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Review of Auditory Stimulation as Treatment for Vocal Stereotypy: A Discussion of Best Practices and Clinical Recommendations

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Abstract: *The use of auditory stimulation to decrease vocal stereotypy in individuals with autism spectrum disorder has been the focus of several studies in recent years. Some of these studies investigated the use of auditory stimulation in the form of music, some evaluated the use of other interventions in tandem with auditory stimulation, and others examined emergent behavior that increases as vocal stereotypy decreases. The purpose of this review and discussion paper is to synthesize information from several of these studies in order to suggest best practices for using auditory stimulation to decrease vocal stereotypy based on these empirical evaluations and provide clinical recommendations for working with children with autism spectrum disorder who engage in vocal stereotypy.*

Engagement in vocal or motor stereotypy is one of the diagnostic criteria for an autism diagnosis according to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed; DSM-5; American Psychiatric Association, 2013), and is defined as restricted, repetitive patterns of behavior. Individuals with autism tend to have more frequent and intense occurrences of stereotypy compared to those with other intellectual disabilities (MacDonald et al., 2007). Stereotypy can hinder new skill development, decrease positive interactions with others, and lead to stigma (MacDonald et al., 2007). Vocal stereotypy can also have detrimental implications for social skillsets, adaptive behaviors, and learning (Lanovaz & Sladeczek, 2011).

Stereotypy, which can be observed early in the development of most children, decreases with age; for children with autism, vocal stereotypy may continue to increase with age (MacDonald et al., 2007). As outlined by MacDonald et al. (2007), differences in levels of stereotypy between typically developing children and children with autism increase with age. In their direct observation study, all of the typically developing children and the 2-year-old children with autism had low levels of vocal stereotypy, but the 4-year-old children with autism displayed significantly higher levels. The 4-year-old children with autism also engaged in "true stereotypy" (i.e., vocalizations with no functional or communicative intent) whereas the typically developing 4-year-old children engaged in vocalizations that were communicative. These results provide some evidence that treatments for vocal stereotypy should include the training of appropriate and contextual verbal behavior (MacDonald et al., 2007).

Vocal stereotypy is defined as a repeated vocalization that persists and can occur as a variety of topographies, such as humming, singing, grunting, squealing, babbling, or words that are unrelated to the situation (Ahearn et al., 2007). Repetitive vocalizations may be considered appropriate when they include repeating a direction, requests for attention or social interaction from another person, breaks from an activity, tangible items or activities, and any type of comment about one's surroundings (Ahearn et al., 2007). Repetitive vocalizations are not considered appropriate and thus labeled as vocal stereotypy when they are acontextual or not functional, produced outside of the context of an

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activity requiring vocal imitation or compliance to a request, or manifested as laughter without a funny event (Ahearn et al., 2007).

Much evidence points to stereotypy as being maintained by automatic positive reinforcement than any other function. According to Rapp and Vollmer (2005), the idea that stereotypic behaviors are maintained by automatic positive reinforcement is supported by studies demonstrating that stereotypy is present even without social consequences, enriching the environment with competing or replacement sources of automatic reinforcement tends to reduce stereotypy, decreasing the assumed sensory results of stereotypy reduces the behavior, providing contingent access to stereotypy acts as reinforcement for other behaviors, decreasing access to stereotypy may then increase future stereotypy, and providing earlier access to stereotypy decreases future stereotypy. Thus, treating vocal stereotypy can be challenging because in order to assess and treat it, the clinician must manipulate an automatic reinforcer that is a natural part of the behavior itself (Taylor et al., 2005). For instance, when someone emits a vocal stereotypy, the auditory sensation produced by the sound is a potential reinforcer (Taylor et al., 2005). Given this challenge, researchers have focused on a variety of treatments for vocal stereotypy including the use of competing stimuli, response interruption and redirection, non-contingent access to any sort of auditory stimulation, and non-contingent access to music as a form of auditory stimulation. The purpose of this paper is to synthesize information from several studies about vocal stereotypy in order to propose potential future research directions and outline best practices and clinical recommendations for using auditory stimulation to decrease vocal stereotypy.

