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THE ANALYSIS AND TREATMENT OF VOCAL STEREOTYPY IN A CHILD WITH AUTISM

Bridget A. Taylor[1]*, Hannah Hoch[2] and Marjorie Weissman[1]
[1]Alpine Learning Group, Paramus, NJ, USA
[2]Graduate Center of CUNY, New York, NY, USA

This study examined procedures for the assessment and treatment of automatically reinforced vocal stereotypy of a 6-year-old girl with autism. Stimulus assessments were conducted to identify toys that were correlated with higher rates of vocal stereotypy and toys that were not. A concurrent operants assessment identified preferred stimuli (toys that produced auditory stimulation), which were then used as reinforcers for the non-occurrence of vocal stereotypy. A reversal design was used to compare the effects of a fixed time schedule of reinforcement (FT 1-min) to differential reinforcement for the non-occurrence of behavior (DRO) to reduce vocal stereotypy. Implementation of the FT schedule revealed no effect, whereas the DRO schedule led to a reduction in the target behavior during treatment sessions and across the school day. This study adds to the body of literature supporting the identification of matched stimuli to reduce non-socially mediated problem behavior. Copyright © 2005 John Wiley & Sons, Ltd.

INTRODUCTION

Children with autism often display repetitive behavior that does not appear to be maintained by social contingencies (Turner & Durham, 1999). For example, children with autism may engage in non-contextual vocalizations, or vocal stereotypy (Gunter, Brady, Shores, Fox, Owen, & Goldzeweig, 1984). This behavior may consist of vocalizations unrelated to the context such as repeating portions of conversations, videos or books previously heard, and general unintelligible vocalizations. Several studies have used functional analysis methods to assess repetitive vocalizations in adults with various disabilities and mental illness. A number of these studies have identified social attention as a maintaining contingency (e.g., Dixon, Benedict, & Larson, 2001; Mace & Lalli, 1991; Rehfeldt & Chambers, 2003; Wilder, Masuda,

*Correspondence to: Bridget A. Taylor, Alpine Learning Group, 777 Paramus Road, Paramus, New Jersey 07652, USA. E-mail: btaylor@alpinelearninggroup.org

O'Conner, & Baham, 2001). In a more recent study, Buchanan and Fisher (2002) found that continuous access to music and social attention led to a decrease in disruptive vocalizations for an elderly woman with dementia, suggesting that the vocalizations were partially maintained by sensory consequences. Similarly, Falcomata, Roane, Hovanetz, Kettering, and Keeney (2004) determined that an 18-year-old individual with autism who exhibited repetitive vocalizations chose more appropriate forms of auditory stimulation (music) over self-generated vocalizations (singing), which indicated that these vocalizations may have been maintained by the sensory consequence of auditory stimulation.

The assessment and treatment of non-socially mediated behavior poses challenges because it requires the manipulation of a reinforcer that is often intrinsic to the action itself. For example, with repetitive vocalizations, the auditory stimulus produced as a result of the vocalization is the reinforcer. It is virtually impossible then to manipulate the auditory stimulus if it is produced by the response itself—unless the response can be blocked. Some research suggests that blocking the reinforcing consequence of the response by using sensory extinction can lead to the reduction of behavior maintained by automatic reinforcement (Aiken & Salzberg, 1984; Kennedy & Souza, 1995; Rincover, 1978). For example, Roscoe, Iwata, and Goh (1998) used sensory extinction in the form of gloves and protective sleeves to attenuate the stimulation produced by self-injury that was believed to be maintained by sensory consequences. In the case of stereotypic vocalizations, Aiken and Salzberg (1984) used sensory extinction in the form of white noise via headphones to reduce the stereotypic noises of two children with autism. The procedure was successful in reducing the repetitive vocalization but did not reduce other repetitive behavior (i.e., dropping objects and clapping). Gunter et al. (1984) and Gunter, Fox, McEvoy, Shores and Denny (1993) investigated the effects of auditory stimulation, in the form of music played on headphones, on the inappropriate vocalizations of three students with autism. Results showed that this intervention successfully decreased the occurrence of inappropriate vocalizations using a more socially valid stimulus (music via headphones). Sensory extinction and continuous access to auditory stimuli, while successful in reducing the vocalizations for these individuals, may not always be appropriate, because the procedure itself (continuous blocking with white noise or continuous access to music via headphones) may block access to necessary auditory input (teacher's instructions) and interfere with the development of appropriate verbalizations.

