behavioral suppression.

A comparison of the effectiveness of treatments incorporating a redirection component and treatments incorporating RIRD was conducted. Treatments incorporating a redirection component led to a mean reduction of 72.53% (range 43.48-100) from baseline levels of the target behaviors, and received a mean PZD score of 16.35 which indicated that such treatments are typically ineffective at suppressing challenging behaviors. Treatment incorporating a RIRD component was slightly more effective and led to a mean reduction of 77.25% (range 43.64-99.48) from baseline levels of the target behaviors, but led to a mean PZD score of 9.78 which indicated that it too was ineffective at suppressing target behaviors.

Increases in alternative appropriate behavior, including appropriate vocalizations, on-task behavior, leisure item engagement, and independent discards of inedible items, were

more frequently reported (70%) in studies evaluating treatments with an RIRD component than in studies (25%) evaluating treatments with a redirection component.

Few data were presented on the maintenance or generalization of treatment effects. Two studies reported some maintenance of treatment effects (Ahearn et al., 2007; McEntee et al., 1996). One study reported that the treatment effects did not generalize to novel settings or instructors (Cassella et al., 2011). Two studies compared the efficacy of interventions in a clinical setting and in a natural setting with both finding that intervention in the natural environment was more effective in reducing challenging behavior (Hagopian et al., 2011; Turner et al., 1996).

3.7. Research Strength and Evidence-Based Practice Evaluation

An evaluation of the research strength of included studies, in accordance with Reichow's (2011) criteria, led to seven studies (38.89%) being rated as "adequate" and 11 studies (61.11%) being rated as "weak". None of the included studies were rated as "strong".

For treatments incorporating a redirection component, an evidence-based status Z score of 18 was calculated $[(0*30)+(0*15)+(0*4)+(9*2) = 18]$, indicating that such interventions cannot be categorized as evidence-based practice (Reichow, 2011). Treatments incorporating a RIRD component received a Z score of 6 $[(0*30)+(0*15) + (0*4)+(3*2) = 6]$ and thus, according to Reichow's (2011) criteria, do not currently constitute evidence-based practice.

3.8. Research Strength and Treatment Efficacy

Treatment efficacy, using PBR, was compared to research strength rating (adequate/weak) in order to determine whether such ratings were related to behavior reduction. Treatments classified as "adequate" had a mean PRB of 74.32% (range 56.62-100)

and a PZD score of 18.11%. Treatments classified as “weak” had a mean PRB of 78.43% (range 43.48-99.48) and a mean PZD score of 9.08%.

4. Discussion

Interventions involving response redirection have been primarily used to treat automatically reinforced motor or vocal stereotypy among children diagnosed with developmental disabilities. However, in spite of the widespread use of such interventions in practice, relatively few empirical studies to date have evaluated the efficacy of such treatments. The current review identified a number of variants of response redirection procedures. It was most commonly implemented with response interruption as a treatment for vocal stereotypy in the manner first described by Ahearn et al. (2007). However, studies also evaluated redirection to a variety of different stimuli or activities, physical and verbal redirection, and the combination of response interruption with response redirection or RIRD with other procedures, such as differential reinforcement, noncontingent reinforcement, verbal operant training, and medication. The efficacy of such permutations varied with some treatments resulting in insubstantial decreases in challenging behaviors and other applications virtually eliminating challenging behavior.

A comparison of treatment packages incorporating response redirection and treatment packages with RIRD revealed that both were similarly effective at reducing challenging behavior from baseline levels and that neither effectively suppressed challenging behavior. However, treatments involving RIRD more frequently led to increases in alternative appropriate behaviors which may be an important factor for practitioners to consider. The finding that neither type of intervention led to the suppression of target behaviors should also be considered by practitioners when developing treatments. For behaviors such as stereotypy, that are not resulting in harm to the individual themselves or others, but which have a

negative impact when they occur at high frequencies, it may be acceptable to utilize response redirection procedures which are likely to reduce the behaviors to low levels but may not result in total elimination. For behaviors such as self-injury, where even low levels of the behavior can lead to physical harm and other undesirable consequences, interventions involving response redirection, which are unlikely to completely eliminate or suppress the behavior, may be unsuitable. However, results of the current review suggest that response redirection may be a useful treatment for pica; two studies demonstrated effectiveness in suppressing potentially dangerous pica (Hagopian & Toole, 2009; Hagopian et al., 2011).

