
Vocal Stereotypy in Individuals With Autism Spectrum Disorders: A Review of Behavioral Interventions

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Abstract

Vocal stereotypy is a common problem behavior in individuals with autism spectrum disorders that may interfere considerably with learning and social inclusion. To assist clinicians in treating the behavior and to guide researchers in identifying gaps in the research literature, the authors provide an overview of research on vocal stereotypy in individuals with autism spectrum disorders. Specifically, the authors review the research literature on behavioral interventions to reduce engagement in vocal stereotypy with an emphasis on the applicability of the procedures in the natural environment and discuss the clinical implications and limitations of research conducted to date. Researchers have shown that several antecedent-based and consequence-based interventions may be effective at reducing vocal stereotypy. However, the review suggests that more research is needed to assist clinicians in initially selecting interventions most likely to produce desirable changes in vocal stereotypy and collateral behavior in specific circumstances.

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In general, vocalizations emitted by children and adults are maintained by access to or avoidance of a social consequence provided by a listener (e.g., DeLeon, Arnold, Rodriguez-Catter, & Uy, 2003; Lerman et al., 2005; Mace & Lalli, 1991). Skinner (1957) recognized that vocalizations often have a social function and coined the expression “verbal behavior” to describe behaviors maintained by reinforcers mediated by others. Although sounds or words produced by individuals are typically forms of verbal behavior, researchers have shown that some vocalizations persist despite the absence of a listener (e.g., Ahearn, Clark, MacDonald, & Chung, 2007; M. A. Cunningham, 1968; Lovaas, Varni, Koegel, & Lorsch, 1977). For example, a recent survey indicates that nearly 7 out of 10 drivers sing or hum along a melody on the radio in their car (Pew Research Center, 2006). The vocalizations persist even though most drivers are alone in their car and thus no listeners are present to respond to the sounds emitted during the journey. Albeit not directed to a listener, humming or singing alone in one’s car is generally perceived as socially acceptable because it does not interfere with social inclusion and engagement in other tasks (e.g., driving).

According to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000), individuals with autism may also engage in repetitive and stereotyped vocalizations, which may be maintained by nonsocial consequences. In individuals with autism spectrum disorders, repetitive vocalizations with a nonsocial function can be problematic because the behavior may (a) occur at significantly higher rates than in the general population and (b) interfere considerably with learning and social inclusion (MacDonald et al., 2007). These repetitive vocalizations share defining features with stereotypy, which are repetitive and invariant movements that typically persist in the absence of social consequences (Rapp & Vollmer, 2005). As such, repetitive vocalizations with a nonsocial function are often referred to as vocal stereotypy and may take on a wide variety of forms such as humming (e.g., Taylor, Hoch, & Weissman, 2005), producing instrument sounds (e.g., Falcomata, Roane, Hovanetz, Kettering, & Keeney, 2004), repeating previously heard words (e.g., Mancina, Tankersley, Kamps, Kravits, & Parrett, 2000), and grunting (e.g., Ahearn, Clark, Gardenier, Chung, & Dube, 2003).

Rapp and Vollmer’s (2005) definition of stereotypy included a functional component (i.e., being maintained by nonsocial reinforcement), but it is

important to note that some researchers have argued that the definition of stereotypy should be based on topography only (e.g., A. B. Cunningham & Schreibman, 2008). Although repetitive vocalizations may be maintained by social consequences, we focused the review on behaviors maintained by non-social consequences because (a) stereotypy generally persists in the absence of social reinforcement (Matson, Bamburg, Cherry, & Paclawskyj, 1999; Rapp & Vollmer, 2005), (b) interventions for socially reinforced vocalizations considerably differ (see Lancaster et al., 2004; Mace & Lalli, 1991) and would require a separate review, and (c) repetitive vocalizations maintained by social consequences would be more accurately labeled using the verbal operants described and defined by Skinner (1957). Therefore, the current review will use the term *vocal stereotypy* to refer to any repetitive sounds or words produced by an individual's vocal apparatus that are maintained by nonsocial reinforcement.

Clinicians and researchers generally assume that repetitive vocalizations maintained by nonsocial reinforcement produce some type of internal reinforcing stimulation (see Lovaas, Newsom, & Hickman, 1987). The process is referred to as automatic reinforcement in the behavioral literature because engagement in the vocalizations "automatically" produces reinforcement. That is, automatically reinforced behaviors are maintained by consequences that are independent of the individual's social environment (Kennedy, 1994; Vollmer, 1994). However, the specific source of the reinforcing stimulation maintaining vocal stereotypy in individuals with autism spectrum disorders often remains unidentified. For example, a child may emit vocal stereotypy because the auditory stimulation (i.e., sounds) produced by the repetitive vocalizations is reinforcing the behavior. Some studies that have shown that auditory stimulation reduces immediate and subsequent engagement in vocal stereotypy support this position (e.g., Lanovaz, Fletcher, & Rapp, 2009; Rapp, 2007). Then again, the vibration of the rib cage or the vocal cords could also be forms of stimulation maintaining vocal stereotypy. Thus, more research must be conducted to further examine the sensory products that may maintain engagement in the behavior.

