March 2019

Evaluating the Effects of Matched Stimulation on Vocal Stereotypy and Skill Acquisition

Joel D. Greenbaum
University of South Florida, joelg813@gmail.com

Follow this and additional works at: https://digitalcommons.usf.edu/etd
Part of the Social and Behavioral Sciences Commons

Scholar Commons Citation
Greenbaum, Joel D., "Evaluating the Effects of Matched Stimulation on Vocal Stereotypy and Skill Acquisition" (2019). USF Tampa Graduate Theses and Dissertations. https://digitalcommons.usf.edu/etd/7800

This Thesis is brought to you for free and open access by the USF Graduate Theses and Dissertations at Digital Commons @ University of South Florida. It has been accepted for inclusion in USF Tampa Graduate Theses and Dissertations by an authorized administrator of Digital Commons @ University of South Florida. For more information, please contact digitalcommons@usf.edu.
Evaluating the Effects of Matched Stimulation on Vocal Stereotypy and Skill Acquisition

by

Joel D. Greenbaum

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts Department of Child and Family Studies College of Behavioral and Community Sciences University of South Florida

Major Professor: Catia Cividini-Motta, Ph.D. Raymond Miltenberger, Ph.D. Kwang-Sun Blair, Ph.D.

Date of Approval: March 21, 2019

Keywords: Music, competing items, Autism Spectrum Disorder, noncontingent reinforcement

Copyright © 2019, Joel D. Greenbaum
TABLE OF CONTENTS

List of Tables ........................................................................................................... ii
List of Figures .......................................................................................................... iii
Abstract ..................................................................................................................... iv

Chapter One: Introduction ...................................................................................... 1

Chapter Two: Method ............................................................................................. 6
  Participants, Setting, and Materials ................................................................. 6
  Dependent Measure and Response Measurement ........................................... 7
    Vocal Stereotypy ................................................................................................. 7
    Item Selection .................................................................................................... 8
    Speed of Acquisition ....................................................................................... 8
    Latency to Respond ......................................................................................... 8

Interobserver Agreement and Procedural Integrity .............................................. 9

Experimental Design ............................................................................................ 10

General Procedures ............................................................................................... 10
  Participant Screening ......................................................................................... 11
  Preference Assessments ...................................................................................... 12
  Functional Analysis ............................................................................................ 14
  Competing Items Assessment ........................................................................... 15
  Evaluation of Performance on Academic Tasks ............................................... 16

Chapter Three: Results .......................................................................................... 20

Chapter Four: Discussion ...................................................................................... 24

References .............................................................................................................. 28

Appendices ............................................................................................................ 40
  Appendix A: Sample Procedural Integrity Data Sheet ....................................... 41
  Appendix B: Sample Competing Items Assessment Procedural Integrity Data Sheet ........................................ 42
  Appendix C: Sample Preference Assessment Procedural Integrity Data Sheet ....... 43
LIST OF TABLES

Table 1: Mean IOA, PI, and range per assessment, per participant.................................10

Table 2: Participant Information, Results of Auto Screening and Prerequisite Assessment, and Target Stimuli.................................................................12
LIST OF FIGURES

Figure 1: Percentage of sessions with vocal stereotypy during the automatic screening Assessment................................................................. 31

Figure 2: Edible, toy, and music preference assessment data for Nate................................. 32

Figure 3: Toy and music preference assessment data for Chad............................................. 33

Figure 4: Functional analysis data for Nate and Chad......................................................... 34

Figure 5: Competing items assessment data for Nate and Chad............................................ 35

Figure 6: Speed of acquisition data for the skill acquisition evaluation for Nate and Chad... 36

Figure 7: Percentage of sessions with vocal stereotypy during the skill acquisition evaluation for Nate and Chad................................................................. 37

Figure 8: Latency data for the latency evaluation for Nate and Chad................................. 38

Figure 9: Percentage of sessions with vocal stereotypy during the latency evaluation for Nate and Chad................................................................. 39
ABSTRACT