Research interest in RIRD is increasing and several of the included studies have further refined and elucidated the procedure first described by Ahearn and colleagues (2007). For instance, Ahrens et al. (2011) did not require participants to complete three consecutive responses in the absence of stereotypy for the termination of RIRD procedures but their intervention nonetheless occasioned significant decreases in stereotypy. The authors also found that redirection to a motor activity, rather than a vocal activity, was just as effective, and sometimes more so, at reducing vocal and motor stereotypy. This may indicate that the efficacy of the intervention is not always dependent on matching topographies of the redirection activity and the target behavior. Given this finding, Ahrens et al. (2011) evaluated whether punishment or extinction were responsible for treatment effects and found that the pattern of responding during schedule thinning suggested that RIRD functions to reduce behavior through punishment.

Using the criteria outlined by Reichow (2011) to provide an evaluation of existing empirical investigations of response redirection or RIRD, revealed that such interventions may not be considered evidence-based practice at this time. While these interventions typically result in large decreases from baseline levels of challenging behavior, the studies identified as part of this review often lacked rigorous evaluation, and thus do not constitute a

solid base from which to draw conclusions about the efficacy of such treatments. Future evaluations involving component analysis to determine actual treatment effects and the extent of behavior change using such procedures are warranted.

To our knowledge, the current review is the first to apply Reichow's (2011) criteria for determining evidence-based practice. The development of such detailed, thorough criteria is a positive step for single-subject research and may lead to a greater appreciation and acceptance of such designs. However, among the studies included in this review, the majority were rated as "weak" and none were rated as "strong". According to Reichow's criteria, studies were primarily faulted due to issues with baseline, including unstable baselines or insufficient baseline data points, as well as inadequate participant description. The infrequent assessment of maintenance or generalization among the studies was also problematic. It is unlikely that such issues are unique to this body of literature and it may be the case that a common feature of studies reporting single-subject research designs is that they lack some of the rigorous methodological detail described under Reichow's quality indicators. Thus, the use of such criteria to evaluate single-subject research may lead to a heightened awareness of excellence in methodological rigor and improvements in planning, conducting and reporting the findings of single-subject research. While the evaluative method in determining evidence-based practice employed within this review is well-described and objectively outlined, there are several elements which may be considered over-stringent. For example, a measure of treatment fidelity must be included in 100% of treatment sessions if it is to be rated positive. Several studies included in this review included treatment fidelity measures across a large percentage of treatment sessions but failed to meet the outlined fidelity criterion. Furthermore, for the quality indicator of "generalization or maintenance" to be marked as positive, data must be collected post-treatment. Several studies included generalization

probes during treatment phases but this did not constitute the assessment of generalization according to Reichow's criterion.

In addition to the evaluative method outlined by Reichow (2011), other evidence-based practice criteria have been developed and used (e.g., Carr et al., 2009; Chambless & Hollon, 1998). Such criteria may involve less stringent indicators than the methodology employed within the current review and therefore, it is possible that more favorable outcomes may have been demonstrated, if alternative assessment methods had been used. Future research should examine the comparative use of these methods to determine differential outcomes of treatment approaches as evidence-based practice.

A further issue to consider when interpreting EBP in accordance with the current criteria is that the research strength categorization (based on a synthesis of a range of quality indicators) outlined in Reichow's evaluative method did not differentiate studies based on behavior reduction (PBR calculations). Treatments classified as "adequate" had a mean PRB of 74.32% whereas treatments classified as "weak" had a mean PRB of 78.43%. Some differentiation was shown however, in relation to behavior suppression (PZD calculations). Treatments classified as "adequate" had a mean PZD score of 18.11% and treatments classified as "weak" had a mean PZD score of 9.08%. Further investigation of the utility of Reichow's evaluative method in accordance with various effect sizes should be conducted.