To find studies to inform best practices for vocal stereotypy using auditory stimulation, a brief search of recent research was conducted using the search terms, "music and vocal stereotypy" and "auditory stimulation and vocal stereotypy" within the American Psychological Association PsycInfo database through the online library at The Chicago School of Professional Psychology between the dates of October of 2018 and July of 2020. The search was conducted during the aforementioned dates, but articles from any year were included in this paper if they met inclusion criteria. Articles were included in this paper if the dependent variable was defined as vocal stereotypy, the independent variable was defined as some form of auditory stimulation, and the research design was a single case research design. The total number of studies included in this paper is 15. Some articles were also included in this paper about competing stimuli, preference assessments, and demographics of children engaging in vocal stereotypy to provide additional context for the interventions.

Competing Stimuli

Vocal stereotypy is maintained by automatic reinforcement. Automatic reinforcers cannot be presented or removed by a clinician, so this poses some treatment challenges. It is a common treatment to identify a stimulus that matches the function of the automatic reinforcer to use in various reinforcement schedules. Specifically, studies have focused on presenting stimuli that compete with the reinforcer produced by the vocal stereotypy (Hagopian & Toole, 2009; Piazza et al., 2000; Piazza et al., 1998). Competing stimuli are stimuli that compete with the behavior itself because they often are associated with high levels of appropriate interaction with said stimuli and low levels of the problem behavior (e.g., a child engages with a puzzle and is less likely to engage in hand flapping; Hagopian & Toole, 2009).

Hagopian and Toole (2009) conducted a study evaluating the effects of competing stimuli on body tensing stereotypy and aggression that was the result of response blocking of the stereotypy. The study included one participant, a 10-year-old girl with autism and intellectual disability who displayed multiple self-injurious behaviors and aggression. Within the study, a functional analysis and competing stimulus assessment were conducted to determine the function of a body tensing behavior displayed by the participant and to determine stimuli that could potentially compete with the behavior. A treatment analysis was done in which the participant was given free access to the competing stimuli and told that she could play with it and given additional verbal redirection to engage with the stimulus upon engaging in body tensing. Results showed that

providing competing stimuli led to a decrease in body tensing without the need for response blocking, which had previously led to aggression. This suggests that access to competing stimuli may be a more effective treatment that is also more feasible for caregivers to implement than response blocking (Hagopian & Toole, 2009).

Competing stimuli have also been used successfully to decrease other automatically-reinforced problem behavior such as pica, but consideration must be given to the function of the behavior prior to implementing treatment. Piazza et al. (1998) conducted a series of five analyses to determine the function of pica for participants as well as effective treatments for pica that is maintained by social reinforcement. Participants within the analyses were two girls ages 4- and 17-years-old and one 5-year-old boy all with a diagnosis of pica. In the first analysis, a functional analysis was conducted to determine the function of the pica. During this analysis, results showed that pica behaviors for the participants were maintained by automatic and social reinforcement. These results demonstrated that just because a person displays pica, clinicians should not assume that it is maintained by automatic reinforcement.

In the second study conducted by Piazza et al. (1998), noncontingent reinforcement was evaluated as an intervention for treating pica maintained by social reinforcement. During this analysis, researchers provided noncontingent verbal and physical attention in an attempt to decrease socially-maintained pica for one of the participants. Pica did decrease; however, not to clinically acceptable levels, so it is possible that pica also in this case could be maintained by automatic reinforcement, and not just social reinforcement.

Analysis three in the study by Piazza et al. (1998) involved utilizing a preference assessment to determine if providing oral stimulation was more preferred than access to stimuli that were not orally stimulating. It also investigated if treatments based on the function of the pica were more effective than those not based on the function. Results of this analysis indicated that preferred stimuli that have been matched to pica such as food are often effective at reducing pica, even without supervision. These results are important because pica often becomes most dangerous when someone is not able to watch the person engaging in the behavior.

