

January 01, 2012

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Recommended Citation

Palmer, Lauren K., "The effect of differential reinforcement and response cost on vocal stereotypy" (2012). *Applied Behavioral Analysis Master's Theses*. Paper 96. <http://hdl.handle.net/2047/d20002652>

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The Effect of Differential Reinforcement and Response Cost on Vocal Stereotypy

A Thesis Presented

by

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In partial fulfillment of the requirements

for the degree of

Master of Science

in the field of

Applied Behavior Analysis

Northeastern University

Boston, MA

April 2012

NORTHEASTERN UNIVERSITY

Bouvé College of Health Sciences Graduate School

Thesis Title: The Effect of Differential Reinforcement and Response Cost on Vocal Stereotypy

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Submitted in partial fulfillment of the requirements for the degree of
Master of Science in Applied Behavior Analysis
in the Bouvé College of Health Sciences Graduate School
of Northeastern University, April 2012

Acknowledgements

The author would like to express her gratitude to Brown Middle School for facilitating this research, as well as its continued service to adolescents with intellectual and developmental disabilities. The author would like to also acknowledge the dedication of the members of her thesis committee; Dan Almeida, Karen Gould, and Hanna Rue for providing their support and feedback throughout the thesis process. Additional appreciation goes to Emily Snow, Monica Massucco, Rachel Schmitt, Allison Barnes, Kelly Gandolfo, and Amy Connors for conducting sessions and taking interobserver agreement data.

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Abstract

Previous research implies that vocal stereotypy is often reinforced automatically and is not sensitive to social consequences. Researchers have had success in suppressing vocal stereotypy through comprehensive treatment packages. The current study examined the repetitive and perseverative vocalizations of a 14 year-old boy with autism. First, an analog functional analysis was conducted to determine the function of the vocal stereotypy. Then a naturalistic functional analysis was conducted to confirm these results. It was determined that the student's stereotypic behavior was automatically reinforced, and possibly multiply maintained with social reinforcement. Following these assessments, a differential reinforcement procedure was implemented in a changing criterion design. When this procedure was unsuccessful, a token economy with a response cost was added to the differential reinforcement to comprise a treatment package. Tokens were presented contingent upon successful intervals with a quiet voice, and tokens were removed contingent upon each instance of vocal stereotypy. The treatment package of differential reinforcement plus response cost was successful in reducing the student's vocal stereotypy within measured sessions. This reduction in vocal stereotypy generalized when trained across activities and environments.

Keywords: autism, vocal stereotypy, automatic reinforcement, functional analysis, differential reinforcement, response cost

The Effect of Differential Reinforcement and Response Cost on Vocal Stereotypy

Stereotypic behavior is a commonly researched subject in the field of Applied Behavior Analysis (Ahearn, Clark, MacDonald, & Chung, 2007). Examples of stereotypic behaviors include body rocking, hand flapping, repetitive finger movements, mouthing, and bizarre, noncontextual, or repetitive vocal behavior. These behaviors are estimated to occur in one-third to two-thirds of individuals with severe to profound mental retardation (Berkson & Davenport, 1962), and their persistence in some individuals hinders skill acquisition and negatively impacts social interactions, which makes it a major concern to educators and caregivers. Indeed, a large portion of the diagnostic criteria for autism spectrum disorders in the *Diagnostic and Statistical Manual of Mental Disorders* is “restricted repetitive and stereotyped patterns of behavior” (4th ed.; *DSM-IV*; American Psychiatric Association, 2000). Stereotypy is a complex problem because stereotypic behaviors typically do not have a socially mediated function, and the results of functional analyses of these behaviors are often inconclusive or suggest automatic reinforcement (i.e., Falcomata, Roane, Hovanetz, Kettering, & Keeney, 2004; Ahearn et al., 2007). Because of this, many of the most basic and powerful reinforcement contingencies of the behavior are inaccessible to researchers and it is very difficult to gain control over the behavior. However, research has shown that in some cases stereotypic behaviors serve other functions and are maintained by socially mediated reinforcing conditions such as escape from demand or social attention (see Ahearn et al., 2007 for discussion).

