

Effects of Reducing Stereotypy on Other Behaviors: A Systematic Review

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Abstract

Researchers have shown that high levels of stereotypy in individuals diagnosed with autism spectrum disorders are correlated with more significant impairments in social and adaptive functioning. Thus, reducing stereotypy may potentially occasion an increase in appropriate social and adaptive behaviors. The purpose of this systematic review was to examine the effects of reducing stereotypy on engagement in other behaviors. Following a thorough literature search, we identified 60 studies that both reduced engagement in stereotypy and measured engagement in at least one other behavior. We divided the studies into six broad categories: noncontingent reinforcement, differential reinforcement, punishment-based interventions, multiple contingencies, physical exercise, and other antecedent-based interventions. The results of our analyses suggest that reducing stereotypy produces reallocation towards other behaviors, albeit not necessarily appropriate. As such, clinicians and researchers targeting stereotypy should plan to strengthen an appropriate alternative behavior while targeting all response forms of stereotypy for reduction. Moreover, our review suggests that measuring untargeted behaviors when implementing interventions designed to reduce stereotypy may be essential in clinical and research settings.

Keywords: autism, collateral behavior, developmental disabilities, intervention, literature review, stereotypy

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1. Introduction

Most children and adults with autism spectrum disorders (ASD) and other developmental disabilities engage in repetitive vocal and motor behaviors, which are generally referred to as stereotypy in the research literature (Bodfish, Symons, Parker, & Lewis, 2000; Campbell et al., 1990; Goldman et al., 2009; MacDonald et al., 2007; Matson & Dempsey, 2008; Matson, Dempsey, & Fodstad, 2009). Stereotypy can assume multiple forms: examples include mouthing non-edible items or body parts, body rocking, hand flapping, repetitive vocalizations, and object twirling or tapping (DiGennaro Reed, Hirst, & Hyman, 2012). In general, these behaviors do not have a social function; that is, stereotypy persists in the absence of social consequences (Rapp & Vollmer, 2005). Typically developing infants often engage in stereotypy, but the frequency of these behaviors decrease after the age of 2 (Thelen, 1981). For many individuals with ASD and other developmental disabilities, stereotypy often continues unabated long after age 2, the effects of which severely curtail the emerging behaviors within their social repertoire (Cunningham & Schreibman, 2008; Goldman et al., 2009; MacDonald et al., 2007). Although researchers have implicated both the dopaminergic system and the basal ganglia, the exact neurobiological mechanisms responsible for the maintenance of stereotypy in individuals with ASD and other developmental disabilities remains largely unknown (Lanovaz, 2011).

One clinical concern with stereotypy is that it has been correlated with other behavioral deficits and excesses. More specifically, researchers have found a positive correlation between engagement in stereotypy and severity of autism, and a negative correlation between engagement in stereotypy and IQ (Bodfish et al., 2000; Campbell et al., 1990; Goldman et al. 2009; Matson, Wilkins, & Macken, 2008). For example, individuals with lower IQs generally engage in more

forms of stereotypy and emit stereotypy more often than do individuals with higher IQs. In a series of studies, Matson and colleagues have also shown that higher levels of stereotypy were associated with more significant impairments in social and adaptive skills (Matson, Hamilton et al., 1997; Matson, Kiely, & Bamburg, 1997; Matson, Minshawi, Gonzalez, & Mayville, 2006; Matson, Smiroldo, & Bamburg, 1998). As such, stereotypy is associated with a paucity of skills essential to facilitate the social participation of individuals with ASD and other developmental disabilities.

The results of the previous research raise the following question: Is the relationship between stereotypy and skill deficits correlational only, or does engagement in stereotypy interfere with the acquisition and maintenance of emerging social and adaptive skills? One approach to answering this question is to implement interventions while also measuring other behaviors. If stereotypy was interfering with the acquisition or maintenance of skills, appropriate behaviors should increase when an intervention designed to reduce stereotypy is being implemented. To this end, several studies have examined the effects of reducing one or more forms of stereotypy on engagement in other appropriate and inappropriate behaviors, but their results have not been systematically compared and reviewed (e.g., Cuvo, May, & Post, 2001; Lang et al., 2010; Rapp, Vollmer, Peter, Dozier, & Cotnoir, 2004; Saunders, Saunders, & Marquis, 1998).