The fourth analysis in the study by Piazza et al. (1998) considered the sensory aspects of oral stimulation that were part of the automatic reinforcement for pica. This analysis found that firmer stimuli such as a breadstick led to lower levels of pica whereas softer stimuli such as tofu led to higher levels of the behavior. These results indicated that various aspects of matched stimuli may be relevant to the treatment of pica. The fifth analysis evaluated noncontingent attention and tangible reinforcers on pica maintained by both social and automatic reinforcement. Results of this analysis indicated that when non-contingent attention was provided, pica levels remained about the same as baseline. However, when matched oral stimulation was added to the attention condition, pica levels decreased to zero. Providing access to a tangible also decreased pica, but because the tangible involved oral stimulation, it was not clear if the behavior was truly maintained by access to tangible reinforcers. Overall, these analyses indicated that when treating behaviors that are typically maintained by automatic reinforcement, specifically pica behaviors, it is still important to conduct functional analyses, run preference assessments, and consider structural and functional matching of stimuli when determining treatment protocols (Piazza et al., 1998).

In another study, Piazza et al. (2000) conducted research regarding the use of functionally matched preferred stimuli to decrease three target behaviors of different topographies. Participants included one 6-year-old girl and two boys ages 8- and 17-years-old. All participants displayed behaviors that could potentially endanger themselves or others and that were maintained by automatic reinforcement as determined by functional analyses. This study consisted of three separate phases. In the first phase, Piazza et al. (2000) conducted functional analyses for the behaviors. In the second phase, the researchers conducted stimulus preference assessments for stimuli that seemed to provide the same sensory stimulation as the target behaviors. In the final phase, the researchers evaluated the effects of the functionally matched and unmatched preferred

stimuli on the target behaviors. Results indicated that functionally matched preferred stimuli were most effective at reducing the target behaviors for all participants. This research demonstrated that considering the function of a behavior as well as stimulus preference are important when choosing competing stimuli to reduce a target behavior maintained by automatic reinforcement (Piazza et al., 2000).

Vocal Stereotypy, Auditory Stimulation, and Response Interruption and Redirection

As seen in the studies by Piazza et al. (1998), Piazza et al. (2000), and Hagopian and Toole (2009), several behaviors maintained by automatic reinforcement can be reduced by providing a competing stimulus that is functionally matched to the behavior targeted for reduction. There is also evidence that vocal stereotypy specifically can be decreased by other procedures such as providing various forms of non-contingent auditory stimulation such as music or recordings of the child's own vocal stereotypy (Gibbs et al., 2018; Lanovaz, Sladeczek, & Rapp, 2011, 2012; Saylor et al., 2012), by using auditory stimulation that is functionally matched to the stereotypy as determined by a functional analysis (Love et al., 2012; Taylor et al., 2005), by using response interruption and redirection interventions (Gibbs et al., 2018; Love et al., 2012), or some combination of these procedures (Lanovaz, Rapp, & Ferguson, 2012). Non-contingent auditory stimulation is providing auditory stimulation consistently and independently of any behavior, such as providing a toy that makes sound for the entire treatment session (Love et al., 2012). An example of functionally matched stimuli is giving a toy that produces noise to a child that engages in vocal stereotypy. Both toys that emit some form of sound and vocal stereotypy provide auditory stimulation (Love et al., 2012). As cited by Ahearn et al. (2007), response interruption and redirection for vocal stereotypy involves interrupting the stereotypy and providing a prompt to say something else, such as the answer to a question. When using this procedure, no consequences are programmed for vocal stereotypy, but social reinforcement is provided if the child vocalizes an appropriate response. An example of response interruption and redirection would be delivering a social question as a verbal prompt upon the child engaging in vocal stereotypy with the intent of them answering the question with an appropriate response. For instance, a child could answer a question such as, "what color are my shoes?" (Ahearn et al., 2007). Each of these procedures has shown to be effective at reducing vocal stereotypy and there are examples of each in the research literature.