Vocal stereotypy in particular comprises a complex and perplexing set of behaviors that requires an equally complex and well thought-out analysis and treatment package. Vocal stereotypy is often shown to be maintained by automatic reinforcement, and it is therefore very difficult to intervene upon. In other words, “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,” yet “there have been few studies that have examined non-socially mediated vocalizations in children with autism” (Taylor, Hoch, & Weissman, 2005). To reduce automatically reinforced vocal stereotypy, some clinicians have had success extinguishing the behavior, such as by using noise-blocking headphones (i.e., Aiken & Salzberg, 1984). Others have used sensory matching and have played music over headphones for the student (i.e., Lanovaz, Sladeczek, & Rapp, 2011), with the assumption that the sensory stimulation produced by the music would eliminate the motivating operation for the vocal stereotypy. However, these sensory-based consequences are only effective if the stereotypy is maintained by the aural stimulation, and if the reinforcing value of the matching stimulus is of equal or higher value to the constantly-accessible self-talk, echolalia, repetitive speech, and bizarre vocalizations that characterize vocal stereotypy. Still others have succeeded in reducing vocal stereotypy by interrupting and redirecting the behavior (e.g., Ahearn, et al. 2007). While this has been effective in some cases, the attention provided to the individual from interrupting the vocal stereotypy could inadvertently reinforce the behavior.

There are two possible patterns of responding in a functional analysis that could lead to a hypothesis of automatic reinforcement as the maintaining contingency for a behavior. In one case, a high rate of responding in the alone condition with low responding in the other conditions would suggest that the behavior is maintained by automatic reinforcement since it is present only in the absence of social stimuli. In the other case, high or variable rates of responding across conditions would also suggest automatic reinforcement, since the behavior is pervasive across contingencies. Because the functional analyses that lead to a hypothesis of automatic reinforcement are often inconclusive, in many cases it is possible that the behaviors are multiply

maintained and the behaviors are therefore less susceptible to suppression by any single treatment. Therefore, much success in reducing automatically maintained vocal stereotypy in the current research has been found in using treatment packages, and therefore controlling for any social sensitivities, such as the combination of noncontingent attention, contingent demands, and response cost (Athens, Vollmer, Sloman, & St. Peter Pipkin, 2008); discrimination training, differential reinforcement, and self-monitoring (Shabani, Wilder, & Flood, 2001); or noncontingent reinforcement and response cost (Falcomata et al., 2004). Each of these three studies involved a male adolescent with autism whose stereotypic behaviors were determined through functional assessments to be maintained by automatic reinforcement.

The purpose of the current study was to treat the vocal stereotypy of a teenage boy diagnosed with autism. Initially, the student's vocal stereotypy was analyzed to determine the function. When the results were inconclusive, suggesting automatic reinforcement, several treatments such as RIRD and sensory matching were tried unsuccessfully and then abandoned. Finally, the student's behavior was reduced through a treatment package comprising of differential reinforcement of other behavior with a response cost. Differential reinforcement was used in the current study as an intervention for vocal stereotypy because it had been previously successful in reducing the student's other problem behaviors, including shouting. While there was no functional assessment on the shouting behavior, and so it was unknown as to whether it had the same function as the vocal stereotypy, the similar topographies suggested that the differential reinforcement procedure could be effective. Furthermore, differential reinforcement has been shown to be successful in previous research on reducing automatically maintained vocal stereotypy. Response cost was considered for addition of a treatment component because of its previously shown efficacy in reducing stereotypic behaviors.

Method

Participants and Setting

The participant, Peter, was a 14 year-old boy diagnosed with an autism spectrum disorder. The results of several Vineland-II assessments indicated that Peter functioned at a low adaptive level across domains. He had a long history of vocal stereotypy across home and school settings. In the time the student had been in his current placement in a public middle school special education classroom, the frequency and intensity of the behavior had markedly increased. While Peter's shouting behavior was successfully brought under control using differential reinforcement, vocal stereotypy was reportedly never successfully managed. Peter's parents reported a decrease in functional communication concurrent with the increase in vocal stereotypy.