Despite the publication of several review articles on the assessment and treatment of vocal and motor stereotypy (Boyd, McDonough, & Bodfish, 2012; DiGennaro Reed et al., 2012; Lanovaz & Sladeczek, 2012; Rapp & Vollmer, 2005), no prior review has systematically examined the effects of reducing stereotypy on engagement in other behaviors. Conducting a review on the topic may be important because one of the most oft-cited reasons for reducing

stereotypy is that it interferes with learning and engagement in appropriate behaviors (e.g., Cunningham & Schreibman, 2008; MacDonald et al., 2007). Clinicians and researchers both need an overview of what happens to appropriate and inappropriate behaviors when stereotypy is reduced. Thus, the purpose of our study is to systematically review previous research that examined the effects of reducing engagement in stereotypy on other behaviors.

2. Method

To identify relevant articles, we first conducted a literature search in September 2012 in the PsycInfo® database using the keywords *stereotypy*, *stereotyped behavior*, *repetitive behavior*, *stereotypic behavior*, *self-stimulation*, *self-stimulatory*, *sensory reinforcement*, and *automatic reinforcement* combined with *autism*, *pervasive developmental disorder*, *developmental disability*, *intellectual disability*, and *mental retardation* as well as *intervention* and *treatment*. Second, we read the title and abstract of each article and excluded all those that did not involve the treatment of stereotypy. Third, a research assistant reviewed all the remaining articles and retained only those that met the inclusion and exclusion criteria (see below). Fourth, a second assistant reviewed the rejected articles to ensure that no study had been inadvertently left out. Fifth, we examined the references of each article that met the inclusion criteria to identify additional articles that may have been overlooked by our original search terms. Finally, the principal investigator set up a Google Scholar® alert to identify articles that were published or indexed following the initial search (i.e., articles available after September 2012).

To be included in the review, the research study had to (a) include participants with an ASD, an intellectual disability (ID), or a developmental delay (DD), (b) target at least one form of stereotypy, (c) measure at least one other behavior, and (d) implement an intervention that resulted in the reduction of stereotypy. For the purpose of the literature search, we defined

stereotypy as repetitive and invariant vocal and motor behaviors that generally persisted in the absence of social consequences (Rapp & Vollmer, 2005). However, we included all studies regardless of whether the researchers had confirmed an automatic function via a functional analysis. The other behaviors could be either appropriate (e.g., on-task, play, item engagement) or inappropriate (e.g., aggression). We also included studies that targeted one form of stereotypy and examined its effects on other untargeted forms of stereotypy.

Given that the purpose of the review was to examine the effects of reducing engagement in stereotypy on other behaviors, we excluded participants when the intervention failed to reduce stereotypy in studies using single-case experimental designs. For example, if the intervention reduced stereotypy in three of four participants, we only reviewed the results of the three datasets that involved reductions in stereotypy (e.g., Lanovaz, Sladeczek, & Rapp, 2012; Rapp et al., 2013). If the intervention failed to reduce stereotypy in all participants, we did not include the study in the review (e.g., Kane, Luiselli, Dearborn, & Young, 2004). Moreover, we did not review studies that collapsed the stereotypy measures with other disruptive behaviors (e.g., Elliott, Dobbin, Rose, & Soper, 1994; Lamella, & Tincani, 2012). Studies that only used quasi-experimental designs such as a series of nonconcurrent AB designs were also excluded from the review (e.g., Beare, Severson, & Brandt, 2004; Ferreri, Tamm, & Wier, 2006). When both quasi-experimental and experimental designs were used within the same study, we excluded participants with whom a quasi-experimental design was employed (e.g., Colón, Ahearn, Clark, & Masalsky, 2012; Koegel & Covert, 1972; Lancioni, Smeets, Ceccarani, & Goossens, 1983; Lindberg, Iwata, Roscoe, Worsdell, & Hanley, 2003).

3. Results

Table 1 shows a summary of the 60 studies (involving 218 individuals with ASD and other developmental disabilities). To facilitate comparisons, we divided the studies into six broad intervention categories: noncontingent reinforcement (NCR), differential reinforcement, punishment-based procedures, multiple contingencies, physical exercise, and other antecedent-based procedures. Studies that assessed interventions from different categories appear more than once in Table 1.