Taylor et al. (2005) conducted research evaluating the use of auditory stimulation to decrease vocal stereotypy. They observed the effects of providing fixed-time exposure to the functionally matched stimuli on fixed-time and differential reinforcement for the absence of vocal stereotypy. The study's participant was a 4-year-old girl with autism. The authors conducted a functional analysis of the vocal stereotypy and an antecedent analysis of toys that produced or did not produce sound as well as a preference assessment to determine which toys might be effective reinforcers to use when vocal stereotypy did not occur. They then used an ABCBC reversal design to compare the two reinforcement schedules. Results showed that the participant almost always chose auditory toys over non-auditory toys, which suggested that the auditory toys could be an effective reinforcer for decreasing vocal stereotypy. Results also indicated that a fixed-time schedule with the auditory toy had no effects on vocal stereotypy, but that the participant learned to not engage in vocal stereotypy when the auditory toy was provided on a DRO schedule. The authors chose to examine the effects of different reinforcement schedules because it may not always be practical for a child to have non-contingent access to an auditory toy. If they do, it may impact their ability to focus on socially valid goal work or activities. However, if an auditory toy is the only form of auditory stimulation available, then providing it on a DRO schedule may be an effective way to decrease vocal stereotypy (Taylor et al., 2005).

Love et al. (2012) conducted a study to determine if the use of functionally matched stimuli (MS) could lead to an increase in the effectiveness of response interruption and redirection (RIRD) on vocal stereotypy.

Functionally matched stimuli are stimuli that produce the same type of reinforcer as the target behavior. Participants were two boys with autism, ages 8- and 9-years-old. Throughout the study, researchers measured vocal stereotypy duration, vocalizations that were appropriate for the situation, the frequency of the RIRD intervention, and the length of the session. After completion of functional analyses of the vocal stereotypy, MS assessments, and RIRD probes, the participants took part in MS+RIRD, RIRD alone, and MS alone experimental conditions. Results of the functional analyses indicated that the behaviors were maintained by sensory stimulation. The MS component involved providing constant access to a preferred toy with auditory stimulation and the RIRD component involved removing the toy contingent on occurrence of vocal stereotypy and redirection was provided by saying the participant's name and prompting him to say a predetermined word. All experimental conditions were part of a multitreatment reversal design. All treatment conditions resulted in a decrease of vocal stereotypy relative to baseline for both participants, but the MS+RIRD condition had the greatest decrease. Both participants emitted vocal stereotypy at "moderate" levels in the first baseline sessions and emitted vocal stereotypy at lower levels within the MS+RIRD treatment conditions.

These results support previous research that stereotypy can be affected by manipulation of motivating operation. While the RIRD alone conditions sometimes produced more appropriate vocalizations than the other conditions, it is important to note that the vocal stereotypy had the greatest decrease in the MS+RIRD conditions because the stereotypy could have possibly occurred when the participants were provided with the matched stimuli. This study also addressed the social validity of these interventions, and the MS+RIRD treatment conditions were rated positively and as preferred by parents. Adding MS to RIRD may be more likely to be utilized by caregivers and other staff because it requires fewer sessions to decrease stereotypy. However, Love et al. (2012) recognized that providing toys as they did in the study as MS may not be practical in all settings. More research should be done to look at the practicality of this intervention. In addition, more research is also needed to observe the occurrence of stereotypy after treatment sessions (Love et al., 2012).

Gibbs et al. (2018) sought to replicate and extend the aforementioned study by Love et al. (2012). Instead of using musical toys as matched stimuli like Love et al. (2012), they used noncontingent music that was provided through headphones. Gibbs et al.'s (2018) study also involved two participants, ages 4- and 7-years-old with an autism spectrum diagnosis. The authors measured the same dependent variables as Love et al. (2012), but instead of measuring appropriate vocalizations as appropriate behaviors in the session, they measured on-task behaviors. They also conducted functional analyses for the vocal stereotypy, preference assessments for matched stimuli, competing stimuli assessments, and RIRD command probes.