At the time of the study, Peter could spontaneously request a limited amount of leisure activities such as specific movies, edibles such as cheese, raisins, and water, and could accurately communicate immediately relevant wants and needs such as hunger and thirst. Conversation skills were minimal and responses to most questions had to be explicitly trained, one at a time. Peter had a history of several unsuccessful interventions for his vocal stereotypy, including Response Interruption and Redirection (Ahearn et al., 2007) and sensory competition (Rapp, 2007).

Sessions of both functional analyses and both differential reinforcement procedures were conducted in a public middle school special education classroom suite. The analog functional analysis was conducted in a contrived analog setting. Instead of a traditional separate room, a cubicle was set up in an empty classroom adjacent to the familiar classroom suite. Within the cubicle was a desk, two chairs, data collection materials, four tablecloths of various colors

corresponding to each functional condition, as well as lesson materials for each. Lesson materials included puzzles, educational flashcards, coins for sorting, a shape sorter, and picture books. During the naturalistic functional analysis, sessions were run both at the student's desk and in the computer area, as well as walking through the hallways of the school. Sessions of both differential reinforcement procedures were run at the student's desk with reinforcement materials, visual supports such as a "quiet voice" visual, and data collection materials. The second differential reinforcement procedure also included a choice board, i.e. laminated strips of paper with the names of reinforcing activities printed on them, and a token board, i.e. a laminated sheet with twenty boxes used for earning and removing checks.

Response Measurement and Interobserver Agreement

Vocal stereotypy was defined as any request or statement out of context to the current setting as well as any repetition of requests or statements. Repetition was defined as more than one occurrence per ten seconds. Examples include repeating "Seuss, Seuss, Seuss" while practicing vocational skills. Further examples include scripting a television show, such as saying "stop that pickle" or "best in the West" not in the presence of a television. Nonexamples include saying "bathroom" one time to initiate toileting, or saying "my hair is red" when asked the question "what color is your hair?" Quiet voice was defined as sitting with an independent activity or participating in a lesson without emitting any vocal responses, with the exception of requesting items such as water or the bathroom with no repetition. In order to aid in discrimination between vocal stereotypy and quiet voice, sessions were never run during an activity that required a vocal response from Peter during either functional analysis nor during the differential reinforcement procedures.

Sessions of both functional analyses were ten minutes in length and occurred at least ten minutes apart. Data was collected using a 15-second partial interval recording system. Interobserver agreement was calculated in the same manner for both functional analyses. Data was collected for 20% of sessions by a trained observer and was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100%. The average interobserver agreement for Peter's vocal stereotypy was 95.2% during the analog functional analysis (ranging from 91.5% to 100%) and was 98.75% during the naturalistic functional analysis (ranging from 96.3% to 100%).

Sessions of the first differential reinforcement procedure (DRO only) were five minutes in length and data were collected using a partial interval recording system with resetting intervals. Interobserver agreement was not collected due to lack of available staff. Sessions of the second differential reinforcement condition (DRO with response cost) varied in length according to responses emitted and interval length. Interobserver agreement was recorded for 6% of sessions and was calculated by dividing the total number of agreements plus disagreements and multiplying by 100%. The average interobserver agreement for successful intervals was 99.8% (ranging from 98.3% to 100%).

Procedure

Analog Functional Analysis. Informed by the functional analysis methodology described by Iwata et al (1982/1994), Peter's vocal stereotypy was recorded during four reinforcement conditions: alone, attention, demand, and play. During the alone condition, Peter sat at the desk in the cubicle with a shape sorter, a mastered independent activity, and the observer sat outside of the cubicle but in view. After the instruction, "it's time to play by yourself," no attention was given to Peter and all mands were ignored. When property destruction or aggression to staff