3.1. Noncontingent Reinforcement

Six of twelve studies involving NCR examined the effects of reducing stereotypy on item engagement (Britton, Carr, Landaburu, & Romick, 2002; Cuvo et al., 2001; Lanovaz et al., 2012; Lindberg et al., 2003; Rapp et al., 2004; Rosales, Worsdell, & Trahan, 2010). In general, levels of item engagement increased during the implementation of NCR (Cuvo et al., 2001; Rapp et al., 2004; Rosales et al., 2010). However, Britton et al. (2002) observed that item engagement increased to socially significant levels only following the introduction of prompts in three individuals with developmental disabilities. Similarly, Lanovaz et al. (2012) found that continuous access to music increased item engagement for just one of the three participants for whom the intervention reduced engagement in stereotypy.

Using NCR to reduce stereotypy may also lead to increased engagement in other appropriate behaviors (Fava & Strauss, 2010; Love, Miguel, Fernand, & LaBrie, 2012; Shapiro, Parush, Green, & Roth, 1997). Notably, Shapiro et al. (1997) showed that engagement in adaptive behaviors increased and stereotypy decreased when participants were in a multisensory environment. Finally, a handful of studies examined the effects of NCR on untargeted problem behaviors with mixed results (Fava & Strauss, 2010; Gunter et al., 1984; Hagopian & Toole,

2009; Rapp et al., 2004; Rapp et al. 2013). For example, Rapp et al. (2013) found that reducing one form of stereotypy using NCR immediately or subsequently increased an untargeted form of stereotypy in 5 of 10 participants. Most other studies have observed no consistent effect on engagement in disruptive behaviors or other forms of stereotypy (Gunter et al., 1984; Hagopian & Toole, 2009; Rapp et al., 2004). One exception is Fava and Strauss (2010), who noted a reduction in disruptive behaviors in the multisensory environment. In sum, these studies indicate that NCR as a stand-alone tactic may increase item engagement, but that the introduction of prompts may be necessary. Moreover, these results suggest that reducing one form of stereotypy may lead to reallocation towards another, untargeted form of stereotypy.

3.2. Differential Reinforcement

Given that differential reinforcement is designed to strengthen behaviors, increased engagement in an appropriate behavior was observed in all individuals who participated in the 10 studies in this category. Five studies assessed the effects of differential reinforcement of alternative behavior (DRA). In all five studies, DRA both reduced stereotypy and increased the alternative behavior (e.g., Koegel & Covert, 1972; Lancioni et al., 2008a, 2008b; Lanovaz, Rapp, & Ferguson, 2013; Saunders et al., 1998). For example, Lancioni et al. (2008a) found that hand mouthing decreased and object-contact responses (via a microswitch) increased when a DRA schedule was in effect for a girl with multiple disabilities. In a recently published study, Lanovaz et al. (2013) observed that implementing a DRA schedule for an alternative behavior associated with low levels of stereotypy (i.e., sitting), not only increased sitting but also reduced engagement in the automatically reinforced behavior.

Four other studies examined the effects of treatment packages involving differential reinforcement and prompting on engagement in stereotypy and other behaviors (Lee, Odom, &

Loftin, 2007; Loftin, Odom, & Lantz, 2008; Machalicek et al., 2009; Stahmer & Schreibman, 1992). In one of these studies, Machalicek et al. (2009) used activity schedules and task correspondence training, which involved a combination of prompting and differential reinforcement to increase engagement in play while reducing engagement in automatically reinforced challenging behaviors. In the only study examining differential reinforcement of other behavior (DRO), Haring, Breen, Pitts-Conway, and Gaylord-Ross (1986) found that reducing stereotypy using a DRO schedule increased correct responding on tasks in two children with autism. In general, the results of studies on differential reinforcement are fairly consistent as the interventions increase engagement in appropriate, alternative behaviors.

3.3. Punishment-Based Interventions

In total, nine studies examined the effects of reducing stereotypy using punishment on engagement in other behaviors. Five studies measured untargeted forms of stereotypy and clearly showed that targeting only one response form may increase other response forms of stereotypy (Rapp, 2005; Rapp et al., 2004; Rollings & Baumeister, 1981; Rollings, Baumeister, & Baumeister, 1977; Simpson & Swenson, 1980). Interestingly, Rapp et al. (2004) systematically blocked various response forms of stereotypy in four children with developmental disabilities and found that blocking increased at least one and also decreased at least another untargeted response form of stereotypy for three participants. The four studies that measured alternative, appropriate behaviors observed an increase in three of six participants (J. Anderson & Le, 2011; Conroy, Asmus, Sellers, & Ladwig, 2005; Simpson & Swenson, 1980; Wells, Forehand, Hickey, & Green, 1977). For example, J. Anderson and Le (2011) observed that using overcorrection to reduce vocal stereotypy produced higher levels of item engagement than DRA. Finally, Hagopian and Toole (2009) showed that implementing response blocking to reduce stereotypy

may increase aggression. The nine studies suggest that targeting just one response form of stereotypy for reduction may increase either appropriate or inappropriate untargeted behaviors.