To identify the function of repetitive vocalizations, researchers who have conducted studies on vocal stereotypy have relied on experimental functional analyses (e.g., Ahearn et al., 2007; Lanovaz & Sladeczek, 2011; Taylor et al., 2005). Patterns that indicate that repetitive vocalizations are automatically reinforced include (a) the highest levels of vocalizations are observed in no-interaction conditions, (b) high and variable levels of vocalizations are observed across all conditions, or (c) high levels of vocalizations are observed in conditions in which stimulation is low (Hagopian et al., 1997).

One limitation of conducting an experimental functional analysis using a multielement design is that intermittent social reinforcement schedules and carryover effects may also produce some of these same patterns (Vollmer, Marcus, Ringdahl, & Roane, 1995). To extend the methodology, Vollmer et al. (1995) have recommended that researchers and clinicians conduct a series of no-interaction conditions to identify behaviors maintained by automatic reinforcement. The persistence of the behavior across the series of no-interaction conditions supports an automatic function. Generally, this series of no-interaction conditions is conducted following undifferentiated patterns of responding during an experimental functional analysis, but some researchers have recommended starting with a series of consecutive no-interaction sessions (i.e., without conducting a complete functional analysis) to rapidly identify the function of behaviors that are strongly suspected to be at least partly automatically reinforced (Rapp, 2007; Rapp & Lanovaz, 2011).

The other types of functional assessments (i.e., informant-based assessments and descriptive analyses) have serious limitations that restrict their use in identifying the function of repetitive vocalizations, which may explain their absence in the research literature on vocal stereotypy. First, researchers have shown that descriptive analyses produce a high proportion of false positives for the attention function (Hall, 2005; Lerman & Iwata, 1993; Thompson & Iwata, 2007). That is, attention is often correlated with problem behavior regardless of its function because caregivers and educators typically provide attention (e.g., a verbal reprimand) when a problem behavior occurs. Second, informant-based assessments often erroneously identify the function of the target behavior and may also be unreliable (Hall, 2005; Paclawskyj, Matson, Rush, Smalls, & Vollmer, 2001; Tarbox et al., 2009; Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991). Given that repetitive vocalizations may serve different functions from one individual to another, relying on either informant-based assessments or descriptive analyses may misguide researchers and clinicians in providing interventions designed for an erroneous function.

The exact prevalence of vocal stereotypy in individuals with autism spectrum disorders is currently unknown. In a study of autistic symptomatology, parents have reported that more than 85% of children and adolescents with autism emitted atypical, repetitive vocalizations or speech (Mayes & Calhoun, 2011). Given that atypical vocalizations and speech were included in the same category as repetitive vocalizations, we cannot determine the percentage of children that only emitted repetitive vocalizations. In another recent study, MacDonald et al. (2007) compared the duration of vocal stereotypy among 2-, 3-, and 4-year-old children with and without autism spectrum

disorders. The results indicated that children with autism spectrum disorders displayed significantly more vocal stereotypy than typically developing children and the duration of vocal stereotypy in children with autism spectrum disorders was higher in 4-year-old children than in 2-year-old children. Studies on vocal stereotypy in individuals with autism spectrum disorders are limited insofar as no study has examined the prevalence of the behavior in adults. Nonetheless, the results obtained by Mayes and Calhoun (2011) show that the prevalence of atypical and repetitive vocalizations is similar in children and adolescents, which indicates that the behavior may persist in adulthood.

In recent years, there has been a considerable amount of research conducted on the treatment of vocal stereotypy (e.g., Ahearn et al., 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Athens, Vollmer, Sloman, & St. Peter Pipkin, 2008; Cassella, Sidener, Sidener, & Progar, 2011; Lanovaz et al., 2009; Liu-Gitz & Banda, 2010; Rapp, 2007; Rozenblat, Brown, Brown, Reeve, & Reeve, 2009), but to our knowledge, no review has been published to organize and summarize findings for clinicians and researchers who work with individuals with autism spectrum disorders. Vocal stereotypy presents unique challenges that are often different from those presented by motor forms of stereotypy. For example, repetitive vocalizations cannot be physically prompted or stopped, which make them difficult to treat. Furthermore, clinicians must be cautious not to extinguish other types of vocalizations (e.g., appropriate requests) when reducing vocal stereotypy. Therefore, the purpose of the current review is to provide an overview of research on the treatment of vocal stereotypy in individuals with autism spectrum disorders, suggest recommendations for clinicians, and guide researchers in identifying gaps in the research literature. First, we present research on behavioral interventions to reduce engagement in vocal stereotypy with an emphasis on the applicability of the procedures in the natural environment. Second, the clinical implications and the limitations of research are discussed in terms of improving the treatment of vocal stereotypy in applied settings.

Behavioral Interventions for Vocal Stereotypy

A variety of antecedent- and consequence-based procedures have been used to treat stereotypic behaviors (see Rapp & Vollmer, 2005). Even though the treatment of vocal stereotypy presents unique challenges, most interventions designed to decrease repetitive vocalizations have been originally developed to treat motor forms of stereotypy. Researchers have adapted these procedures to deal with the specific difficulties posed by the treatment of vocal stereotypy.