The current analysis also suggests that PZD is a useful albeit highly-stringent measure of treatment effectiveness. Campbell (2003) found that PZD scores were correlated with experimental quality, however, such a relationship was not evident in the current study. PZD scores effectively distinguish between highly effective treatments which result in the elimination of challenging behavior, and less effective interventions that may lead to clinically significant reductions in the behavior, but which do not eliminate it. The use of

PZD statistics may be more suitable for the evaluation of treatments designed to reduce severe, harmful challenging behaviors where the total elimination of behavior is the ultimate goal. Among the included studies, interventions for pica were successful in eliminating the behavior which, given the serious nature of this problem behavior, was most likely the desired outcome. For studies in which stereotypy was the target behavior it is likely that the low levels, but non-elimination, of the behavior resulting from treatment in most of the studies would have been an acceptable level within the natural setting. Thus, the PZD score may reflect a degree of success in which clinically significant decreases in challenging behaviors were observed in the majority of studies. Such significant decreases may be considered a valid outcome for treatment providers and clients. Future reviews should perhaps consider whether significant reductions in challenging behavior, or total suppression of behavior, is the desired outcome when selecting an effect size statistic.

The current review has several important implications. First, it demonstrates the need for improvements in conducting single-subject design research if such research is to be evaluated against stringent evidence-based practice criteria such as those outlined here. Second, it suggests that further evaluation of the use of response redirection as a treatment for stereotypy is necessary to determine its effectiveness in behavior reduction and suppression. Finally, studies which have implemented response redirection or RIRD in combination with skills training or reinforcement procedures suggest that it may be a useful component of treatment packages designed to reduce behavior. The extent of the effectiveness of both response redirection and RIRD as elements of multi-component treatments and the precise mechanism of such procedures requires further analysis with individuals with developmental disabilities and challenging behavior.

References

- * Ahearn, W. H., Clark, K. M., MacDonald, R. P., & Chung, B. I. (2007). Assessing and treating vocal stereotypy in children with autism. *Journal of Applied Behavior Analysis, 40*, 263-275.
- * Ahrens, E. N., Lerman, D. C., Kodak, T., Worsdell, A. S., & Keegan, C. (2011). Further evaluation of response interruption and redirection as treatment for stereotypy. *Journal of Applied Behavior Analysis, 44*, 95-108.
- Brosnan, J., & Healy, O. (2011). A review of behavioral interventions for the treatment of aggression in individuals with developmental disabilities. *Research in Developmental Disabilities, 32*, 437-446.
- * Brusa, E., & Richman, D. (2008). Developing stimulus control for occurrences of stereotypy exhibited by a child with autism. *International Journal of Behavioral Consultation and Therapy, 4*, 264-269.
- Campbell, J. M. (2003). Efficacy of behavioral interventions for reducing problem behavior in persons with autism: a quantitative synthesis of single-subject research. *Research in Developmental Disabilities, 24*, 120-138.
- Carr, J. E., Severtson, J. M., & Lepper, T. L. (2009). Noncontingent reinforcement is an empirically supported treatment for problem behavior exhibited by individuals with developmental disabilities. *Research in Developmental Disabilities, 30*, 44-57.
- * Cassella, M. D., Sidener, T. M., Sidener, D. W., & Progar, P. R. (2011). Response interruption and redirection for vocal stereotypy in children with autism: A systematic replication. *Journal of Applied Behavior Analysis, 44*, 169-173.