Studies in the assessment and treatment of automatically reinforced behavior have indicated the importance of identifying stimuli that may compete with the reinforcing properties of the response (Favell, McGimsey, & Schell, 1982; LeBlanc, Patel, & Car, 2000; Luiselli, 1994; Sprague, Holland, & Thomas, 1997) or identifying stimuli that may actually match the sensory consequence produced by the aberrant behavior

(Piazza et al., 1998). Typically, this is accomplished by examining the topography of the response which may suggest the modality of the sensory reinforcer. For example, Piazza and colleagues (1998) found through a stimulus preference assessment that matched stimuli (items which were topographically similar to pica) were more preferred than unmatched stimuli (items that did not produce oral stimulation). These matched items were then used in a treatment package to reduce pica.

Patel and colleagues (2000) conducted antecedent assessments to identify stimuli that were correlated with lower rates of tongue movements for one individual. Based on the hypothesis that tongue movements were maintained by the production of an auditory stimulus, an audiotape was made of the sound produced by tongue movements. Sessions in which the audiotape was played continuously were correlated with lower rates of tongue movements. Preference assessments were then conducted to identify auditory stimuli to be used in a DRO procedure.

Concurrent operant assessment procedures (Fisher & Mazur, 1997) provide a framework for identifying stimuli that may compete with automatic reinforcement. These assessment procedures allow an individual to choose freely among a number of concurrently available stimuli. During assessment sessions stimuli are presented that provide similar reinforcing consequences to the automatically reinforced response. Data are then collected to determine the amount of time allocated or engaged with the alternative stimuli, and the amount of time engaged in the aberrant response. It is then hypothesized that if the individual chooses to allocate more time with the alternative stimuli, rather than engage in the aberrant response, these stimuli can then be used in a treatment intervention (e.g., NCR or DRO) and effectively compete with the aberrant response.

To date, there have been few studies that have examined non-socially mediated vocalizations in children with autism (see Falcomata et al., 2004, for a notable exception). The purpose of this study was to identify stimuli that would compete with the reinforcing properties of repetitive vocalizations in a youngster with autism. Similar to the studies conducted by Patel, Carr, and Kim (2000) and Falcomata et al. (2004), an antecedent analysis was conducted to determine rates of vocalizations when access to other auditory stimulation was present. As an extension, a concurrent operant analysis was conducted, which allowed free access to toys with batteries that produced auditory stimulation and the same toys without batteries, to examine time allocated to those stimuli that produced the auditory stimulation. Because an NCR procedure that would have provided continuous access to auditory stimulation was judged to be non-functional for this participant (since it would block out other necessary auditory input), the stimuli identified in the assessments were then used to compare a fixed time (FT 1-min) schedule of reinforcement to a DRO (differential reinforcement of the omission of behavior) schedule of reinforcement within a reversal design.

METHOD

Participant and Setting

The participant in this study was Mary, a 4-year-old child with autism. At the time of the study, Mary had been attending the Alpine Learning Group for approximately 1 year, and was able to follow multi-step commands, read simple sight words, speak in three to five word sentences, and engage in simple conversational exchanges. Her performance on the Stanford Binet revealed a composite score of 79.

Despite learning many skills at school, Mary engaged in vocal stereotypy at a high rate (i.e., mean of 82% of 3-min partial intervals) throughout the day, which reportedly interfered with her attention during instruction, her participation in a regular education preschool, and her engagement in social interactions with peers.