Antecedent-Based Interventions

During antecedent-based treatments, events are manipulated independent of the occurrence of the target behavior. In terms of vocal stereotypy, antecedent-based procedures often involve noncontingent reinforcement (sometimes referred to as environmental enrichment), which consists of providing access to stimuli (e.g., toys) on time-based schedules or on a continuous basis (Carr et al., 2000; LeBlanc, Patel, & Carr, 2000). The stimuli presented during the intervention may be either unmatched or matched to the sensory product of vocal stereotypy (i.e., auditory stimulation). A structurally unmatched stimulus provides stimulation that does not match the putative sensory product of vocal stereotypy. For example, a teacher may provide access to a preferred stimulus that does not produce auditory stimulation (e.g., a puzzle, figurines) to decrease engagement in vocal stereotypy. In contrast, a structurally matched stimulus provides stimulation that matches the putative sensory product of vocal stereotypy. In this case, an educator may provide access to a preferred stimulus that produces auditory stimulation (e.g., sound-producing toys, music) to decrease the repetitive vocalizations. Given that noncontingent reinforcement does not require the undivided attention of a trainer, the intervention is practical to implement in environments in which staff or caregivers are unable to intervene contingent on every occurrence of the behavior.

Several researchers have investigated the effects of unmatched and matched stimulation on vocal stereotypy (Ahearn, Clark, DeBar, & Florentino, 2005; Lanovaz & Argumedes, 2009; Lanovaz et al., 2009, Lanovaz, Sladeczek, & Rapp, 2011; Rapp, 2007). In general, these researchers found that the effects of unmatched and matched stimuli on immediate levels of vocal stereotypy were idiosyncratic. The structurally matched stimuli were more effective at decreasing vocal stereotypy for some individuals (e.g., Lanovaz et al., 2009) whereas the structurally unmatched stimuli were more effective for another (Ahearn et al., 2005). One disadvantage of noncontingent reinforcement is that providing continuous access to preferred stimuli may interfere with engagement in other behavior (e.g., completing tasks, listening to instructions). As such, the intervention is often implemented for short periods of time interspersed with activities that the individual has to complete. Thus, some studies have also examined the effects of noncontingent reinforcement on subsequent engagement (i.e., when the intervention procedures are withdrawn) in vocal stereotypy.

To date, researchers have found that only noncontingent access to structurally matched stimuli (e.g., music, sound-producing toys) decreased subsequent engagement in vocal stereotypy for some individuals (Lanovaz & Argumedes,

2009; Lanovaz et al., 2009; Rapp, 2007). In these cases, the auditory stimulation is said to be “functionally matched” to vocal stereotypy because its effects on subsequent engagement are functionally equivalent to the stimulation produced by the behavior (Lanovaz, Rapp, & Fletcher, 2010). That is, the stimulation produced by the preferred stimuli may produce satiation or an abolishing effect for the stimulation generated by vocal stereotypy. Similarly, researchers and clinicians should note that repeated exposure to the intervention may also produce satiation for the preferred stimuli and thus reduce their effectiveness over extended periods of time (Lanovaz et al., 2011).

A limited number of studies have investigated other antecedent procedures to decrease vocal stereotypy such as noncontingent physical exercise (Levinson & Reid, 1993; Prupas & Reid, 2001) and visual cues (Haley, Heick, & Luiselli, 2010). For example, Levinson and Reid (1993) showed that vigorous exercise (i.e., 15 min of jogging) decreased subsequent engagement in vocal stereotypy for one of three participants with autism, but that prior baseline levels of stereotypy were recovered within 1.5 hr following the termination of the exercise session. In a study on stimulus control, Haley et al. (2010) have taught a child with autism to refrain from engaging in vocal stereotypy in the presence of a specific visual cue (i.e., a red card labeled quiet). The intervention reduced engagement in vocal stereotypy, but the prompting procedure (i.e., putting the card 6 inches in front the child’s face) may have functioned as a mild punisher, which questions whether the intervention was antecedent based. Specifically, the card may have been established as an inhibitory stimulus for vocal stereotypy through pairing with the punishment contingency. Nonetheless, both interventions are promising alternatives in the treatment of vocal stereotypy, but more research is needed before a widespread implementation in applied settings can take place.

Consequence-Based Interventions

During consequence-based treatments, events are manipulated contingent on the occurrence or nonoccurrence of vocal stereotypy. Two of the consequence-based interventions with the most empirical support are response interruption and redirection (RIRD) and differential reinforcement of other behavior (DRO). Ahearn et al. (2007) used RIRD to decrease vocal stereotypy in four children with autism. Following each occurrence of vocal stereotypy, a trainer asked three social questions (e.g., How old are you?) or made three verbal imitation requests (e.g., say “ball”) and socially reinforced the child’s appropriate vocalizations. The intervention was successful at decreasing vocal stereotypy in all four children and increased appropriate vocalizations

in three of them, but the treatment component responsible for the behavior change remained unclear. The social reinforcement provided for appropriate vocalizations may have been competing with the stimulation generated by vocal stereotypy; alternatively, the interruption of vocal stereotypy with contingent demands may have functioned as a mild punisher that decreased levels of vocal stereotypy. In a study examining a procedural variation of the intervention, Ahrens et al. (2011) have shown that RIRD functioned as punisher. Furthermore, the researchers showed that RIRD remained effective at reducing vocal stereotypy and increasing appropriate vocalizations when the participants were required to provide a motor response rather than a vocal response to the contingent prompt.