3.4. Multiple Contingencies

Researchers have conducted 18 studies in which the effects of two interventions were assessed together. First, 14 studies have combined differential reinforcement with a punishment contingency (Ahearn, Clark, MacDonald, & Chung, 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; C. M. Anderson, Doughty, Doughty, Williams, & Saunders, 2010; Aurand, Sisson, Aach, & Van Hasselt, 1989; Boyd, McDonough, Rupp, Khan, & Bodfish, 2011; Colón et al., 2012; Denny, 1980; Dickman, Bright, Montgomery, & Miguel, 2012; Fellner, Laroche, & Sulzer-Azaroff, 1984; Guzinski, Cihon, & Eshleman, 2012; Lancioni et al., 1983; Love et al., 2012; Miguel, Clark, Tereshko, & Ahearn, 2009; Pastrana, Rapp, & Frewing, 2013). Nine of these studies used response interruption and redirection (RIRD). For example, Ahearn et al. (2007) interrupted vocal stereotypy using contingent demands requiring vocal responses and socially reinforced appropriate vocalizations, which led to an increase in appropriate vocalizations in three of four participants with ASD. In a variation, Ahrens et al. (2012) showed that RIRD requiring motor responses also increased appropriate vocalizations. However, Dickman et al. (2012) showed that it may be necessary to add another reinforcer (e.g., tokens) in order to increase appropriate vocalizations to significant levels. In a study using DRA and punishment on behaviors other than appropriate vocalizations, Lancioni et al. (1983) showed that the addition of punishment during DRA may not only reduce stereotypy, but also increase engagement in task-related responding. Researchers have also shown that reducing one form of stereotypy using blocking or interruption may increase or fail to reduce untargeted forms of stereotypy (Aurand et al., 1989; Feller et al., 1984; Pastrana et al., 2013).

Five studies examined the effects of combining NCR with contingent punishment, differential reinforcement, or both (Lerman, Kelley, Vorndran, & Camp, 2003; Love et al., 2012; Rapp, 2004; Rapp et al., 2004; Rodriguez, Thompson, Schlichenmeyer, & Stocco, 2012). For example, Rapp (2004) observed that the removal of music during noncontingent music conditions increased item engagement. Three of the studies found that combining a second intervention with NCR (i.e., prompting, response blocking, or differential reinforcement) was necessary to produce increases in item engagement during the intervention (Lerman et al., 2003; Rapp et al., 2004; Rodriguez et al., 2012). Fifteen of the eighteen studies using multiple contingencies reported increases in engagement in appropriate behaviors when combining more than one intervention. These results suggest that combining interventions may be a suitable treatment option to reducing stereotypy while increasing engagement in other behaviors.

3.5. Physical Exercise

Seven studies examined the effects of physical exercise on stereotypy and other behaviors (Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Cuvo et al., 2001; Kern, Koegel, Dyer, Blew, & Fenton, 1982; Powers, Thibadeau, & Rose, 1992; Reid, Factor, Freeman, & Sherman, 1988; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980). Four of these studies showed that the reductions in stereotypy were associated with increases in immediate or subsequent engagement in academic and leisure activities (Cuvo et al., 2001; Kern et al., 1982; Powers et al., 1992; Reid et al., 1988). The effects of physical exercises on correct responding were more equivocal: Rosenthal-Malek and Mitchell (1997) conducted a study in which correct responding increased following exercises whereas Watters and Watters (1980) found no consistent effects. Researchers have also observed that out-of-seat behavior and inappropriate vocalizations may decrease following physical exercise (Celiberti et al., 1997; Reid et al., 1988).