- * Colón, C. L., Ahearn, W. H., Clark, K. M., & Masalsky, J. (2012). The effects of verbal operant training and response interruption and redirection on appropriate and inappropriate vocalizations. *Journal of Applied Behavior Analysis, 45*, 107-120.
- Chambless, D. L., & Hollon, S. D. (1998). Defining empirically supported therapies. *Journal of Consulting and Clinical Psychology, 66*, 7-18.
- Chowdhury, M., & Benson, B. A. (2011). Use of differential reinforcement to reduce behavior problems in adults with intellectual disabilities: A methodological review. *Research in developmental disabilities, 32*(2), 383-394.
- Cunningham, A. B., & Schreibman, L. (2008). Stereotypy in autism: The importance of function. *Research in Autism Spectrum Disorders, 2*, 469-479.
- * Dickman, S. E., Bright, C. N., Montgomery, D. H., & Miguel, C. F. (2012). The effects of response interruption and redirection (RIRD) and differential reinforcement on vocal stereotypy and appropriate vocalizations. *Behavioral Interventions, 27*, 185-192.
- * Duker, P. C., & Schaapveld, M. (1996). Increasing on-task behavior through interruption-prompting. *Journal of Intellectual Disability Research, 40*, 291-297.
- * Giles, A. F., St Peter, C. C., Pence, S. T., & Gibson, A. B. (2012). Preference for blocking or response redirection during stereotypy treatment. *Research in Developmental Disabilities, 33*, 1691-1700.
- * Hagopian, L. P., & Adelinis, J. D. (2001). Response blocking with and without redirection for the treatment of pica. *Journal of Applied Behavior Analysis, 34*, 527-530.

- * Hagopian, L. P., & Toole, L. M. (2009). Effects of response blocking and competing stimuli on stereotypic behavior. *Behavioral Interventions, 24*(2), 117-125.
- * Hagopian, L. P., González, M. L., Rivet, T. T., Triggs, M., & Clark, S. B. (2011). Response interruption and differential reinforcement of alternative behavior for the treatment of pica. *Behavioral Interventions, 26*(4), 309-325.
- 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.
- Harchik, A. E., Sherman, J. A., & Sheldon, J. B. (1992). The use of self-management procedures by people with developmental disabilities: A brief review. *Research in Developmental Disabilities, 13*, 211-227.
- Kahng, S., Iwata, B. A., & Lewin, A. B. (2002). Behavioral treatment of self-injury, 1964 to 2000. *American Journal on Mental Retardation, 107*, 212-221.
- Kurtz, P. F., Boelter, E. W., Jarmolowicz, D. P., Chin, M. D., & Hagopian, L. P. (2011). An analysis of functional communication training as an empirically supported treatment for problem behavior displayed by individuals with intellectual disabilities. *Research in Developmental Disabilities, 32*, 2935-2942.
- LeBlanc, L. A., Patel, M. R., & Carr, J. E. (2000). Recent advances in the assessment of aberrant behavior maintained by automatic reinforcement in individuals with developmental disabilities. *Journal of Behavior Therapy and Experimental Psychiatry, 31*, 137-154.

- Lerman, D. C., Kelley, M. E., Vorndran, C. M., & Van Camp, C. M. (2003). Collateral effects of response blocking during the treatment of stereotypic behavior. *Journal of Applied Behavior Analysis, 36*, 119-123.
- Lequia, J., Machalicek, W., & Rispoli, M. J. (2012). Effects of activity schedules on challenging behavior exhibited in children with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 6*, 480-492.
- * Liu, Gitz, L., & Banda, D. R. (2010). A replication of the RIRD strategy to decrease vocal stereotypy in a student with autism. *Behavioral Interventions, 25*, 77-87.
- * Love, J. J., Miguel, C. F., Fernand, J. K., & LaBrie, J. K. (2012). The effects of matched stimulation and response interruption and redirection on vocal stereotypy. *Journal of Applied Behavior Analysis, 45*, 549-564.
- McAdam, D. B., Sherman, J. A., Sheldon, J. B., & Napolitano, D. A. (2004). Behavioral interventions to reduce the pica of persons with developmental disabilities. *Behavior modification, 28*, 45-72.
- * McEntee, J. E., Parker, E. H., Brown, M. B., & Poulson, R. L. (1996). The effects of response interruption, DRO and positive reinforcement on the reduction of hand-mouth behavior. *Behavioral Interventions, 11*, 163-170.
- * Miguel, C. F., Clark, K., Tereshko, L., & Ahearn, W. H. (2009). The effects of response interruption and redirection and sertraline on vocal stereotypy. *Journal of Applied Behavior Analysis, 42*, 883-888.
- Mulligan, S., Healy, O., & Lydon, S. (2013). An analysis of treatment efficacy for stereotyped and repetitive behaviors in autism. Unpublished Masters Manuscript.