Other researchers have also shown that RIRD reduced engagement in vocal stereotypy (e.g., Cassella et al., 2011; Liu-Gitz & Banda, 2010), increased engagement in spontaneous appropriate vocalizations (Miguel, Clark, Tereshko, & Ahearn, 2009), and did not increase subsequent engagement in vocal stereotypy (Schumacher & Rapp, 2011). The main benefit of RIRD is that the procedures may also produce an increase in appropriate vocalizations, which may facilitate the social inclusion of individuals who emit the behavior. However, some researchers have found that RIRD sometimes fails to increase engagement in appropriate vocalizations (Cassella et al., 2011). Furthermore, the intervention may require frequent prompting, which may prevent its implementation in settings in which staff or caregivers are unavailable to deliver prompts contingent on every occurrence of the behavior.

In an example of DRO to treat vocal stereotypy, Taylor et al. (2005) compared the effects of noncontingent reinforcement with DRO for a child with autism using matched stimuli (i.e., toys that produced auditory stimulation). The researchers showed that providing access to the toys (for 30 s) for the absence of vocal stereotypy during 1-min periods was more effective at decreasing engagement in vocal stereotypy than noncontingent delivery of the same toys every 1 min (i.e., independent of the occurrence of vocal stereotypy). In a variation of the intervention, Mancina et al. (2000) have taught a child to monitor her own behavior and consume or engage with preferred stimuli following the absence of vocalizations during 5-s and 10-s intervals, but replications are necessary to determine whether most children with autism spectrum disorders are able to self-manage their intervention.

The main advantage of DRO is that the intervention does not interfere with ongoing activities when provided on a lean schedule. However, Rozenblat et al. (2009) have found that the duration of the intervals during which vocal stereotypy must be absent for the child to receive a preferred item may need to

be very short (e.g., 2 or 3 s) for the DRO procedure to effectively reduce vocal stereotypy in some individuals with autism, which may be challenging to implement in applied settings. Under dense schedules of stimulus delivery, researchers have suggested that matched stimulation may be more practical to implement than DRO (Lanovaz & Argumedes, 2009). Furthermore, DRO does not teach the individual an alternative communicative response (as in RIRD). Although DRO is often perceived as a reinforcement procedure, it should be noted that the effects are often conceptualized in terms of negative punishment wherein access to reinforcement is postponed contingent on the occurrence of the behavior (Cooper, Heron, & Heward, 2007).

Other punishment-based procedures such as verbal reprimands (Rapp, Patel, Ghezzi, O'Flaherty, & Titterington, 2009), contingent demands (Athens et al., 2008), and response cost (Falcomata et al., 2004) have also been successful at reducing engagement in vocal stereotypy in individuals with autism spectrum disorders. For example, Falcomata et al. (2004) have shown that withdrawing access to a preferred stimulus contingent on the occurrence of vocal stereotypy in a young adult with autism reduced engagement in the behavior to near-zero levels when noncontingent reinforcement alone had been ineffective. Although punishment-based procedures may produce rapid reductions in vocal stereotypy when other interventions have failed to do so, the treatment may produce some side effects that are clinically undesirable.

For example, using punishment procedures to decrease vocal stereotypy may lead to an increase in other forms of stereotypy (Rapp, 2005; Rapp, Vollmer, St. Peter, Dozier, & Cotnoir, 2004). Furthermore, punishment may need to be applied for every occurrence of vocal stereotypy to remain effective (see Lerman & Vorndran, 2002). Thus, punishment-based procedures are generally impractical in applied settings because caregivers and educators are often unable to punish every occurrence of the behavior. One promising approach to facilitate the implementation of punishment-based procedures in applied settings is to establish inhibitory stimulus control over stereotypic behavior by correlating a stimulus with the procedure. By repeatedly associating a stimulus with punishment, the stimulus alone may reduce engagement in stereotypy and decrease the number of times the punishment procedure has to be implemented (McKenzie, Smith, Simmons, & Soderlund, 2008). However, results of the only study conducted on vocal stereotypy suggest that the association does not always produce inhibitory stimulus control (Rapp et al., 2009).

An alternative to punishment is extinction, which usually involves no longer delivering stimulation that has functioned as the maintaining reinforcer in the past contingent on the occurrence of a target behavior (Lerman & Iwata,

1996). A single study has investigated the effects of extinction on vocal stereotypy (Aiken & Salzberg, 1984). Aiken and Salzberg (1984) provided access to white noise via headphones to mask the auditory stimulation generated by the vocal stereotypy of children with autism. The treatment was effective at decreasing vocal stereotypy to near-zero levels. Aiken and Salzberg attributed their results to extinction, but several methodological problems limit the conclusions that may be drawn from their data. A functional analysis was not performed prior to the implementation of treatment, which does not rule out that the vocalizations had a social function. Similarly to the effects of music, the white noise may have functioned as a matched stimulus rather than eliminated the sensory product maintaining vocal stereotypy. The scarcity of research on the extinction of vocal stereotypy is not unintended; current technology makes it difficult to eliminate the auditory stimulation produced by vocal stereotypy. Furthermore, the intervention would be impractical to implement in many settings (e.g., school), and the withdrawal of the apparatus that eliminates or attenuates the sensory product of vocal stereotypy would likely increase vocal stereotypy above baseline levels (Rapp, 2006, 2007).