All assessment and treatment sessions took place in Mary's classroom, which was arranged like a typical preschool classroom with various toys and educational stimuli. Experimenters were familiar teaching staff and a research assistant at Mary's school who had been trained in the assessment and intervention procedures. At various times during treatment, one or two other students with autism were present in the classroom, engaged in their typical learning or play activities.

Materials

Auditory Toys consisted of toys capable of producing auditory stimulation when activated, such as an electronic keyboard, singing stuffed animals, a cassette player, and books with buttons that could be pressed to produce various sounds. Non-operative Auditory Toys were the same toys as Auditory Toys without batteries and therefore incapable of producing auditory stimulation. Non-auditory Toys were those which at no time were capable of producing sound on their own and which Mary never used in such a way that sound was produced (i.e., by banging them): puzzles, books, blocks, dolls, and drawing materials.

Dependent Measure

The dependent measure was vocal stereotypy, defined as any audible vocalization not related to the context. Such vocalizations included humming, singing parts of songs, delayed echolalia, and repeating text/narrative fragments from previously viewed videos or previously read books (e.g., portions of an Arthur video, or a Sesame Street book). Appropriate vocalizations (e.g., tacts of items she was playing with, mands for desired items, greetings, and initiations) were not scored. A 10-s partial interval data collection system was used to record the percentage of intervals of vocal stereotypy during 10-min analyses and treatment sessions. When treatment

was extended across the school day, a 3-min partial interval data collection system was used.

Design and Inter-observer Agreement

A multi-element design was used to conduct an analog functional analysis of vocal stereotypy, and to identify toys that were correlated with inappropriate vocalizations and toys that were not. A concurrent operant choice assessment was conducted to identify toys that could be used as reinforcers for the nonoccurrence of vocal stereotypy. An ABCBC reversal design was used to compare the effects of fixed time reinforcement and a DRO schedule of reinforcement on the occurrence of vocal stereotypy.

Inter-observer agreement (IOA) data were scored for 30% of all sessions. IOA was calculated by using an interval-by-interval comparison for agreement and disagreement. Mean IOA across all conditions was 92% (range 87–100%).

Procedures

Functional Analysis

A standard analog functional analysis was conducted using procedures similar to those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982, 1994). The functional analysis took place in Mary's classroom. During the control condition, Mary had continuous access to preferred toys and teacher attention. No demands were presented during this condition. During the escape condition, tasks demands were presented and removed for 30 s contingent on the occurrence of vocal stereotypy. During the attention condition, Mary had continuous access to toys but her teacher's attention was restricted and only presented (for 30 s) contingent on the occurrence of vocal stereotypy. Attention consisted of a verbal request to play quietly. During the tangible condition, Mary had access to several toys. A highly preferred toy was restricted and only presented contingent on the occurrence of vocal stereotypy. No demands were presented during the attention or tangible conditions. Additional alone sessions (in which Mary was alone in the classroom without any adult or preferred toys) were conducted to determine if vocal stereotypy persisted in the absence of adult supervision and social contingencies. During these sessions Mary was observed through a one-way mirror and a monitor was used that allowed observers to hear Mary's vocalizations.

Antecedent Analysis

In order to determine if Mary would engage in vocal stereotypy when playing with toys that produced auditory stimulation, an antecedent analysis was conducted comparing her vocalizations during play sessions with toys that produced auditory

stimulation (Operative Auditory Toys) to play sessions with toys that did not produce auditory stimulation (Non-Auditory Toys). During this analysis, Mary was brought to a play table where either Auditory Toys or Non-auditory Toys were presented. She was told to play with the toys. No contingencies were arranged for the occurrence of vocal stereotypy. The experimenter sat approximately 6-feet away from Mary and recorded the percentage of intervals with vocal stereotypy during each 10-min play session.