Gibbs et al. (2018) used an ABAB reversal design and the treatment conditions included RIRD alone and MS+RIRD. MS was only added to the RIRD intervention when the stereotypy increased, and the on-task behavior decreased for three consecutive sessions. The treatment conditions were the same as those in Love et al.'s (2012) study, but the music was used instead of the toys. Gibbs et al. (2018) also included generality probes which involved training parents about the RIRD procedures and allowing them to work with their child. In addition, social validity was measured. Both participants had similar results in this study even though their vocal stereotypy behaviors were maintained by different functions. One participant had moderate vocal stereotypy levels in the first RIRD alone treatment condition and low levels of vocal stereotypy in the MS+RIRD condition. After the first MS+RIRD condition, that participant's vocal stereotypy increased again when the RIRD alone condition was in effect and then decreased when the MS+RIRD was brought back. Her vocal stereotypy was still at low levels when the generality probe was used. The second participant had high stereotypy levels in the first RIRD alone treatment condition and decreased levels of vocal stereotypy in the MS+RIRD condition. Like the first participant, his vocal stereotypy also increased again when the RIRD alone condition was re-implemented and decreased when the MS was added back in. He also had lower levels of

vocal stereotypy during the generality probe. Motivating operations (MOs) were also implicated in the Love et al. (2012) study, and the findings from Gibbs et al. (2018) supported the idea that noncontingent access to auditory stimulation can act as an abolishing operation for the occurrence of vocal stereotypy. They also supported the idea that stereotypy behaviors are affected by MOs because the stereotypy could have occurred when the music was playing. One specific limitation of this study included the fact that it was not clear which component of the music, such as pitch or tempo, led to the decrease in vocal stereotypy. Gibbs et al. (2018) explained that future research may want to examine the properties of music that lead to decrease in vocal stereotypy.

Vocal Stereotypy and Music as Auditory Stimulation

One specific form of auditory stimulation is music. Love et al. (2012) and Taylor et al. (2005) observed that matched stimuli in the form of an auditory toy could produce decreases in vocal stereotypy, but Taylor et al. (2005) highlighted the fact that non-contingent access to an auditory toy may not be practical. Gibbs et al. (2018) found that recorded music could also act as a matched stimulus for vocal stereotypy and non-contingent access to music via headphones has the potential to be more practical than an auditory toy. Other studies have also focused on the use of non-contingent auditory stimulation, specifically music, to decrease vocal stereotypy in children with autism. One such study by Saylor et al. (2012) explored the effects of non-contingent white noise, music, and a recording of the participant's stereotypy on vocal stereotypy. Participants included two children ages 5- and 6-years-old with autism spectrum disorder. A reversal design with alternating treatments was used so that all variables could be evaluated. All sounds were played through headphones that had been set at an adequate volume. After all treatment conditions, extension sessions were done in parent-chosen settings. Social validity was also measured. Both participants had high vocal stereotypy levels in the baseline sessions, and near-zero levels of vocal stereotypy in both the music and self-conditions. White noise did not decrease the vocal stereotypy. Music was then chosen for the extended conditions because of the low levels of stereotypy in the experimental condition and the high level of preference and social validity. Limitations of this study include the fact that a functional analysis was not conducted and that a direct preference assessment was not done for the auditory stimuli. Saylor et al. (2012) suggested that further research may want to consider the practicality of the intervention since headphones may not be able to worn all day as well as how to maintain treatment effects.

Lanovaz et al. (2011) conducted another study that focused on the effect of music on stereotypy. Instead of comparing music to other auditory stimuli like Saylor et al. (2012), they manipulated the intensity (volume) of non-contingent music and observed its effects of both immediate and future occurrences of vocal stereotypy. They also utilized a greater number of music sessions to see if the effects were maintained across sessions. Participants included two children with autism spectrum disorder ages 5- and 6-years-old. Before the treatment conditions began, both participants took part in a functional analysis for the vocal stereotypy. A reversal design with both a three-component multiple-schedule and multielement design was then used to test the treatment conditions. The treatment conditions included an alternating high-intensity music sequence and low-intensity music sequence. Results showed different outcomes for the two participants, which may indicate that different clients may have different outcomes in a clinical setting. For both participants, the high-intensity and low-intensity conditions produced a change in immediate engagement in stereotypy, which suggests that the intensity of the music is not relevant to decreasing the behavior. However, the high-intensity condition eventually led to an increase in the behavior for one participant and a reduction for the other participant. While this study was one of the first to manipulate qualities of music, Lanovaz et al. (2011) suggested that future research should involve the participants wearing headphones, since they did not wear headphones in this study. This will make the intensities of the music more quantifiable and constant. Even though listening to music on headphones is relatively unobtrusive in most settings, research could also be done to see

if the listening to music interferes with other important activities. If music does not interfere with activities such as on-task behavior, music may be an effective way to decrease vocal stereotypy across settings (Lanovaz et al., 2011).