Current Status and Future Directions

Treatment Recommendations

More than half of the studies reviewed that examined the effects of behavioral interventions on vocal stereotypy were published in the past 5 years, which limits the number of replications, variations, and comparisons conducted for each intervention. Nonetheless, some general recommendations can be made for clinical practice based on the limited evidence available. Before assessing the effects of an intervention on vocal stereotypy, clinicians should consider conducting an experimental functional analysis and/or a series of no-interaction conditions to identify the function of the repetitive vocalizations (Rapp & Lanovaz, 2011). It is important to note that the recommendations in the current review are primarily designed for repetitive vocalizations maintained by nonsocial reinforcement. Given that RIRD is the only intervention that has been shown to increase engagement in appropriate vocalizations (e.g., Ahearn et al., 2007), the intervention should be strongly considered when designing a treatment plan to reduce engagement in vocal stereotypy. However, RIRD requires frequent prompting, which may limit its applicability in some environments (Miguel et al., 2009).

When the client:staff ratio does not allow the implementation of RIRD, noncontingent reinforcement may be implemented as an alternative. Although both matched and unmatched stimulation may be effective at reducing engagement in vocal stereotypy, clinicians may consider providing noncontingent access to matched stimuli (e.g., music, sound-producing toys) first because (a) more research has supported the use of matched stimulation than unmatched stimulation for vocal stereotypy and (b) matched stimulation may also reduce subsequent engagement in vocal stereotypy (Lanovaz & Argumedes, 2009; Lanovaz et al., 2009, Lanovaz et al., 2011; Rapp, 2007). Because DRO requires the undivided attention of a trainer, does not teach an alternative behavior, and may be difficult to apply under dense schedules (Lanovaz & Argumedes, 2009; Rozenblat et al., 2009), the intervention may be challenging to implement in applied settings. Nonetheless, DRO may be implemented when other procedures have failed to reduce vocal stereotypy to desirable levels or when the DRO schedule can be relatively lean and still remain effective (e.g., every 60 s; see Taylor et al., 2005). To facilitate its implementation, DRO may also be combined with matched stimulation (e.g., noncontingent access to music). Combining DRO with matched stimulation may reduce the frequency of reinforcer delivery by increasing the average time between two instances of vocal stereotypy (Lanovaz & Sladeczek, 2011).

If the previous interventions fail to reduce engagement in vocal stereotypy, clinicians may consider using other forms of punishment (e.g., response cost, verbal reprimands). A stimulus may be correlated with the punishment-based procedure to establish inhibitory stimulus control, and the individual should have the opportunity to access reinforcers for engaging in other behavior. Clinicians should note that punishing vocal stereotypy may increase engagement in other forms of stereotypy (Rapp, 2005; Rapp et al., 2004) and that punishment should be applied on a continuous schedule (Lerman & Vorndran, 2002). As such, every single occurrence of vocal and motor forms of stereotypy should be punished to achieve the desired behavior changes. Clinicians should seek appropriate training and supervision as well as follow national, state, local, and professional laws, standards, and ethical guidelines when considering interventions based primarily on punishment. The other interventions discussed in the review (e.g., physical exercise, extinction) may be implemented in applied settings, but clinicians should closely monitor their effects until more research studies become available. Regardless of the intervention being implemented, clinicians should consider measuring social validity, and always program and assess for generalization and maintenance. It should be noted that the previous recommendations will undoubtedly change as more research on vocal stereotypy is conducted and published.

Future Directions

Several interventions have been shown to reduce engagement in vocal stereotypy, but there are still several gaps in the research literature on the treatment of the behavior. For example, nearly all studies have been conducted with either children or adolescents with autism. The interventions should be implemented with adults to examine whether the effects are the same as with children. The lack of studies comparing different interventions directly together also limits the current scope of the research literature on vocal stereotypy. In a notable exception, Taylor et al. (2005) compared DRO and matched stimulation, but in nearly all other studies, researchers compared the interventions only against a baseline condition. Although showing that an intervention decreases a behavior compared with baseline is important, the results do not assist clinicians in selecting an intervention over another in specific circumstances.

Given the lack of comparison studies, clinicians mostly rely on trial and error to identify an intervention that will effectively decrease vocal stereotypy and increase engagement in appropriate behavior. For example, a clinician who designs an intervention plan to reduce engagement in vocal stereotypy in a child with autism does not know whether RIRD, matched stimulation, or DRO is more likely to reduce the behavior. Relying on the trial-and-error method presents several disadvantages for individuals who emit vocal stereotypy: (a) a longer amount of time may be spent identifying an effective intervention, (b) the individual may not receive the most effective intervention, and (c) the side-effects of the selected intervention may be less desirable than those of another intervention that would have had the same effectiveness.