Concurrent Operants Assessment

In order to control for toy effect and to determine if Mary would reliably choose toys that produced auditory stimulation, a concurrent operant choice assessment was conducted. Assessment procedures were similar to those used by Harding and colleagues (1999). During the assessment, auditory toys were divided into two sets. In one set the toys were operable (when activated, auditory stimulation was produced) and in the second set they were inoperable (batteries had been removed from the toys, so activation did not result in auditory stimulation). The placement of batteries was counterbalanced across conditions: if Set A contained batteries during session one, Set B contained batteries during the subsequent session. During these sessions toys were placed on either side of a play area that had been evenly divided using a piece of tape. The placement of the auditory toys was counter-balanced across sessions. Prior to the start of the choice assessment, Mary was brought to the play area and shown both sets of toys. The operative toys were activated to demonstrate auditory feedback and inoperative toys were manipulated to demonstrate their inability to produce auditory stimulation. Mary was then brought to the front of the play area to the line that separated the toy sets. She was told that she could go and play. The experimenter sat approximately 6-feet away from the play area and, for each 10-min play session, recorded the percentage of time allocated to both sets of toys and the percentage of intervals in which vocal stereotypy occurred.

Treatment Analysis

Baseline

Data collected from the non-auditory sessions of the antecedent analysis were used as the baseline data.

Fixed-Time Reinforcement

During these sessions, Mary was brought to a table and provided with the same non-auditory toys used during the antecedent analysis (e.g., puzzles, books, drawing material). An experimenter sat about 1-foot away from Mary. A timer was set for

1-min intervals to signal the schedule of reinforcement. When the timer rang, Mary was provided with access to the auditory toys for 30 s. Following 30 s of access, the auditory toys were removed and Mary was told to play with the non-auditory toys. This sequence was repeated each minute for the entire play session. There were no contingencies for the occurrence of vocal stereotypy during these sessions: if Mary asked questions or made comments toward the experimenter, the experimenter responded with socially relevant responses (e.g., she answered the question).

DRO

During these sessions, Mary was brought to the table and provided with the same toys that had been presented during the fixed time reinforcement sessions (Non-auditory Toys). An experimenter sat approximately one foot away from Mary. At the start of the play session Mary was told, 'If you play quietly, when the timer rings, you can play with the music toys' (Auditory Toys). A card with the word 'Quiet' was attached to the timer and the timer was placed next to the play activities. The timer was activated to signal every minute. If Mary engaged in vocal stereotypy during the 1-min interval she was told 'No, that's not quiet, I have to reset your timer.' The timer was then reset for the 1-min interval. If Mary did not engage in vocal stereotypy for the entire interval, when the timer rang, the experimenter said, 'That's great playing quietly!' and she was provided with access to the Auditory Toys for 30 s. When the playtime with the Auditory Toys elapsed, the toys were removed and Mary was again reminded of the contingency. This sequence was repeated throughout the play session. During these sessions, if Mary engaged in appropriate vocalizations (e.g., requests, comments, or questions), these were responded to by the experimenter. At no time was the contingency in effect for appropriate vocalizations.

When the interval of the DRO was increased to 2 min, a token board was introduced and a sticker provided for each 1-min interval during which Mary did not engage in vocal stereotypy. When the token board was introduced, Mary was told, 'Play quietly and you can earn a sticker. When you get all your stickers, you can play with the music toys.' The duration of the DRO time interval was increased in 1-min intervals. Once the DRO schedule was increased to 5-min during 10-min treatment sessions, the DRO was introduced into normal instructional activities across the school day.

RESULTS

The results of the analog functional analysis are displayed in Figure 1. The results show that Mary's vocal stereotypy was undifferentiated across conditions and