3.6. Other Antecedent-Based Interventions

Researchers have also examined the effects of additional interventions on engagement in stereotypy and other behaviors. Three studies reported the effects of pre-session access to stereotypy or to environmental contingencies with abolishing operation (AO) effects on subsequent engagement in appropriate behaviors (Lang et al., 2009, 2010; Chung & Cannella-Malone, 2010). For example, Lang et al. (2010) showed that functional play increased to a greater extent when training sessions were preceded by free access to object stereotypy. On the other hand, Chung and Cannella-Malone (2010) showed that correct responding increased when sessions were preceded by activities that reduced engagement in stereotypy. Other antecedent interventions such as priming, modifying the task presentation and the environment, implementing massage therapy, and increasing the response effort to engage in stereotypy may also lead to response reallocation towards appropriate engagement (Bennett, Reichow, & Wolery, 2011; Escalona, Field, Singer-Strunck, Cullen, & Hartshorn, 2001; Mace, Browder, & Martin, 1988; Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002; Smith, Watthen Lovaas, & Lovaas, 2002; Zhou, Goff, & Iwata, 2000).

Nuzzolo-Gomez et al. (2002) showed that conducting toy play conditioning prior to sessions (i.e., similar to priming) reduced stereotypy and increased appropriate item engagement in three children with autism. In a unique study, Zhou et al. (2000) showed that increasing response effort to engage in hand mouthing by augmenting resistance for elbow flexion increased item engagement in four individuals with an ID. Other researchers have manipulated the environment by involving a peer without a delay, by increasing the pace of instruction, or by modifying the structure of task presentation, all of which have increased engagement in play and on-task behaviors (Bennett et al., 2011; Mace et al., 1988; Smith et al., 2002). Finally, Escalona

et al. (2011) showed that, on average, children who received massage therapy had reduced levels of stereotypy accompanied by increased on-task behavior and attentiveness. The previous studies indicate that various antecedent-based procedures may also produce beneficial effects on appropriate behaviors in addition to reducing stereotypy.

4. Discussion

Altogether, the results of the studies reviewed suggest that reducing stereotypy generally leads to changes in other behaviors. The studies using punishment alone are the most relevant to examine the effects of reducing stereotypy on other behaviors due to the absence of confounding variables that may alter the latter (e.g., reinforcement, availability of novel preferred items). Researchers have shown that reducing stereotypy using punishment alone may lead to reallocation towards untargeted forms of stereotypy, other inappropriate behaviors, or appropriate behaviors, which supports the hypothesis that engaging in stereotypy may interfere with the development of more appropriate alternatives (e.g., J. Anderson & Le, 2011; Hagopian & Toole, 2009; Rollings & Baumeister, 1981). Similarly, studies showing that the introduction of punishment was necessary to increase an appropriate behavior (despite the presence of another intervention) also indicate that it may be necessary to reduce stereotypy in order to produce response reallocation (e.g., Feller et al., 1984; Rapp, 2004; Rodriguez et al., 2012). Interventions that produce an AO and subsequently lead to reductions in stereotypy as well as increases in alternative behaviors further support the notion that stereotypy interferes with engagement in other behaviors (Chung & Cannella-Malone, 2010; Lang et al., 2009; Lang et al., 2010).

Although the other interventions reviewed also produced increases or reductions in other behaviors, the observed changes could not be solely attributed to reductions in stereotypy. During NCR, the participants received access to preferred items that were previously

unavailable. Thus, the observed changes in engagement were more likely the product of the availability of new items, which increased engagement in behaviors (i.e., playing, manipulation) incompatible with some forms of stereotypy (e.g., Lindberg et al., 2003; Rapp et al., 2004; Rosales et al., 2010). However, NCR may lead to no changes or increases in untargeted forms of stereotypy when engagement is not incompatible (e.g., listening to music is not incompatible with motor stereotypy), suggesting that reducing stereotypy may produce reallocation towards other behaviors, albeit not necessarily appropriate (Gunter et al., 1984; Rapp et al., 2013). The increases in other behaviors during differential reinforcement were undoubtedly the product of reinforcement, which strengthened an alternative behavior while reducing engagement in stereotypy (e.g., Lancioni et al., 2008a; Lanovaz et al., 2013; Lee et al., 2007; Loftin et al., 2008; Machalicek et al., 2009). Physical exercise produces many collateral effects; thus, it remains unclear what behavioral mechanisms are responsible for increasing alternative behavior while reducing stereotypy (e.g., Kern et al., 1982; Reid et al., 1988).