To improve service delivery, researchers should develop and assess treatment hierarchies that will reduce the time spent identifying an effective intervention while producing desirable side-effects on other behavior emitted by the individual with an autism spectrum disorder. Researchers may also attempt to identify structural or functional characteristics of vocal stereotypy associated with treatment effectiveness, which would predict which intervention would be most likely to produce desirable changes in an individual's behavior (Lanovaz & Sladeczek, 2011). Other alternatives, which may facilitate the selection of an intervention, include conducting a treatment preference assessment (e.g., Hanley, Piazza, Fisher, & Maglieri, 2005) to identify a preferred intervention for vocal stereotypy, examining the social acceptability of the procedures by interviewing caregivers or educators, and considering the skills of the trainer.

A further limitation is that most interventions for vocal stereotypy are impractical to implement when an individual is engaging in other appropriate behaviors such as academic or vocational tasks. That is, the intervention may compete with the occurrence of other behaviors. For example, RIRD may need to be implemented more than 100 times across an entire day to reduce vocal stereotypy (Miguel et al., 2009). Similarly, noncontingent reinforcement often involves providing continuous access to toys, which undoubtedly interferes with ongoing activities. In these cases, measuring the subsequent effects of the intervention (i.e., when withdrawn) on vocal stereotypy is crucial to ensure that the procedures do not evoke subsequent engagement in the behavior (e.g., Rapp, 2007). Given that prior studies on the subsequent effects of interventions on vocal stereotypy have yielded mixed results (e.g., Lanovaz et al., 2009), more research must be conducted to examine how the withdrawal of an intervention alters engagement in the behavior.

To this end, Lanovaz et al. (2010) have proposed a methodology to identify interventions that will effectively substitute for the stimulation generated by automatically reinforced behavior, which may be used to examine the immediate and subsequent effects of treatments on vocal stereotypy. Specifically, levels of vocal stereotypy are measured before, during, and after baseline (i.e., no intervention) and intervention sessions, which are alternated within a multielement design. Patterns wherein (a) postintervention levels of vocal stereotypy are lower following intervention than following baseline or (b) levels of vocal stereotypy are lower postintervention than preintervention are indicative of interventions that are functionally matched. The sequential assessment model has been mainly used to evaluate the effects of various interventions on vocal stereotypy (e.g., Lanovaz & Argumedes, 2009; Lanovaz et al., 2009; Rapp, 2007; Schumacher & Rapp, 2011), but the model could also examine how pre-session access and other abolishing operation (AO) interventions may alter the effectiveness of treatments designed to increase alternative behavior (e.g., Lang et al., 2010).

With the exception of RIRD that has been shown to increase engagement in appropriate vocalizations (e.g., Ahearn et al., 2007; Miguel et al., 2009), studies on vocal stereotypy have mainly focused on the reduction of the behavior. Thus, the effects of reducing vocal stereotypy on engagement in other appropriate behavior (e.g., toy play, academic tasks) remain largely unknown. Rapp and colleagues (Rapp, 2005; Rapp et al., 2004) have shown that reducing one form of stereotypy may produce an increase in another response form, but the results do not indicate whether the response reallocation may shift toward appropriate behavior. To be considered effective from a clinical standpoint, interventions for vocal stereotypy should not only

reduce engagement in vocal stereotypy but also increase engagement in behavior that will ultimately facilitate the individual's social inclusion. Recently, researchers have started examining the effects of reducing motor forms of stereotypy on engagement in appropriate behavior (e.g., Chung & Cannella-Malone, 2010; Lang et al., 2010). Similarly, studies should be conducted to examine the collateral effects of interventions designed to reduce engagement in vocal stereotypy.

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References

- Ahearn, W. H., Clark, K. M., DeBar, R., & Florentino, C. (2005). On the role of preference in response competition. *Journal of Applied Behavior Analysis, 38*, 247-250.
- Ahearn, W. H., Clark, K. M., Gardenier, N. C., Chung, B. I., & Dube, W. V. (2003). Persistence of stereotypic behavior: Examining the effects of external reinforcers. *Journal of Applied Behavior Analysis, 36*, 439-448.
- 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.
- Aiken, J. M., & Salzberg, C. L. (1984). The effects of a sensory extinction procedure on stereotypic sounds of two autistic children. *Journal of Autism and Developmental Disorders, 14*, 291-299.