Noncontingent access to music seems to have collateral effects. For instance, Lanovaz, Sladeczek et al. (2012) sought to continue to extend the literature on music and vocal stereotypy by examining if the decreases in vocal stereotypy as a result of matched stimulation were related to increases in collateral and appropriate behaviors such as manipulation of toys. Lanovaz, Sladeczek et al. (2012) also observed the future effects of matched stimuli on vocal stereotypy and toy manipulation. In their study, participants included four boys with autism spectrum disorder between the ages of 9- and 11-years-old. All participants engaged in vocal stereotypy behaviors. The researchers measured the duration of vocal stereotypy and manipulation of toys for each participant within the study. Before the treatment conditions, a functional analysis was conducted to determine whether the stereotypy was maintained by social consequences. The treatment conditions involved a three-component multiple schedule and multi-element design. The first condition was used to gather baseline levels of behavior, the second condition was used to test the presence of music or prompting and its effects on the vocal stereotypy and toy manipulation, and the third condition was used to measure post-intervention occurrences of the behaviors. Overall, vocal stereotypy was lowest in the second condition of the music sequences, which suggests that music can reduce immediate occurrences of a behavior. Noncontingent music also appeared to increase immediate and future engagement in toy manipulation behaviors. Therefore, results indicated that non-contingent music may decrease vocal stereotypy, increase toy manipulation, or both. This shows that non-contingent music may be an effective intervention in clinical settings. However, because the music did not consistently increase toy manipulation in the study, other interventions may need to be used to encourage other behaviors. Limitations of this study include the fact that a preference assessment was not conducted, and the definition of toy manipulation was simply contact between the participant and toy, so the play may not have been functional. The sessions were also very short in duration, but in a clinical setting, sessions would most likely be longer than five minutes. Future research may want to consider preference of music when providing non-contingent music and should continue to observe other functional behaviors that may increase while vocal stereotypy decreases (Lanovaz, Sladeczek et al., 2012).

These studies have demonstrated that non-contingent access to auditory stimuli, particularly music, has the potential to decrease vocal stereotypy and even increase other functional behaviors such a toy play for children under the age of 11 years. However, not all studies conducted a functional analysis for the stereotypy or a preference assessment for the matched stimuli, and no studies accounted for structural matching of stimuli to the vocal stereotypy.

Structural Components of Vocal Stereotypy

Non-contingent music has been demonstrated to be effective at decreasing vocal stereotypy but based on literature by Lanovaz and Sladeczek (2011) and Lanovaz, Rapp et al. (2012), it may be important to consider structural aspects of both the stereotypy and music as well as musical preference of each participant. Lanovaz and Sladeczek (2011) conducted a study in which they measured structural components of vocal stereotypy and the effects of music on those vocal stereotypy behaviors. Their study included five children between the ages of 5- and 9-years-old with autism spectrum disorder, but data from only three of the participants was included in the final results of the study. The researchers measured percentage of time that was spent engaged in vocal stereotypy, the average duration of each occurrence of vocal stereotypy, and the average inter-response time (IRT) between occurrences. First, a functional analysis was conducted to determine the function of the vocal stereotypy. Then, each participant took part in a free-operant structural assessment during which all participants could engage in vocal stereotypy with no consequences. During the structural assessment, the researchers also noted the pitch of the vocal stereotypy. The pitch did not seem to be

correlated with the percentage of time engaged in vocal stereotypy, but there was a positive correlation between the duration of vocal stereotypy and percentage of time engaged in vocal stereotypy as well as a negative correlation between IRT and percentage of time engaged in vocal stereotypy. This structural assessment showed that vocal stereotypy is unique to individual participants and can vary both across and within participants.