To our knowledge, our review is the first to systematically examine what happens to other behaviors when an intervention reduces engagement in stereotypy. The results are consistent with studies that showed that stereotypy was correlated with more important deficits in adaptive behavior (e.g., Matson et al., 1997). Moreover, the review extends these results by showing that, in general, reducing stereotypy may increase other behaviors. As such, the relationship between stereotypy and appropriate adaptive behaviors appears to be causal rather than only correlational. In other words, engagement in stereotypy may hinder the development of social and adaptive skills by limiting engagement in appropriate behaviors. However, reducing stereotypy does not necessarily lead to increases in appropriate behaviors. As shown by some studies, targeting stereotypy for reduction may lead to increases in other forms of stereotypy

(e.g., Rapp et al., 2013; Rollings et al., 1977). From a clinical standpoint, the results of our review strongly suggest that it may be important to strengthen an appropriate, alternative behavior when reducing stereotypy to minimize reallocation towards other problematic response forms. If punishment is necessary, the review indicates that all forms should be punished simultaneously to prevent undesired reallocation.

This review is limited insofar as we restricted our literature search to peer-reviewed journals, which may be subject to publication bias. Given that researchers are less likely to succeed in publishing non-significant results, the studies reviewed may have been skewed towards observable changes in other behaviors. Second, we did not present the effects of each intervention on stereotypy in Table 1; we solely emphasized other behaviors. Because the inclusion criteria informed the reader that the intervention reduced stereotypy for all participants and the review aimed to examine the effects of reducing stereotypy on other behaviors, describing the effects of each intervention on stereotypy was not essential to meet our purpose. Furthermore, many reviews have already thoroughly described the effects of behavioral interventions on stereotypy (e.g., Boyd et al., 2012; Lanovaz & Sladeczek, 2012; Rapp & Vollmer, 2005).

As the clinical utility of reducing stereotypy without any collateral changes is limited and these changes seem highly idiosyncratic, both researchers and clinicians should continue measuring untargeted behaviors when assessing the effects of interventions designed to reduce stereotypy. To further improve the assessment and treatment of stereotypy, researchers should also conduct comparative studies to examine the most effective interventions for reducing stereotypy and increasing appropriate behaviors. Although single-case experimental designs are important and informative in the development stages of novel interventions, conducting

controlled group trials may further support the implementation of some of the treatments in applied settings. Finally, nearly all studies reviewed examined the effects of reducing stereotypy on specific other behaviors (e.g., item engagement). Because the fundamental purpose of treating ASD and other developmental disabilities is to facilitate social participation, future research should increase the emphasis on measuring behaviors that will directly impact social participation and the social validity of the perceived changes.

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Table 1

Summary of Articles on the Effects of Reducing Stereotypy on Other Behaviors

Study	Participants	Design	Intervention	Effects on Other Behaviors
<i>Noncontingent Reinforcement</i>				
Britton et al. (2002)	2 with ID 1 with DD	Reversal	NCR + prompt	Increased item engagement in all participants (only with prompt)
Cuvo et al. (2001) Experiment 2 only	1 with ASD 2 with ID	Multielement	NCR (multisensory environment)	Increased levels of engagement in all participants
Fava & Strauss (2010)	9 with ASD 18 with ID	Group comparisons	NCR (multisensory environment and preferred item)	Multisensory environment decreased disruptive behavior in all groups whereas NCR with preferred item increased active and social behaviors in individuals with ID only (based on data collapsed within groups)
Gunter et al. (1984)	2 with ASD	Reversal with multiple baseline across settings	NCR (music)	Produced no consistent effect on untargeted forms of motor stereotypy
Hagopian & Toole (2009)	1 with ASD	Reversal	NCR + prompt	Produced no clear effect on aggression
Lanovaz et al. (2012)	3 with ASD	Multielement	NCR (music)	Increased item engagement in one of three participants
Lindberg et al. (2003)	4 with ID	Reversal	NCR	Experiment 1: Decreased engagement with low preference items during brief sessions as well as decreased engagement with high preference items and increased engagement in low preference items during extended sessions for one participant Experiment 2: Increased item engagement during brief sessions for three participants, but decreased engagement during extended exposure for two participants
Love et al. (2012)	2 with ASD	Reversal	NCR	Increased appropriate vocalizations in one of two participants
Rapp et al. (2004) Experiment 2 only	2 with ASD 1 with ID	Reversal	NCR	Increased item engagement in both participants, but no effect on untargeted response forms of stereotypy