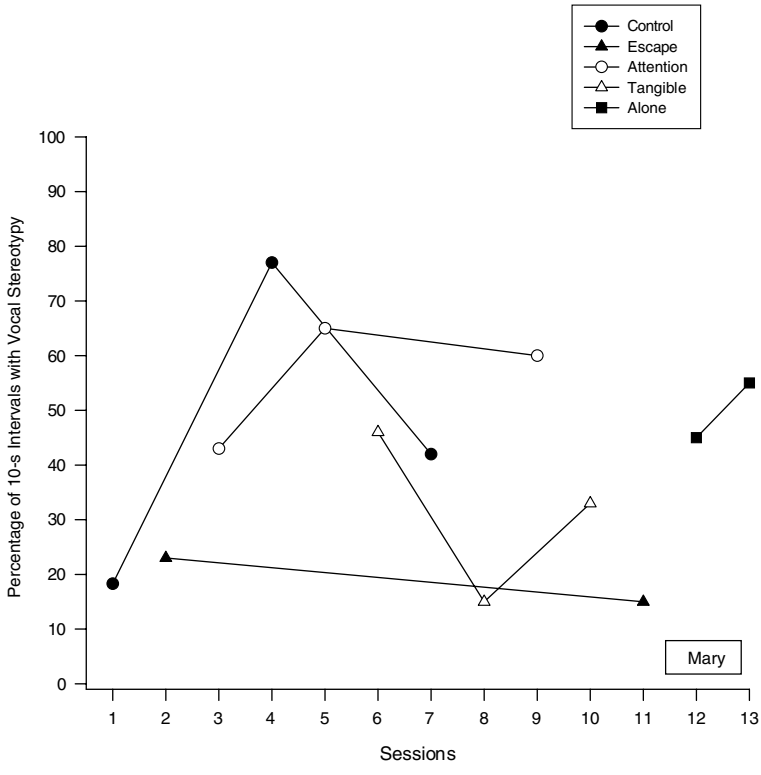

Figure 1. The percentage of intervals with vocal stereotypy across sessions of the functional analysis.

occurred when Mary was alone. The finding that vocal stereotypy occurred across all conditions seemed to indicate that vocal stereotypy was maintained by automatic reinforcement. Although vocal stereotypy occurred at relatively high levels (i.e., mean of 56%) during the attention condition, due to the high rates of the behavior observed in the alone condition (in the absence of any social reinforcement) it was hypothesized that vocal stereotypy was maintained by the auditory stimulation produced by engaging in the behavior.

Figure 2 shows the percentage of intervals with vocal stereotypy during the antecedent analysis. The results indicate that Mary engaged in higher rates of vocal stereotypy when playing with toys that did not produce auditory stimulation (mean 68% of intervals) but displayed virtually no vocal stereotypy when playing with toys that did produce auditory stimulation.

The results of the concurrent choice assessment are presented in Figure 3. The top panel shows that Mary allocated her time almost exclusively to the area in which the Operative Auditory Toys were located. In addition, as shown in the bottom panel, the

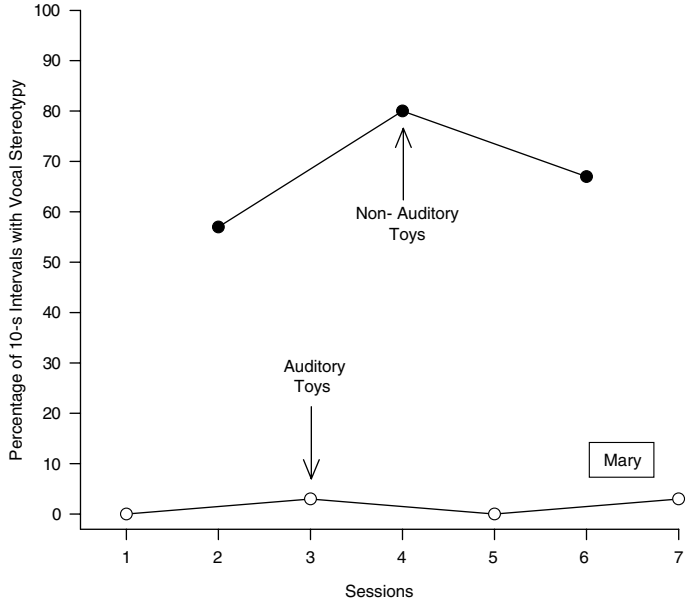

Figure 2. The percentage of intervals with vocal stereotypy across sessions of the antecedent analysis.

percentage of intervals with vocal stereotypy was much lower during play with Operative Auditory Toys (mean 35%) than during play with Non-operative Auditory toys (mean 67%).