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.
- Athens, E. S., Vollmer, T. R., Sloman, K. N., & St. Peter Pipkin, C. (2008). An analysis of vocal stereotypy and therapist fading. *Journal of Applied Behavior Analysis, 41*, 291-297.
- Carr, J. E., Coriaty, S., Wilder, D. A., Gaunt, B. T., Dozier, C. L., Britton, L. N., . . . Reed, C. L. (2000). A review of "noncontingent" reinforcement as treatment for the aberrant behavior of individuals with developmental disabilities. *Research in Developmental Disabilities, 21*, 377-391.
- 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.
- Chung, Y.-C., & Cannella-Malone, H. I. (2010). The effects of pre-session manipulations on automatically maintained challenging behavior and task responding. *Behavior Modification, 34*, 479-502.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behaviour analysis*. Columbus, OH: Merrill.
- Cunningham, A. B., & Schreibman, L. (2008). Stereotypy in autism: The importance of function. *Research in Autism Spectrum Disorders, 2*, 469-479.
- Cunningham, M. A. (1968). A comparison of the language of psychotic and non-psychotic children who are mentally retarded. *Journal of Child Psychology and Psychiatry, 9*, 229-244.
- DeLeon, I. G., Arnold, K. L., Rodriguez-Catter, V., & Uy, M. L. (2003). Covariation between bizarre and nonbizarre speech as a function of the content of verbal attention. *Journal of Applied Behavior Analysis, 36*, 101-104.
- Falcomata, T. S., Roane, H. S., Hovanetz, A. N., Kettering, T. L., & Keeney, K. M. (2004). An evaluation of response cost in the treatment of inappropriate vocalizations maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 37*, 83-87.
- Hagopian, L. P., Fisher, W. W., Thompson, R. H., Owen-DeSchryver, J., Iwata, B. A., & Wacker, D. P. (1997). Toward the development of structured criteria for interpretation of functional analysis data. *Journal of Applied Behavior Analysis, 30*, 313-326.
- Haley, J. L., Heck, P. F., & Luiselli, J. K. (2010). Use of an antecedent intervention to decrease vocal stereotypy of a student with autism in the general education classroom. *Child & Family Behavior Therapy, 4*, 311-321.
- Hall, S. S. (2005). Comparing descriptive, experimental and informant-based assessments of problem behaviors. *Research in Developmental Disabilities, 26*, 514-526.

- Hanley, G. P., Piazza, C. C., Fisher, W. W., & Maglieri, K. A. (2005). On the effectiveness of and preference for punishment and extinction components of function-based interventions. *Journal of Applied Behavior Analysis, 38*, 51-65.
- Kennedy, C. H. (1994). Automatic reinforcement: Oxymoron or hypothetical construct? *Journal of Behavioral Education, 4*, 387-396.
- Lancaster, B. M., LeBlanc, L. A., Carr, J. E., Brenske, S., Peet, M. M., & Culver, S. J. (2004). Functional analysis and treatment of the bizarre speech of dually diagnosed adults. *Journal of Applied Behavior Analysis, 37*, 395-399.
- Lang, R., O'Reilly, M., Sigafoos, J., Machalicek, W., Rispoli, M., Lancioni, G. E., . . . Fragale, C. (2010). The effects of an abolishing operation intervention component on play skills, challenging behavior, and stereotypy. *Behavior Modification, 34*, 267-289.
- Lanovaz, M. J., & Argumedes, M. (2009). Using the three-component multiple-schedule to examine the effects of treatments on stereotypy. *Journal on Developmental Disabilities, 15*(3), 64-68.
- Lanovaz, M. J., Fletcher, S. E., & Rapp, J. T. (2009). Identifying stimuli that alter immediate and subsequent levels of vocal stereotypy: A further analysis of functionally matched stimulation. *Behavior Modification, 33*, 682-704.
- Lanovaz, M. J., Rapp, J. T., & Fletcher, S. E. (2010). Expanding functional analysis of automatically reinforced behavior using a three-component multiple-schedule. *European Journal of Behavior Analysis, 11*, 17-27.
- Lanovaz, M. J., & Sladeczek, I. E. (2011). Vocal stereotypy in children with autism: Structural characteristics, variability, and effects of auditory stimulation. *Research in Autism Spectrum Disorders, 5*, 1159-1168.
- Lanovaz, M. J., Sladeczek, I. E., & Rapp, J. T. (2011). Effects of music on vocal stereotypy in children with autism. *Journal of Applied Behavior Analysis, 44*, 647-651.
- 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., & Iwata, B. A. (1993). Descriptive and experimental analyses of variables maintaining self-injurious behavior. *Journal of Applied Behavior Analysis, 26*, 293-319.
- Lerman, D. C., & Iwata, B. A. (1996). Developing a technology for the use of operant extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29*, 345-382.
- Lerman, D. C., Parten, M., Addison, L. R., Vorndran, C. M., Volkert, V. M., & Kodak, T. (2005). A methodology for assessing the functions of emerging speech in children with developmental disabilities. *Journal of Applied Behavior Analysis, 38*, 303-316.