Study	Participants	Design	Intervention	Effects on Other Behaviors
Rapp et al. (2013) Experiment 2 only	10 with ASD	Multielement	NCR	Increased untargeted motor stereotypy in five of ten participants
Rosales et al. (2010)	4 with ASD	Reversal with multielement	NCR	Increased item engagement most when multiple items were available
Shapiro et al. (1997)	20 with ID	AB design with counterbalanced groups	NCR (multisensory environment)	Increased engagement in adaptive behaviors (based on data collapsed across participants)
<i>Differential Reinforcement</i>				
Haring et al. (1986)	2 with ASD	Reversal	DRO	Increased correct responding in both participants
Koegel & Covert (1972)	1 with ASD	Reversal	DRA	Increased correct responding
Lancioni et al. (2008a)	1 with ID	Reversal	DRA	Increased item engagement
Lancioni et al. (2008b)	1 with ID	Reversal	DRA	Increased item engagement
Lanovaz et al. (2013)	1 with ASD	Multielement	DRA	Increased appropriate sitting
Lee et al. (2007)	3 with ASD	Multiple baseline across participants	DR + prompting by peers	Increased social interactions in all participants
Loftin et al. (2008)	3 with ASD	Multiple baseline across participants	DR + prompting and self-monitoring	Increased social interactions in all participants
Machalicek et al. (2009)	2 with ASD	Multiple baseline across participants	DR + prompting	Increased engagement in play in both participants
Saunders et al. (1998)	3 with ID	Reversal	DRA	Increased work engagement in all participants
Stahmer & Schreibman (1992)	3 with ASD	Multiple baseline across participants	DR + prompting + self-management	Increased engagement in play in all participants

Study	Participants	Design	Intervention	Effects on Other Behaviors
<i>Punishment-Based Interventions</i>				
Anderson & Le (2011)	1 with ASD	Reversal	Overcorrection	Increased item engagement when compared to DRA
Conroy et al. (2005)	1 with ASD	Multiple schedule with reversal	Interruption	Produced no clear effect on on-task behavior
Hagopian & Toole (2009)	1 with ASD	Multielement	Response blocking	Increased aggression
Rapp (2005) Experiment 1 only	1 with ASD	Reversal	Removal of TV	Increased untargeted forms of stereotypy
Rapp et al. (2004) Experiment 1 only	3 with ASD 1 with ID	Reversal	Response blocking	Reduced at least one untargeted form and increased at least another untargeted form in three of four participants
Rollings et al. (1977) Experiment 1 only	1 with ID	Multielement	Overcorrection	Increased untargeted forms of stereotypy
Rollings & Baumeister (1981)	2 with ID	Multiple schedule	Overcorrection	Increased untargeted forms of stereotypy in both participants
Simpson & Swenson (1980)	2 with ASD	Reversal	Overcorrection	Produced no changes in play and reduced at least one untargeted form of stereotypy for both participants; increased proximity to others and one untargeted form of stereotypy for one participant
Wells et al. (1977)	2 with ASD	Multiple baseline across participants and behavior	Positive practice overcorrection	Increased engagement in play in one of two participants
<i>Multiple Contingencies</i>				
Ahearn et al. (2007)	4 with ASD	Reversal	RIRD	Increased appropriate vocalizations in three of four participants
Ahrens et al. (2011)	4 with ASD	Reversal	RIRD (vocal and motor)	Increased appropriate vocalizations in three of four participants for both vocal and motor RIRD
Anderson et al. (2010)	2 with ID	Multiple schedule	Mand training + response blocking	Increased mands in both participants
Aurand et al. (1989)	1 with DD	Multiple baseline across behaviors	DRA + response blocking	Produced no consistent effects on untargeted stereotypy until the response form became the target of blocking