The results of the treatment analysis are shown in Figure 4. The reversal design revealed that during baseline, Mary engaged in vocal stereotypy at a mean of 68% of the intervals. When Fixed-timed access to the auditory stimuli was introduced at 1-min intervals, this did not lead to a reduction in vocal stereotypy (it continued to occur at a mean of 71% of intervals). When the DRO procedure was introduced, it led to a reduction in stereotypy to a mean of 12%. Vocal stereotypy increased again when fixed time access was reintroduced (mean of 49%). When the DRO interval was once again implemented, vocal stereotypy decreased to a mean of 8%. Vocalizations remained suppressed when the DRO interval was increased to 5-mins. Further, over time, the DRO interval was gradually increased so that eventually Mary was earning access to the auditory toys following 10-mins of the non-occurrence of the target behavior.

Table 1 shows the percentage of 3-min intervals with vocal stereotypy in the classroom. Prior to the implementation of DRO treatment in the classroom, vocal stereotypy occurred at a mean of 82%. After implementation of the DRO intervention, vocal stereotypy decreased to a mean of 9%.

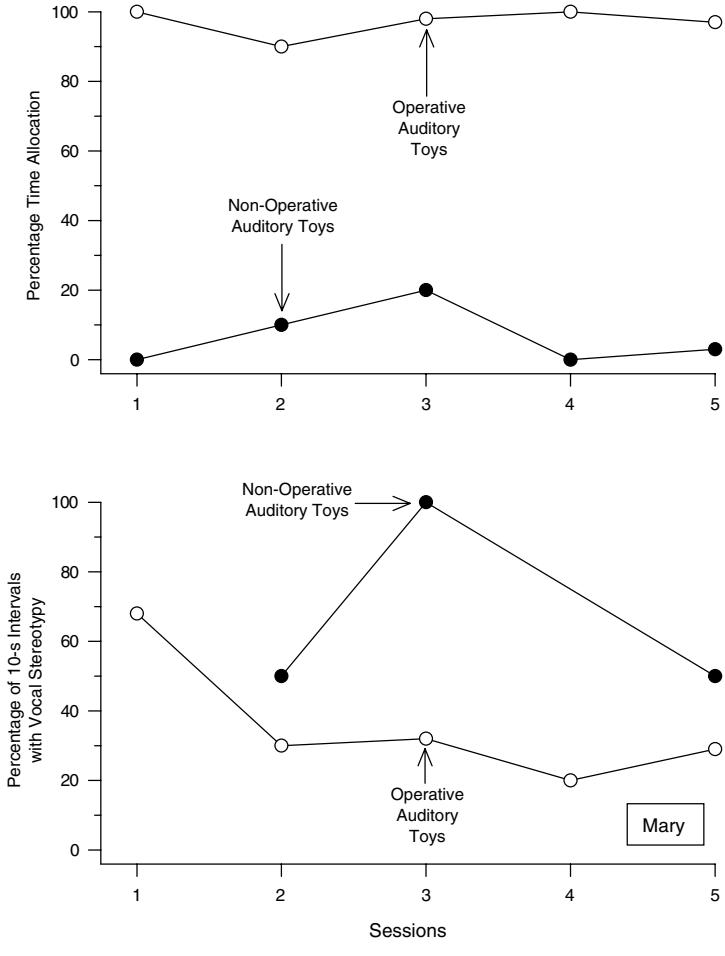

Figure 3. The percentage of time allocation (top panel) and intervals with vocal stereotypy (bottom panel) across sessions of the concurrent operants assessment.

DISCUSSION

The results of these analyses indicate that Mary's vocalizations were maintained by automatic reinforcement in the form of auditory stimulation. Further, when provided with a choice between toys that produced auditory stimulation and those that did not, Mary almost exclusively allocated her responses to the Auditory Toys and engaged in much lower levels of vocal stereotypy. Therefore, it was hypothesized that toys that produced auditory stimulation could be used as a reinforcer to reduce vocal stereotypy.