Stereotypic behavior is often observed in children diagnosed with an Autism Spectrum Disorder (ASD; American Psychiatric Association, 2013). Stereotypy can inhibit skill acquisition by leading to inaccuracy on task performance and/or slower task completion (e.g., Koegel & Covert, 1972; Morrison & Rosales-Ruiz, 1997). Several studies have demonstrated that access to preferred matched stimulation leads to a reduction of vocal stereotypical behavior (e.g., Lanovaz, Rapp, & Ferguson, 2012). However, it is paramount that treatments not only be effective in decreasing the problem behavior, but do so without further inhibiting academic progress. The current study evaluated the effects of matched stimulation (i.e., music) on vocal stereotypy and acquisition of novel skills. Non-contingent access to music decreased levels of vocal stereotypy across participants and did not hinder mastery of discrimination skills. In addition, noncontingent access to music had only a minor impact on the participant’s latency to perform mastered tasks.
Autism Spectrum Disorder (ASD) is often associated with repetitive behavior such as hand flapping and repetitive non-functional vocals. The term stereotypy, defined as “repetitive behavior that does not serve any social function” (Miltenberger, 2016, p. 320), has often been used as a label for these responses. Stereotypy, or stereotypical behavior, is often maintained by automatic reinforcement (Miltenberger, 2016) and although stereotypical behavior may be acceptable at certain times or in certain environments (i.e. bedroom or another isolated area), these responses may interfere with or prevent children from engaging in appropriate activities and/or from learning new skills (e.g., Koegel & Covert, 1972; Morrison & Rosales-Ruiz, 1997). Therefore additional research on procedures for decreasing stereotypy while also promoting skill acquisition and task performance is necessary.

Research on treatments for vocal stereotypy has identified several interventions effective in decreasing vocal stereotypy. Examples of consequence-based procedures include response interruption and response redirection (RIRD; e.g., Ahearn, Clark, & Macdonald, 2007), response cost (RC; e.g., Rapp, Patel, Ghezzi, O’Flaherty, & Titterington, 2009) and positive punishment such as reprimand (e.g., Rapp et al., 2009). Response interruption and redirection (RIRD) is a procedure that involves interrupting the target behavior and redirecting the individual to engage in appropriate tasks such as answering social questions or following simple directions (Ahearn et
al., 2007). Cassella, Sidener, Sidener, and Progar (2011) evaluated the effects of RIRD consisting of compliance with motor tasks on vocal stereotypy of two boys diagnosed with severe autism. This study, which employed an ABAB design, found that stereotypy decreased during the intervention phases showing that motor RIRD may be an effective intervention for vocal stereotypy. Although RIRD has been found to suppress levels of stereotypy in a number of studies (e.g., Ahearn et al., 2007; Cassella et al., 2011), this procedure has some limitations. For instance, the effects did not generalize across people and environment thus requiring additional intervention sessions (e.g., Ahrens & Lerman, 2011). For instance, Cassella et al. (2011) required ten motor responses contingent on vocal stereotypy, and noted that sessions often lasted 30 min and the results did not generalize to novel therapists. Finally, the mechanism through which RIRD reduces stereotypy is not known (i.e. punishment or extinction; Cassella et al., 2011).

Rapp et al. (2009) evaluated the effects of response cost and verbal reprimands on stereotypy. Both of their experiments involved the use of green and red cards to establish stimulus control over vocal stereotypy. In the first experiment stereotypy in the presence of green card resulted in no consequences whereas stereotypy in the presence of the red card resulted in a verbal reprimand. Levels of stereotypy decreased when the red card was present suggesting that verbal reprimands were aversive. In the second study, Rapp et al. examined the effects of response cost on vocal stereotypy. Participants had access to a preferred toy across all sessions however stereotypy in the presence of the red card resulted in the removal of the toy for 10 s. This study found that removal of a preferred toy contingent on the occurrence of stereotypy led to a decrease in that behavior. These experiments demonstrate that both positive and negative punishment can suppress vocal stereotypy, however, the effects of these interventions may not always generalize to new environments. For instance, Rapp and colleagues found that more
extensive histories with the punishment contingencies associated with the red card were necessary to produce similar results in a classroom environment.