- Lerman, D. C., & Vorndran, C. M. (2002). On the status of knowledge for using punishment: Implications for treating behavior disorders. *Journal of Applied Behavior Analysis, 35*, 431-464.
- Levinson, L. J., & Reid, G. (1993). The effects of exercise intensity on the stereotypic behaviors of individuals with autism. *Adapted Physical Activity Quarterly, 10*, 255-268.
- 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.
- Lovaas, O. I., Newsom, C., & Hickman, C. (1987). Self-stimulatory behavior and perceptual reinforcement. *Journal of Applied Behavior Analysis, 20*, 45-68.
- Lovaas, O. I., Varni, J. W., Koegel, R. L., & Lorsch, N. (1977). Some observations on the nonextinguishability of children's speech. *Child Development, 48*, 1121-1127.
- MacDonald, R., Green, G., Mansfield, R., Geckeler, A., Gardenier, N., Anderson, J., . . . Sanchez, J. (2007). Stereotypy in young children with autism and typically developing children. *Research in Developmental Disabilities, 28*, 266-277.
- Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analysis in the treatment of bizarre speech. *Journal of Applied Behavior Analysis, 24*, 553-562.
- Mancina, C., Tankersley, M., Kamps, D., Kravits, T., & Parrett, J. (2000). Reduction of inappropriate vocalizations for a child with autism using a self-management treatment program. *Journal of Autism and Developmental Disorders, 30*, 599-606.
- Matson, J. L., Bamburg, J. W., Cherry, K. E., & Paclawskyj, T. R. (1999). A validity study on the Questions About Behavioral Function (QABF) Scale: Predicting treatment success for self-injury, aggression and stereotypes. *Research in Developmental Disabilities, 20*, 163-176.
- Mayes, S. D., & Calhoun, S. L. (2011). Impact of IQ, age, SES, gender, and race on autistic symptoms. *Research in Autism Spectrum Disorders, 5*, 749-757.
- McKenzie, S. D., Smith, R. G., Simmons, J. N., & Soderlund, M. J. (2008). Using a stimulus correlated with reprimands to suppress automatically reinforced eye poking. *Journal of Applied Behavior Analysis, 41*, 255-259.
- 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.
- Paclawskyj, T. R., Matson, J. L., Rush, K. S., Smalls, Y., & Vollmer, T. R. (2001). Assessment of the convergent validity of the Questions About Behavioral Function Scale with analogue functional analysis and the Motivation Assessment Scale. *Journal of Intellectual Disability Research, 45*, 484-494.
- Pew Research Center. (2006, August 1). *Americans and their cars: Is the romance on the skids?* Retrieved from <http://pewresearch.org/assets/social/pdf/Cars.pdf>

- Prupas, A., & Reid, G. (2001). Effects of exercise frequency on stereotypic behaviors of children with developmental disabilities. *Education and Training in Mental Retardation and Developmental Disabilities, 36*, 196-206.
- Rapp, J. T. (2005). Some effects of audio and visual stimulation on multiple forms of stereotypy. *Behavioral Interventions, 20*, 255-272.
- Rapp, J. T. (2006). Toward an empirical method for identifying matched stimulation for automatically reinforced behavior: A preliminary investigation. *Journal of Applied Behavior Analysis, 39*, 137-140.
- Rapp, J. T. (2007). Further evaluation of methods to identify matched stimulation. *Journal of Applied Behavior Analysis, 39*, 73-88.
- Rapp, J. T., & Lanovaz, M. J. (2011). Stereotypy. In J. K. Luiselli (Ed.), *Teaching and behavior support for children and adults with autism spectrum disorders: A practitioner's guide* (pp. 127-135). New York, NY: Oxford University Press.
- Rapp, J. T., Patel, M. R., Ghezzi, P. M., O'Flaherty, C. H., & Titterington, C. J. (2009). Establishing stimulus control of vocal stereotypy displayed by young children with autism. *Behavioral Interventions, 24*, 85-105.
- Rapp, J. T., & Vollmer T. R. (2005). Stereotypy I: A review of behavioral assessment and treatment. *Research in Developmental Disabilities, 26*, 527-547.
- Rapp, J. T., Vollmer, T. R., St. Peter, C., Dozier, C. L., & Cotnoir, N. M. (2004). Analysis of response allocation in individuals with multiple forms of stereotyped behavior. *Journal of Applied Behavior Analysis, 37*, 481-501.
- Rozenblat, E., Brown, J. L., Brown, A. K., Reeve, S. A., & Reeve, K. F. (2009). Effects of adjusting DRO schedules on the reduction of stereotypic vocalizations in children with autism. *Behavioral Interventions, 24*, 1-15.
- 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.
- Skinner, B. F. (1957). *Verbal behavior*. Cambridge, MA: B.F. Skinner Foundation.
- Tarbox, J., Wilke, A. E., Najdowski, A. C., Findel-Pyles, R. S., Balasanyan, S., Caveney, A. C., . . . Tia, B. (2009). Comparing indirect, descriptive, and experimental functional assessments of challenging behavior in children with autism. *Journal of Physical and Developmental Disabilities, 21*, 493-514.
- Taylor, B. A., Hoch, H., & Weissman, M. (2005). The analysis and treatment of vocal stereotypy in a child with autism. *Behavioral Interventions, 20*, 239-253.
- Thompson, R. H., & Iwata, B. A. (2007). A comparison of outcomes from descriptive and functional analyses of problem behavior. *Journal of Applied Behavior Analysis, 40*, 333-338.
- Vollmer, T. R. (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. *Research in Developmental Disabilities, 15*, 187-207.

- Vollmer, T. R., Marcus, B. A., Ringdahl, J. E., & Roane, H. S. (1995). Progressing from brief assessments to extended experimental analyses in the evaluation of aberrant behavior. *Journal of Applied Behavior Analysis, 28*, 561-576.
- Zarcone, J. R., Rodgers, T. A., Iwata, B. A., Rourke, D. A., & Dorsey, M. F. (1991). Reliability analysis of the Motivation Assessment Scale: A failure to replicate. *Research in Developmental Disabilities, 12*, 349-360.

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