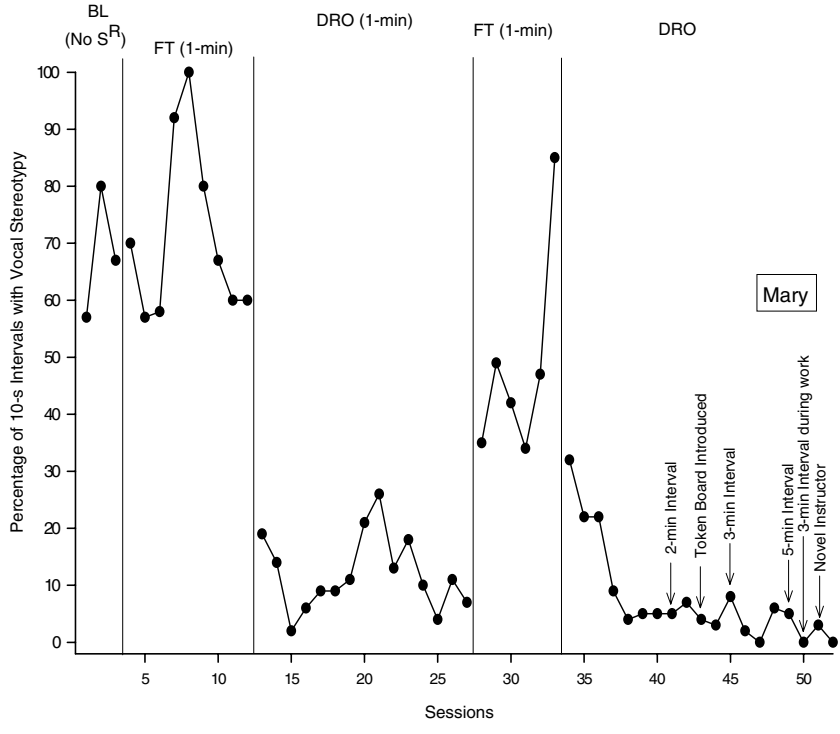

Figure 4. The percentage of intervals with vocal stereotypy across sessions of the treatment analysis.

Table 1. Mean percentage of 3-min intervals with vocal stereotypy in the classroom per month.

Month	*Mean % of intervals*
Baseline	82% (range 56–96%)
June (DRO initiated)	40% (range 25–57%)
July	30% (range 17–50%)
August	33% (range 11–66%)
October	35% (range 9–66%)
November	32% (range 12–50%)
December	31% (range 11–53%)
January	24% (range 12–44%)
February	33% (range 14–56%)
March	17% (range 12–23%)
April	9% (range 2–30%)

The results of this study support previous studies that document the efficacy of identifying competing stimuli when reducing non-socially mediated problem behavior. The antecedent analysis and choice assessment indicated that appropriate auditory stimulation (toys that produced sound and music) successfully competed with inappropriate vocalizations. As a result, Mary rarely engaged in the inappropriate vocalizations while accessing the appropriate auditory stimuli.

While prior studies (e.g., Gunter et al., 1984, 1993) have indicated that continuous, non-contingent access to competing stimuli can reduce non-socially mediated problem behavior, in this particular case, it did not seem reasonable that auditory stimulation could be provided non-contingently throughout the day and still have Mary participate in her daily school activities. This would have required Mary to listen to competing stimuli all the time even though she would have been engaged in instruction. As a result, we initially investigated a fixed-time schedule of access to the auditory stimuli with the hypothesis that perhaps intermittent access to appropriate auditory stimuli would compete with vocal stereotypy thereby reducing the response. The results indicated that this procedure had no effect on vocal stereotypy. A DRO program was then implemented. The reversal design indicated that Mary successfully learned to inhibit vocal stereotypy when auditory stimuli were presented contingent upon the non-occurrence of the target behavior. Because only auditory toys were used as reinforcers, however, it remains unknown whether other stimuli (e.g., edibles, adult attention) could have also been effective reinforcers for the absence of vocal stereotypy.