occurred, the timer for the session was paused, Peter was neutrally redirected to his seat with no eye contact, and the timer was restarted. During the play condition, Peter was provided with three highly-preferred books in the cubby. After the instruction, “it’s time to look at books,” the observer sat across from Peter at the desk and praised appropriate play behavior and ignored occurrences of vocal stereotypy. During the demand condition, Peter received instruction in both skill acquisition and mastered academic programs; in this case, counting money and sorting. The observer sat across from Peter at the desk and gave the instruction, “it’s time to work.” Upon the occurrence of vocal stereotypy, the observer removed the work materials from the desk and ceased instruction for 15 seconds. During the attention condition, Peter was provided with social attention contingent upon each instance of vocal stereotypy, while appropriate behavior was ignored. When Peter engaged in vocal stereotypy, researchers would briefly reprimand him with a phrase such as, “that is way too loud” or “you need to have a quiet voice in school”. During this condition, Peter was provided with puzzles (an independent activity in his repertoire) and given the instruction “it’s time to hang out and do puzzles.” Peter was presented with a puzzle and prompted to complete it as necessary, but no vocal attention was provided until an emission of vocal stereotypy.

Naturalistic Functional Analysis. Peter’s vocal stereotypy was analyzed using the same conditions as during the analog functional analysis except these sessions were run in natural settings and during routine activities of Peter’s school day. This was done in order to confirm the results of the analog functional analysis and to test for any variables present in the natural environment and absent in the analog setting that could have affected Peter’s vocal stereotypy. During the alone condition, Peter sat in his seat at his regular desk with an independent activity from his leisure repertoire. In this case, various picture books were used. After one of various

instructions, such as “I need you to sit by yourself while I do some work” or “I’ll be right back, sit quietly,” the observer sat outside of Peter’s cubicle and out of view, and no attention was given to Peter and all mands were ignored. When property destruction or aggression to staff occurred, the timer for the session was paused, Peter was neutrally redirected to his seat with no eye contact, and the timer was restarted. During the play condition, observers recorded vocal stereotypy while Peter was playing on the computer during his earned reinforcement break. After completing a work contract, Peter was told that he earned the computer, and the timer was started when he began to engage in watching YouTube videos. The observer ignored all behavior. During the demand condition, Peter’s vocal stereotypy was recorded during a variety of contracted work tasks at his desk. No instructions were given other than the program-specific discriminative stimuli. For example, if a session of the functional analysis was being run during a sight words program, the observer would say “find (sight word)”. Upon the occurrence of vocal stereotypy, the observer removed the work materials from the desk and ceased instruction for 15 seconds. The attention condition was conducted during out-of-seat vocational activities across school settings to aid in discrimination. When it was time to complete a vocational task such as photocopying, the observer would engage with Peter in his vocal stereotypy. For example, if Peter said “the pig is going to eat lunch” in the hallway, the observer would say “what pig?” or “you already ate lunch!” Peter was ignored when he walked through the hallways and completed tasks with a quiet voice.

Differential Reinforcement of Other Behaviors. It was incidentally observed that Peter would briefly stop emitting vocal stereotypy when his snack or lunch were removed contingent on the behavior, so it was decided to try a differential reinforcement procedure with Peter using contingent, high-preference edibles. The reason that a response cost procedure wasn’t initially

implemented with the differential reinforcement procedure was because of the importance of using the least restrictive interventions possible. Using the results of a recent edible preference assessment, observers provided an array of cheese, raisins, and soda to Peter and allowed him to choose one item for every interval with a quiet voice. Sessions were five minutes in length and were run at Peter's desk cleared of lesson materials. After the instruction, "quiet voice," a timer was set for the prescribed interval. After a successful interval, Peter was given vocal praise for having a good quiet voice and was allowed to choose his edible. Upon the occurrence of vocal stereotypy, the observer waited five seconds and then reset the timer and repeated the instruction "quiet voice." A criterion to increase interval length was set at three consecutive sessions with 80% or higher of successful intervals, and interval length was decreased after three consecutive sessions with 60% or fewer successful intervals.

Differential Reinforcement of Other Behaviors with Response Cost. When the differential reinforcement procedure was unsuccessful in reducing Peter's vocal stereotypy, a response cost was added. Instead of edibles, Peter was presented with the choice board used for the differential reinforcement procedure used to reduce his other targeted behaviors, such as shouting and aggression. Peter was instructed to choose a reinforcing activity and affix it to a token board designated for his "quiet voice" procedure. The token board, which had 20 check boxes, was presented with five checks already filled in. After the instruction "if you have a quiet voice and earn your checks, you can earn a break," a timer was set for the designated interval. For each interval absent of vocal stereotypy, Peter was given a check. Upon the occurrence of vocal stereotypy, a check was erased and after five seconds, the timer was reset. When all of the checks were earned, Peter earned his contracted break and reinforcing activity. When all of the checks were lost, the token board was removed and the reinforcing activity was no longer

available. Peter was then instructed to choose a different activity, and was required to complete a schedule of tasks to earn that activity. During the next session of the “quiet voice” procedure, all choices were again made available. A criterion to increase interval length was set at three consecutive sessions with 80% or higher of successful intervals, and interval length was decreased after three consecutive sessions with 60% or fewer successful intervals.