- Poppes, P., van der Putten, A. J. J., & Vlaskamp, C. (2010). Frequency and severity of challenging behavior in people with profound intellectual and multiple disabilities. *Research in Developmental Disabilities, 31*, 1269-1275.
- Rapp, J. T., Dozier, C. L., & Carr, J. E. (2001). Functional assessment and treatment of pica: A single case experiment. *Behavioral Interventions, 16*, 111-125.
- * Reed, D. D., & Martens, B. K. (2008). Treatment of chronic breath-holding in an adult with severe mental retardation: A clinical case study. *International Journal of Behavioral Consultation and Therapy, 4*, 251-258.
- Reichow, B. (2011). Development, procedures, and application of the evaluative method for determining evidence-based practices in autism. In B. Reichow, P. Doehring, D. V. Cicchetti, & F. R. Volkmar (Eds.), *Evidence-based practices and treatments for children with autism* (pp. 25-39). New York: Springer.
- * Schumacher, B. I., & Rapp, J. T. (2011). Evaluation of the immediate and subsequent effects of response interruption and redirection on vocal stereotypy. *Journal of Applied Behavior Analysis, 44*, 681-685. doi: 10.1901/jaba.2011.44-681
- Scotti, J. R., Evans, I. M., Meyer, L. H., & Walker, P. (1991). A meta-analysis of intervention research with problem behavior: Treatment validity and standards of practice. *American Journal on Mental Retardation, 96*, 223-256.
- Shogren, K. A., Faggella-Luby, M. N., Bae, S. J., & Wehmeyer, M. L. (2004). The Effect of Choice-Making as an Intervention for Problem Behavior A Meta-Analysis. *Journal of Positive Behavior Interventions, 6*, 228-237.
- * Turner, W. D., Realon, R. E., Irvin, D., & Robinson, E. (1996). The effects of implementing program consequences with a group of individuals who engaged in

sensory maintained hand mouthing. *Research in Developmental Disabilities, 17*, 311-330.

Vollmer, T. R. (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. *Research in Developmental Disabilities, 15*, 187-207.

Wendt, O. (2009, May). *Calculating effect sizes for single subject experimental designs: An overview and comparison*. Paper presented at the Ninth Annual Campbell Collaboration Colloquium, Oslo, Norway. Retrieved from:
http://www.campbellcollaboration.org/artman2/uploads/1/Wendt_calculating_effect_sizes.pdf

* indicates studies included in the review

Table 1

Studies employing Response Redirection as an Intervention or an intervention component. PRB (percentage reduction from baseline), PZD (percentage zero data), DRO (differential reinforcement of other behaviors), NCR (noncontingent reinforcement).

| Study | N | Age Range (Mean) | Diagnosis | Target Behavior | Assessments Used | Behavioral Function | Experimental Design | Intervention | Outcome | PRB | PZD | Strength Rating |
|--|---|-------------------------|---|---------------------------|--|-------------------------|--|--|---|-------|-------|-----------------|
| Brusa & Richman (2008) | 1 | 8 | Autism | Stereotypy (string play) | Functional analysis | Automatic reinforcement | ABAB Reversal | Discrimination training with two conditions: Response blocking and vocal redirection; No consequences | Gained experimental control over stereotypy; Stereotypy eliminated during response blocking and vocal redirection condition. | 100 | 72.73 | Adequate |
| Duker & Schaapveld (1996) | 5 | 9-31 years (16.6 years) | Autism and Intellectual disability | Stereotypy | - | - | ABAB Reversal | Interruption-prompting | Intervention led to a significant increase in on-task behavior and decreases in stereotypy. | 72.33 | 4 | Weak |
| Giles, St Peter, Pence, & Gibson (2012) | 3 | 6-10 years (8 years) | Autism | Motor stereotypy | Assessment of motor directive performance; Functional analysis | Automatic reinforcement | Combined reversal and multi-element design | Response redirection; Response blocking | Both procedures substantially decreased stereotypy; Response redirection was preferred by all three participants. | 91.19 | 33.33 | Adequate |
| Hagopian & Adelinis (2001) | 1 | 26 | Intellectual disability and bipolar disorder | Pica | Functional analysis; Preference assessment | Automatic reinforcement | ABAB Reversal | Response blocking and noncontingent access to preferred stimuli; Response blocking, redirection, and noncontingent access to preferred stimuli | Response blocking with redirection led to greater reductions in pica and lower levels of aggression than response blocking alone. | 100 | 90.7 | Adequate |
| Hagopian & Toole (2009) | 1 | 10 | Autism and intellectual disability | Stereotypy (Body tensing) | Functional Analysis; Competing stimulus assessment | Automatic reinforcement | ABAB Reversal | Competing stimuli and verbal redirection | Intervention led to low levels of body tensing. | 88.81 | 9.09 | Weak |
| McEntee, Parker, Brown, & Poulson (1996) | 1 | 66 | Intellectual disability, cerebral palsy, and microcephaly | Hand mouthing | - | - | ABAB Reversal | Response interruption, response redirection, and DRO | Reduced the frequency of hand mouthing; Hand mouthing further decreased during follow-up. | 83.18 | 0 | Adequate |