An important additional component of this intervention was that once the DRO program was successful during 10-min treatment sessions, it was integrated into the classroom during typical school activities and the DRO interval was eventually increased to five mins, a practical and manageable time interval. While much research has demonstrated the efficacy of DRO procedures in time-limited (e.g., 10-min) sessions in analog treatment settings (e.g., Cowdery, Iwata, & Pace, 1990; Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993), few studies have examined the effects of these interventions in natural settings throughout the day (see Conyers, Miltenberger, & Romaniuk, 2003; Heard & Watson, 1997; Shabani, Wilder, & Flood, 2001). In the current study, long-term follow-up data are presented (see Table 1) that support the validity of this intervention when used throughout the day in the classroom setting.

One of the limitations of this study is that it did not formally address the effects of the intervention on *appropriate* vocalizations. Although anecdotal observations indicated that the procedure did not impact the production of appropriate vocalizations, we cannot be certain that Mary did not simply learn to be quieter over all. Because a significant deficit for children with autism is limited language skills, it would be essential to document that intervention procedures do not

inadvertently decrease the production of appropriate vocalizations. In this study, Mary seemed to learn to discriminate appropriate vocalizations from vocal stereotypy. Thus, her vocal stereotypy decreased but she continued to use her language functionally (e.g., manding for items). This may have been aided by the immediate contingency of the termination and resetting of the timer and verbal feedback when stereotypic vocalization occurred, and there was no such contingency for appropriate vocalizations.

Future studies may want to simultaneously record data on appropriate vocalizations both during baseline and treatment to determine if DRO contingencies lead to a reduction in appropriate vocalizations. Additionally, treatment programs may benefit from the addition of a DRA (differential reinforcement of an appropriate) contingency to reinforce the occurrence of *appropriate* vocalizations that would compete with the production of vocal stereotypy (Dixon et al., 2001). For example a DRO could be combined with a DRA and a schedule of reinforcement could be provided for appropriate vocalizations. Additionally, because a textual cue (the word 'quite') was used during DRO treatment sessions and subsequently removed during FT sessions, it is unclear if the word had some stimulus control as a direction for Mary to be quiet. Future studies may want to determine if the word 'quiet' could eventually gain stimulus control in limiting a participant's vocalizations in the absence of reinforcement.

Another limitation relates to the stimuli used during the concurrent operants assessment. Several of the auditory toys (i.e., the singing stuffed animals) produced movement as well as auditory feedback. Thus, when the batteries were removed, the toys no longer moved, and this could have made them less attractive for a reason other than the lack of auditory feedback. Although we cannot know for sure if there was a differential effect of non-moving auditory toys vs. animated auditory toys, given that Mary allocated her responding away from the unanimated toys that only produced auditory feedback (e.g., piano, auditory books) when their batteries were removed, it seems likely that it was the auditory feedback that made these toys function as reinforcers during treatment.

Despite several limitations, the results of this study are promising and indicate that antecedent analyses can lead to the identification of competing stimuli in the treatment of vocal stereotypy. Further, once competing stimuli (in this case, toys that themselves produced auditory stimulation) have been identified these stimuli can then be used as reinforcers to increase intervals of the non-occurrence of stereotypy. Increased non-occurrence may have tremendous significance for children with autism whose high rates of vocal stereotypy both impede the development of social relationships with peers and disrupt or hamper instructional opportunities. Thus, while these results effectively demonstrate that vocal stereotypy can be assessed and subsequently reduced through the application of systematic DRO

procedures, the study's collateral benefits have a potentially far broader reach. Once children can be taught to inhibit vocal stereotypy, the resulting non-occurrence can be transformed from lack to abundance, multiplying opportunities to target more socially relevant goals.

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