In the second portion of the study by Lanovaz and Sladeczek (2011), the researchers examined the relationship between non-contingent access to music and vocal stereotypy along with the stereotypy duration and IRT. A reversal design was used to test the independent variable. For two participants, music decreased percentage of time engaged in vocal stereotypy, increased the IRT between behaviors, and decreased the duration of the vocal stereotypy. For another participant, music increased the IRT, but did not have an effect on the percentage of time engaged in vocal stereotypy or the duration of vocal stereotypy. These results demonstrated that music can change the duration and temporal structure of vocal stereotypy behaviors for some children with autism. Limitations included the fact that pitch of the vocal stereotypy was not measured in the music condition and may have changed compared to the assessment session. Future studies may want to make sure that pitch is accounted for in the entire study and also consider how structural characteristics such as pitch and intensity of the stereotypy may play a role in the effectiveness of the intervention. Identifying structural characteristics that could be related to treatment could improve how services are provided to individuals with autism that engage in vocal stereotypy (Lanovaz & Sladeczek, 2011).

Vocal Stereotypy and Music Preference

Music preference is another consideration when utilizing music in the treatment of vocal stereotypy. Lanovaz, Rapp et al. (2012) conducted a study in which they accounted for the musical preference of participants and measured the effects of high and low preference music on vocal stereotypy. They utilized a paired-choice preference assessment created by Horrocks and Higbee (2008) to determine musical preference. Participants included four boys with autism spectrum disorder between the ages of 4- and 9-years-old. The study included a music preference assessment, brief comparison session, free-operant observation period, and treatment assessment. After assessing preference of five different songs, the participants took part in a brief comparison condition, which included six five-minute small sessions. The five-minute sessions alternated between high and low preference songs in a multi-element design. Next, there was a free-operant observation period, during which the participants were observed while having access only to toys that did not make sound. Then, there was a treatment assessment condition during which the free-operant sessions were alternated with high-preference music sessions. Results showed that the higher preference songs produced a lower rate of vocal stereotypy when compared to the lower preference songs for three out of the four participants. When the highly preferred song sessions were compared to the free-operant sessions, the music sessions produced lower rates of vocal stereotypy. Lanovaz, Rapp et al. (2012) explained that limitations included the fact that the low preference songs were not used in a music session to be compared to the free-operant sessions. Future research may want to include more analog conditions and also may want to account for structurally matched and unmatched stimulation as well.

Conclusions

Overall, the research presented here has shown that non-contingent access to music and other auditory stimuli can decrease vocal stereotypy for children between the ages of 4- and 11-years old with autism spectrum disorder. However, the literature does not currently address the combination of effects of musical preference and structurally matched non-contingent music on vocal stereotypy (Lanovaz, Rapp et al., 2012; Lanovaz & Sladeczek, 2011). The literature also does not discuss the practicality of providing non-contingent music or other auditory stimuli to decrease vocal stereotypy outside of the laboratory setting (Love et al., 2012; Saylor et al. 2012). In addition, the research does not

TABLE 1

Summary of Clinical Practice Recommendations for Working with a Child with Autism Spectrum Disorder Who Engages in Vocal Stereotypy

Clinical Practice Recommendations
Conduct functional analysis to determine if stereotypy is automatically reinforced and does not serve communicative functions (Hagopian & Toole, 2009; Piazza et al., 2000; Piazza et al., 1998).
Assess client's musical preference with a paired-choice assessment (Horrocks & Higbee, 2008; Lanovaz, Rapp et al., 2012).
Play preferred music for clients at a low volume initially (Lanovaz et al., 2011). Determine if client is in a space that might require headphones (Gibbs et al., 2018; Saylor et al., 2012).
Consider use of RIRD in conjunction with music for client if appropriate for client's goals (Gibbs et al., 2018; Love et al., 2012).
Track data on vocal stereotypy using duration of occurrences and interresponse time between occurrences (Lanovaz & Sladeczek, 2011). Consider measuring engagement with other on-task behaviors if appropriate for client's goals (Lanovaz, Sladeczek et al., 2012).

currently focus on the effect of the non-contingent music on functional on-task behaviors (Lanovaz et al., 2011; Lanovaz, Sladeczek et al., 2012). Finally, only some of the studies reviewed utilized a functional analysis to determine the function of the vocal stereotypy, despite studies by Piazza et al. (1998), Piazza et al. (2000), and Hagopian and Toole (2009) indicating that automatically reinforced behaviors may decrease when a functionally-matched competing stimulus is provided. However, relative preference for competing stimuli is a critically important variable.