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|--------------------------------|---|-------------------------|---|------------------------------|--|---------------------------------|------------------------------------|---|---|---|---|----------|
| Reed & Martens (2008) | 1 | 38 | Intellectual Disability | Breath-holding | Functional Behavior Assessment | Attention (Physical and verbal) | Multiple treatment reversal design | Physical redirection; NCR attention; DRO; Physical redirection, NCR attention and DRO | Physical redirection alone led to reductions in breath holding; The treatment package as a whole reduced breath-holding to low levels | Physical redirection: 43.48 | Physical redirection: 0 | Weak |
| Turner, Realon, & Irvin (1996) | 3 | 21- 40 years (29 years) | Intellectual disability; Intellectual disability and cerebral palsy | Self-injurious hand mouthing | Preference assessment; Functional analysis (for two participants); Treatment integrity | Automatic reinforcement | ABAB Reversal | Response interruption, redirection, and introduction of preferred leisure item implemented during: Individual sessions; Small Group Sessions; Natural setting | Intervention led to substantial decreases in self-injury and increases in leisure item engagement. | Individual sessions: 56.62 Small group sessions: 60.18 Natural setting: 63.52 | Individual sessions: 0 Small group sessions: 0 Natural setting: 33.33 | Adequate |

Table 2

Studies employing Response Interruption and Redirection as an Intervention or an intervention component. PRB (percentage reduction from baseline), PZD (percentage zero data), RIRD (response interruption and redirection), DRI (differential reinforcement of incompatible behavior), NCS (noncontingent competing stimuli), DRA (differential reinforcement of alternative behavior), SSRI (selective serotonin reuptake inhibitor).

| Study | N | Age Range (Mean) | Diagnosis | Target Behavior | Assessments Used | Behavioral Function | Experimental Design | Intervention | Outcome | PRB | PZD | Strength Rating |
|---|---|-----------------------|--------------------------|------------------------------------|---------------------|-------------------------|--|------------------------|---|--|--|-----------------|
| Ahearn, Cleark, & MacDonald (2007) | 4 | 3-11 years (7 years) | Autism Spectrum Disorder | Vocal Stereotypy | Functional Analysis | Automatic Reinforcement | ABAB Reversal | RIRD | Led to substantial decreases in vocal stereotypy for all participants and increases in appropriate vocalisations for three participants; Follow-up probes and anecdotal reports indicated maintenance of treatment effects. | 80.12 | 0 | Weak |
| Ahrens, Lerman, Kodak, Worsdell, & Keegan (2011)(i) | 2 | 4-6 years (5 years) | Autism | Vocal Stereotypy | - | - | Combined reversal and multi-element design | Vocal RIRD; Motor RIRD | Vocal and motor RIRD were similarly effective at reducing stereotypy and increasing appropriate vocalisations | Vocal RIRD: 72.54 Motor RIRD: 72.85 | Vocal RIRD: 0 Motor RIRD: 0 | Weak |
| Ahrens et al. (2011) (ii) | 2 | 4-5 years (4.5 years) | Autism | Vocal Stereotypy; Motor Stereotypy | - | - | Combined reversal and multi-element design | Vocal RIRD; Motor RIRD | Motor RIRD was slightly more effective than vocal RIRD at reducing both forms of stereotypy and at increasing appropriate vocalisations | Vocal RIRD for vocal stereotypy: 78.1 Vocal RIRD for motor stereotypy: 80.54 Motor RIRD for vocal stereotypy: 89.9 Motor RIRD for motor stereotypy: 88.75 | Vocal RIRD for vocal stereotypy: 0 Vocal RIRD for motor stereotypy: 0 Motor RIRD for vocal stereotypy: 0 Motor RIRD for motor stereotypy: 0 | Weak |