Results

The results of the analog functional analysis were variable across conditions. Vocal stereotypy occurred in 50% or more of intervals in every session except one in each condition (see Figure 1), which suggested that Peter’s vocal stereotypy was maintained by automatic reinforcement. During the analog functional analysis, vocal stereotypy occurred during 78% of intervals during the alone condition, 63% of intervals during the play condition, 71% of intervals during the demand condition, and 62% of intervals during the attention condition. Figure 2 depicts the results of the naturalistic functional analysis with similarly high rates of responding across conditions, which confirmed these results. While the results of both functional analyses were variable, the results of the naturalistic functional analysis showed steady responding at high levels during the attention condition, possibly suggesting that the vocal stereotypy was multiply maintained by automatic reinforcement and attention. During the naturalistic functional analysis, vocal stereotypy occurred during 57% of intervals during the alone condition, 83% of intervals during the play condition, 68% of intervals during the demand condition, and 94% of intervals during the attention condition.

During the differential reinforcement only condition, Peter never met criteria to increase interval length. Interval lengths decreased three times from the longest length at 15 seconds to the shortest at 6 seconds, at which point the intervention was revised. This is depicted in Figure

3 by the data points that fall below the abscissa, or trials to criteria to decrease interval length. Figure 3 also depicts the second intervention, the treatment package of differential reinforcement plus response cost. These data points fall below the abscissa because they represent sessions that resulted in a decreased interval length. As illustrated by the data points above the abscissa, Peter met criteria to increase interval length eight times from a minimum length of 5 seconds through an interval length of 17 seconds, without ever meeting criteria to decrease interval length.

Discussion

The results of the present study indicate that Peter's vocal stereotypy was sensitive to differential reinforcement only when a response cost procedure was added. These results are similar to the findings of Athens et al. (2008) and Falcomata et al. (2004), two studies where response cost procedures were implemented as part of a successful treatment package. As depicted by the data in Figure 3, Peter's vocally stereotypy was successfully suppressed by the differential reinforcement plus response cost intervention. He never met criteria to decrease interval length, and frequently it required only a few sessions to reach criteria to increase interval. What the data does not show, however, is the effect of the intervention on Peter's vocal stereotypy outside of the formal sessions. In fact, though no data was collected on the behavior outside of the sessions, it was anecdotally observed by all of Peter's therapists that the procedure did not seem to affect his vocal stereotypy during the day as a whole, and he would often begin to engage in stereotypic behaviors immediately after the last interval ended and a reinforcement break was received. In fact, Peter's overall vocal stereotypy did seem to decrease at one point, though it was after he began taking guanfacine, a medication prescribed to treat difficulty focusing. This medication was introduced a few weeks after the period being reported in this study.

Data continue to be taken through the present time on Peter's vocal stereotypy, and the differential reinforcement procedure with response cost continues to progress. At the time that this was written, Peter had reached an interval length of 90 seconds. Because the interval had become so long, the number of tokens required to reach reinforcement was reduced from 20 tokens--with 5 presented to allow for the response cost--to 10 tokens with 2 presented. Even with the ratio of tokens presented to total tokens reduced by 5%, Peter continues to be successful in meeting the criteria to increase interval length and can exhibit a quiet voice for long periods of time. However, when the interval length increased, Peter's team discussed the possibility of generalizing the quiet voice procedures across activities, so that Peter's academic programs could be run during the intervals. Not only would this give Peter something productive to do during the long periods of silence at his desk, but the staff hypothesized that Peter's accuracy during his academic programs would increase as his vocal stereotypy decreased. Interestingly, even with the history of reinforcement and success, Peter was not successful during the differential reinforcement procedure with response cost when demands were present. The first stimuli that were presented were receptive identification flashcards in Peter's maintenance repertoire. The discrete trials did not require vocal responses, and the procedure was conducted in the same manner. However, Peter never successfully met criteria to increase interval length in this condition. Next, the team chose previously-mastered leisure activities for Peter to use during the quiet voice procedure. When presented with alphabet flashcards, puzzles, books, and a shape sorter, Peter is currently successful at obtaining his contracted reinforcer and has been meeting criteria to increase interval length. The team continues to look for activities that Peter can engage in while maintaining a quiet voice, with the hopes that the procedure can eventually be generalized across a wide variety of activities.