Study	Participants	Design	Intervention	Effects on Other Behaviors
Boyd et al. (2011)	5 with ASD	Multiple baseline across behavior	RIRD + DR	Increased alternative behavior (varied) in all participants
Colón et al. (2012)	2 with ASD	Reversal	RIRD + verbal operant training	Increased appropriate vocalizations in both participants
Denny (1980)	3 with ID	Multiple baseline across participation	DRA + prompt + overcorrection	Increased play in all participants more than DRA alone
Dickman et al. (2012)	1 with ASD	Reversal	RIRD + DR	Increased appropriate vocalizations only with the addition of DR
Feller et al. (1984)	1 with ID	Reversal	DRA + DRO + interruption	Increased untargeted forms of stereotypy and increased play when interruption implemented
Guzinski et al. (2012)	4 with ASD	Multiple baseline across participants	RIRD with tact training	Increased tacts (labeling) in all participants
Lancioni et al. (1983)	2 with ID	Reversal	DRA + punishment	Increased task-related responding in both participants
Lerman et al. (2003)	1 with ASD	Multielement	NCR + response blocking + prompt	Increased item engagement following the introduction of prompting
Love et al. (2012)	2 with ASD	Reversal	RIRD + NCR	RIRD with NCR and RIRD alone increased appropriate vocalizations in both participants
Miguel et al. (2009)	1 with ASD	Reversal	RIRD + Sertraline	Increased engagement in appropriate vocalizations
Pastrana et al. (2013)	2 with ASD	Multielement	RIRD	Temporarily increased untargeted vocal stereotypy for one participant and reduced untargeted vocal stereotypy for the second participant
Rapp (2004)	1 with ASD	Reversal	NCR + Removal of music	Increased item engagement during contingent removal of music only
Rapp et al. (2004) Experiment 3 only	1 with ASD 1 with ID	Reversal	NCR + response blocking or DRA	Increased item engagement with the introduction of response blocking for one participant and with the introduction of DRA for the other
Rodriguez et al. (2012)	3 with ASD	Reversal	NCR + prompt, response blocking, or DR	Increased item engagement following prompt for the first participant, response blocking for the second participant, and differential reinforcement for the third participant

Study	Participants	Design	Intervention	Effects on Other Behaviors
<i>Physical Exercise</i>				
Celiberti et al. (1997)	1 with ASD	Reversal	Physical exercise	Reduced out-of-seat behavior following exercise
Cuvo et al. (2001) Experiment 2 only	1 with ASD 2 with ID	Multielement	Physical exercise	Increased levels of engagement in all participants
Kern et al. (1982)	7 with ASD	Reversal and multiple schedule	Physical exercise	Increased play and on-task behavior in all participants
Powers et al. (1992)	1 with ID	Reversal	Physical exercise	Increased on-task behavior following exercise
Reid et al. (1988)	2 with ASD	Reversal	Physical exercise	Increased on-task behavior, reduced inappropriate vocalizations, and produced no clear effect on prosocial behavior for both participants following exercise
Rosenthal-Malek & Mitchell (1997)	5 with ASD	Multielement	Physical exercise	Increased correct responding following physical exercise (based on data collapsed across participants)
Watters & Watters (1980)	3 with ASD	Multielement	Physical exercise	Produced no clear effect on correct responding following physical exercise
<i>Other Antecedent-Based Interventions</i>				
Bennett et al. (2011)	2 with ASD 1 with DD	Reversal	Graduated guidance	Increased on-task behavior and tasks completed in all participants
Chung & Cannella-Malone (2010) Experiment 3 only	1 with ASD 2 with ID	Multiple baseline across participants	Pre-session access to AO condition	Increased subsequent correct responding in all participants
Escalona et al. (2001)	20 with ASD	Group comparisons	Massage	Increased on-task behavior and attentiveness (based on data collapsed across participants)
Lang et al. (2009)	1 with ASD	Multielement	Pre-session access to stereotypy	Increased functional play and reduced problem behavior
Lang et al. (2010)	4 with ASD	Multielement	Pre-session access to stereotypy	Increased functional play and reduced problem behavior in all participants
Mace et al. (1988)	1 with ID	Reversal	Access to materials and instruction	Increased item engagement when access to materials and instructions provided

Study	Participants	Design	Intervention	Effects on Other Behaviors
Nuzzolo-Gomez et al. (2002) Experiment 2 only	3 with ASD	Multiple baseline across participants	Toy-play conditioning sessions	Increased item engagement in all participants
Smith et al. (2002)	9 with ASD	Within-subjects crossover design	Peer with and without delay	Increased engagement in play and speech when in the presence of peer without delay
Zhou et al. (2000)	4 with ID	Reversal with multiple baseline across participants	Increase response effort	Increased item engagement for all participants

Note. ASD: Autism spectrum disorders; ID: Intellectual disability; DD: Developmental delay; NCR: noncontingent reinforcement; DR: Differential reinforcement; DRA: Differential reinforcement of alternative behavior; DRO: Differential reinforcement of other behavior; RIRD: Response interruption and redirection