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|---|---|---------------------------|--|---|--|--|--|--|--|---|---|----------|
| Casella, Sidener, Sidener, & Progar (2011) | 2 | 7.2-4.9 years (6.1 years) | Autism | Vocal stereotypy | Functional behavior assessments; Social validity | Automatic reinforcement and attention; Automatic reinforcement | ABAB Reversal | RIRD | RIRD resulted in immediate and substantial decreases in stereotypy. Treatment effects did not generalize to novel settings or instructors. | 75.25 | 6.25 | Adequate |
| Colon, Ahearn, Clark, & Masalsky (2012) | 2 | 8-10 years (9 years) | Autism Spectrum Disorder | Vocal Stereotypy; Appropriate vocalisations (mands and tacts) | Preference assessments; Functional analysis | Automatic reinforcement | Nonconcurrent multiple baseline design across participants | Verbal operant training; Verbal operant training and RIRD; RIRD | Verbal operant training did not reduce stereotypy to acceptably low levels; RIRD reduced stereotypy to low levels; RIRD and verbal operant training, implemented for one participant, led to further increases in appropriate vocalisations. | Verbal operant training and RIRD: 57.66 RIRD: 70.73 | Verbal operant training and RIRD: 8.34 RIRD: 0 | Weak |
| Dickman, Bright, Montgomery, & Miguel (2012) | 1 | 5.5 years | Pervasive developmental disorder not otherwise specified | Vocal stereotypy | Functional analysis | Automatic reinforcement | Multi-treatment (ABABCBC) Reversal | RIRD; RIRD & DRI | RIRD increased appropriate vocalisations and reduced stereotypy but reductions were not clinically significant; RIRD and DRI further reduced stereotypy and greatly increased appropriate vocalisations. | RIRD: 43.64 RIRD & DRI: 61.82 | RIRD: 0 RIRD & DRI: 0 | Weak |
| Hagopian, Gonzalez, Rivet, Triggs, & Clark (2011) | 2 | 13-19 years (16 years) | Autism, intellectual disability, fetal hydantoin syndrome and seizure disorder; Autism, ADHD, and intellectual disability. | Pica | Functional Analysis; Competing Stimulus Assessment | Automatic reinforcement | Multi-treatment (ABABCBC/ABCACDAD) Reversal | NCS; NCS, RIRD, and DRA (clinic); NCS, RIRD, and DRA (natural environment) | NCS reduced pica but not sufficiently; The treatment package substantially reduced pica; Independent discards increased significantly for one participant but not for the other. | NCS, RIRD, & DRA (clinic): 94.12 NCS, RIRD, and DRA (natural environment): 99.48 | NCS, RIRD, & DRA (clinic): 74.7 NCS, RIRD, & DRA (clinic): 74.34 | Weak |