In addition to training generalization across activities, Peter's quiet voice procedure was introduced during his home-based therapy sessions to train generalization across environments. The behavior therapist who works with Peter at home was trained to implement the quiet voice procedure during sessions and presented with identical data collection materials and visuals to those presented at school. The therapist reported anecdotally during team meetings that Peter was successful at sitting with a quiet voice during the sessions, and data supported this, showing that Peter had successfully met criteria to increase the interval length several times. However, similar to the findings at school, Peter's vocal stereotypy was not reduced outside of the formal sessions with the timer and token board; rather, it was reported that Peter would begin to engage in vocal stereotypy almost immediately after his last check was earned.

One limitation of this study is the lack of interobserver agreement data collected during Peter's differential reinforcement procedures. During the first procedure, differential reinforcement only, no interobserver data was collected. During the second procedure, differential reinforcement plus response cost, interobserver data was only collected during 6% of sessions. This lack of interobserver agreement data was due to the ratio of staff to students. In the public school setting, there is rarely a time where trained observers are available to collect data, as they are usually working directly with another student. Fortunately, the limited amount of data collected showed very high agreement, never falling below 98.3%. Furthermore, this study lacks procedural integrity data for the same reason of limited available staff. However, since most of the students in the program worked within a small classroom suite, staff members could often overhear the differential reinforcement procedures as they were being run, and could offer suggestions or ask each other questions about the procedures.

Another limitation of the quiet voice procedure outlined in this study is that a possible artifact of the procedure was that Peter was reinforced for not using any language at all. A large proportion of the vocal stereotypy that Peter emitted consisted of repetitions of mands or tacts. For example, when Peter requested the bathroom, he would repeat “bathroom” several times, often even after he had reached the bathroom. The quiet voice procedure only trained Peter to sit in the absence of vocal stereotypy and any other vocal language, and no provision was made to train him to engage in vocal responses without repetition. Methods for shaping repetitious language to more appropriate vocalizations would be an interesting topic for future research.

Similar to the thought of shaping behavior that is functional yet inappropriate, another topic for future researchers to investigate is the possibility that reducing vocal stereotypy could inadvertently reduce any functional communication responses. In some cases, individuals emit vocal stereotypy in place of appropriate language responses, such as with Peter’s repetitive manding. Though impossible in a typical public school setting with the staffing constraints generally present, a more in-depth examination of the types of language emitted under the general topography of vocal stereotypy, (i.e. manding, tacting, or non-contextual utterance,) is warranted. After such an examination is made, researchers could focus their efforts more precisely. Instead of suppressing all language, they could focus only on repeated or non-contextual utterances. Then they could not only reduce the inappropriate language, but shaping mands and tacts that fall under the same topography into more appropriate functional communication, and possibly increasing the amount of meaningful language in order to enrich the lives of the student, families, and caregivers. My study adds to the previous research of treatment packages reducing stereotypy by replicating certain aspects of these treatment

packages and showing a further example of the efficacy of differential reinforcement and response cost.

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Figure Captions

Figure 1. Percentage of intervals with vocal stereotypy during the analog functional analysis.

Figure 2. Percentage of intervals with vocal stereotypy during the naturalistic functional analysis.

Figure 3. Trials-to-criteria to increase or decrease interval length during the first intervention, differential reinforcement of other behaviors only (DRO) and during the second intervention, the treatment package of differential reinforcement of other behaviors with response cost.