This literature may also inform future research practices. Future research may want to seek to determine the effects of both musical preference and structurally and functionally matched musical stimuli on the vocal stereotypy of children with autism. Along with focusing on structurally matched, preferred musical stimuli, future research could investigate the use of musical stimuli to decrease vocal stereotypy within different age groups. The studies described here only included participants between the ages of 4 and 11 years. It may be beneficial to investigate the effects of musical interventions to decrease vocal stereotypy for those receiving music therapy or music education versus those that have not yet had formal exposure to music as well. Future research should also be done that focuses on the practicality of the use of this intervention in settings outside of the clinic or simultaneously investigating generalization and maintenance of a decreased level of vocal stereotypy outside of the clinic (Love et al., 2012; Saylor et al., 2012). While the primary benefit of providing non-contingent music is a decrease in vocal stereotypy, there may be the secondary benefit of increasing functional on-task behaviors (Lanovaz et al., 2011; Lanovaz, Sladeczek et al., 2012). Future research could potentially investigate the relationship between a decrease in vocal stereotypy and different types of functional on-task behaviors. Any research conducted on this topic in the future should include a functional analysis of the vocal stereotypy to ensure that it is maintained by automatic reinforcement, and not serving a communicative purpose. The functional analysis will ensure that the musical stimuli are functionally matched to the vocal stereotypy (Hagopian & Toole, 2009; Piazza et al., 2000; Piazza et al., 1998).

Clinical Practice

In addition to informing future research directions, the information drawn from these articles might help to direct best clinical practices for using music to decrease vocal stereotypy in children ages 4- to 11-years-old with autism (see Table 1). Before using any music-based interventions to decrease vocal stereotypy, it is important that the clinician conduct a functional analysis to determine whether or

not a client's vocalizations are automatically reinforced, and do not serve any other communicative functions (Hagopian & Toole, 2009; Piazza et al., 2000; Piazza et al., 1998). A functional analysis will ensure that the music as an auditory stimulus is functionally matched to the vocal stereotypy. Structurally matching the music to the vocal stereotypy could be considered as well, but more research is still needed in this area (Lanovaz & Sladeczek, 2011). It is also important that the clinician assess musical preference before choosing a song to play as highly-preferred music decreases vocal stereotypy more than less-preferred music. (Lanovaz, Rapp et al., 2012). A paired choice assessment may be the most beneficial in determining a client's preferred music (Horrocks & Higbee, 2008). To determine the choices to offer in the paired-choice assessment, clinicians could conduct interviews with people in the client's life such as parents or teachers or discuss choices with the client themselves. The volume of the music played does not appear to have an effect on vocal stereotypy in the short-term, and there were mixed results long-term when the higher volume music was played. Therefore, clinicians may want to start with a lower volume of music when playing it for clients (Lanovaz et al., 2011). Headphones may be used depending on the setting as well, but the clinician should consider the practicality of headphones for their specific client (Gibbs et al., 2018; Saylor et al., 2012). In addition, clinicians may want to include the use of RIRD when programming music to decrease vocal stereotypy depending on the client (Gibbs et al., 2018; Love et al., 2012). If this approach is used, the RIRD should be used in conjunction with the musical matched stimuli. When tracking data on vocal stereotypy, it is recommended to consider recording the duration of occurrences and interresponse time between occurrences as these are likely to change while the music is played (Lanovaz & Sladeczek, 2011). One may also choose to measure engagement with other on-task behaviors such as toy manipulation, as these may increase when music has been used to decrease vocal stereotypy (Lanovaz, Sladeczek et al., 2012).

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