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|--|---|-----------------------|--------------------------|------------------|--|-------------------------|---|---|---|--|--|----------|
| Liu-Gitz & Banda (2010) | 1 | 10 | Autism | Vocal stereotypy | Functional analysis; Social validity | Automatic reinforcement | ABAB Reversal | RIRD | RIRD effectively reduced vocal stereotypy; Reports of increased appropriate verbal expression | 96.13 | 50 | Adequate |
| Love, Miguel, Fernand, & LaBrie (2012) | 2 | 8-9 years (8.5 years) | Autism Spectrum Disorder | Vocal stereotypy | Preference assessment; Matched stimuli assessment; Functional analysis; Social validity assessment | Automatic reinforcement | Multi-treatment reversal | Matched stimulation; Matched stimulation and RIRD; RIRD | RIRD led to decreases in stereotypy; However, the addition of matched stimulation only led to increased effectiveness for one participant; For both participants, conditions with an RIRD component led to the greatest increases in appropriate vocalisations. | Matched Stimulation and RIRD: 91.85 RIRD: 89.24 | Matched Stimulation and RIRD: 23.65 RIRD: 0 | Weak |
| Miguel, Clark, Tereshko, & Ahearn (2009) | 1 | 4 | Autism | Vocal stereotypy | Functional analysis | Automatic reinforcement | Multi-treatment (ABABC) Reversal | Sertraline (SSRI); RIRD and sertraline; RIRD | Sertraline alone led to high levels of stereotypy and low levels of appropriate vocalisations; Sertraline and RIRD led to notable decreases in stereotypy and increases in appropriate vocalisations; RIRD alone was as effective as RIRD with sertraline | RIRD and Sertraline: 92.68 RIRD: 92.43 | RIRD and Sertraline: 0 RIRD: 0 | Weak |
| Schumacher & Rapp (2011) | 2 | 5-8 years (6.5 years) | Autism | Vocal stereotypy | - | - | Multi-element design with an embedded three-component multiple schedule | RIRD | RIRD decreased stereotypy to low levels; Removal of RIRD did not lead to levels greater than baseline. | 87.27 | 0 | Weak |

Table 3

Applications and Efficacy of Treatment, or Treatment Packages, with Response Redirection or Response Interruption and Redirection. PRB (percentage reduction from baseline), PZD (percentage zero data), NCR (noncontingent reinforcement), DRO (differential reinforcement of other behaviors), RIRD (response interruption and redirection), SSRI (selective serotonin reuptake inhibitor), NCS (noncontingent competing stimuli), DRA (differential reinforcement of other behavior).

| Treatment | No. of Applications | Behaviors Targeted | PRB | PZD (Categorization) |
|--|----------------------------|------------------------------------|------------|-----------------------------------|
| Redirection to motor activity | 4 | Motor stereotypy | 93.93 | 43.18; Questionable Effectiveness |
| Redirection to preferred stimuli | 1 | Motor Stereotypy | 88.81 | 9.1; Ineffective |
| Response blocking and redirection to preferred stimuli | 1 | Pica | 100 | 90.7; High effectiveness |
| Response interruption and redirection to preferred stimuli | 9 | SIB | 60.11 | 11.11; Ineffective |
| Physical redirection | 1 | Breath-holding | 43.48 | 0; Ineffective |
| Physical redirection, NCR, and DRO | 1 | Breath-holding | 71.43 | 0; Ineffective |
| Response interruption and redirection to academic task | 5 | Motor Stereotypy; Vocal Stereotypy | 72.33 | 4; Ineffective |
| Response Interruption, physical redirection, and DRO | 1 | SIB | 83.18 | 0; Ineffective |
| Vocal RIRD | 21 | Vocal stereotypy; Motor stereotypy | 79.05 | 2.98; Ineffective |
| Vocal RIRD and matched stimulation | 2 | Vocal stereotypy | 91.85 | 23.65; Questionable effectiveness |
| Vocal RIRD and verbal operant training | 1 | Vocal stereotypy | 57.66 | 8.34; Ineffective |
| Vocal RIRD and DRI | 1 | Vocal stereotypy | 61.82 | 0; Ineffective |
| Vocal RIRD and SSRI | 1 | Vocal stereotypy | 92.68 | 0; Ineffective |
| Motor RIRD | 4 | Vocal stereotypy; Motor stereotypy | 83.83 | 0; Ineffective |
| NCS, motor RIRD, and DRA | 4 | Pica | 96.8 | 74.52; Fair effectiveness |