Antecedent-based procedures, usually consisting of non-contingent access to competing items, have also been evaluated (e.g., Lanovaz, Sladeczek, & Rapp, 2012). Studies have shown that noncontingent access to competing items such as auditory stimulation may lead to a decrease in vocal stereotypy. For instance, Gunter, Fox, McEvoy, Shores, and Denny (1993) measured levels of stereotypy of a 14 year-old individual diagnosed with an ASD across various activities, classroom activities, vocational activities, walking in the hallway, and standing in line during lunch. During the intervention phase the participant had continuous access to music via headphones and off-task behavior resulted in the removal of the headphones until the participant began to engage with the assigned activity. In this study, non-contingent access to music, paired with a response cost component for off-task behavior, resulted in a decrease in stereotypy from 80% of intervals during baseline to 1% of intervals during the treatment phase. Similarly, Saylor, Sidener, and Reeve (2012) examined the effects of three types of auditory stimulation, music, white noise, and recordings of the participants’ stereotypy, on each participant’s vocal stereotypy. This study found that stereotypy decreased to near zero levels when the participant had access to music and recordings of their own stereotypical vocalizations but that white noise did not suppress stereotypy. Finally, Lanovaz, Rapp, et al. (2012) demonstrated that access to preferred music produced greater reductions in vocal stereotypy than did access to non-preferred music. The results of these studies suggest that noncontingent access to other forms of auditory stimulation, which presumably matches the reinforcing sensory stimulation resulting from vocal stereotypy, may decrease vocal stereotypy.
Few studies have evaluated the impact of stereotypy on acquisition or performance of academic tasks (e.g., Koegel & Covert, 1972; Morrison & Rosales-Ruiz, 1997). For instance, Koegel and Covert (1972) demonstrated that acquisition of a discrimination between colored lights was slower during trials in which stereotypy occurred as compared to trials when stereotypical behavior was suppressed by the presentation of an aversive stimulus consisting of the researcher sharply saying “No!” and slapping the subject on the hands contingent on the occurrence of stereotypy. In this study accurate performance of the task increased steadily to about 98% during the condition in which stereotypy was suppressed by the aversive consequence. In addition, research has shown that stereotypy can lead to lower accuracy on simple counting tasks (e.g., Morrison & Rosales-Ruiz, 1997). Morrison and Rosales-Ruiz conducted sessions in a room where the participant received most of his daily teaching. Researchers required the participant to count the number of objects placed in front of them. The researchers measured accuracy of task performance during trials in which stereotypy occurred at high and low levels, and they found that accuracy was higher, between 80% and 90%, during the trials where lower levels of stereotypy occurred.

Vocal stereotypy may lead to slower skill acquisition and lower accuracy on simple mastered tasks (e.g., Koegel & Covert, 1972; Morrison & Rosales-Ruiz, 1997). Research has identified several treatments as being effective at reducing stereotypy to near zero levels (e.g., Ahearn et al., 2007; Rapp et al., 2009; Saylor et al., 2012). However, no research to date has assessed whether an intervention effective in suppressing stereotypy impacts acquisition or completion of academic tasks. Given that noncontingent functionally matched stimulation in the form of music is a minimally intrusive intervention that has been shown to suppress stereotypy,
the purpose of the current study was to evaluate the effects of matched stimulation on vocal stereotypy, rate of skill acquisition, and latency to perform mastered tasks.
CHAPTER TWO:

METHOD

Participants, Setting, and Materials

Two children, Nate and Chad, participated in this study. Both children were three years old at the time of recruitment and had an ASD diagnosis. Both children had limited vocal communication, often using one-to-two words to communicate their wants and needs. They were unable to read but had large tact and receptive repertoires, and were able to follow basic instructions such as “fold your hands.” Both had previous exposure to matching tasks presented in a Discrete Trial Training (DTT) format such as the tasks included in this study. Nate and Chad, according to caregiver report, engaged in high rates of vocal stereotypy throughout the day. Participants were recruited through recruitment flyers that were distributed to the PI’s contact list, posted at USF, and posted at clinics that provided letter of supports. Upon contacting the PI, caregivers were given a consent form to agree to participate in the study with the understanding they may withdraw at any time. If the caregivers were interested, the PI reviewed the consent forms and answered any questions they may have. During the consent process parents were also asked to limit the amount of music their child contacted outside of the study environment.

Criteria for participation included engaging in automatically maintained vocal stereotypy, being able to sit at a table for 5 minutes, and tolerate headphones for 5 minutes. To determine
whether participants met participation criterion we completed two 5-min probe sessions and an automatic screen assessment (Querim, Iwata, Roscoe, Schlichenmeyer, Ortega, & Hurl, 2013). Sessions were completed in a 1:1 room at the clinic where participants are receiving ABA services.

Materials included toys, edible items, a wireless Bluetooth stereo, a wireless headphones, participant-specific academic tasks, a video camera to record sessions, a clipboard to mask orientation of stimuli between trials, a digital stopwatch to measure duration of sessions, and data sheets used to record performance on the academic tasks (see Appendix A). The Countee© application was used to measure duration of stereotypy and calculate interobserver agreement. A laptop with a music application (Spotify®) was used to play music over the stereo and over headphones.

**Dependent Measure and Response Measurement**

The main dependent measures were vocal stereotypy and performance of the selected academic tasks. *Vocal stereotypy* consisted of any vocalization that did not serve a social function or was unrelated to the current context. Nate’s vocal stereotypy included non-contextual singing, whispering, humming, and repeating previously heard words or phrases. Chad’s stereotypy included non-contextual high-pitched vocalizations, humming, singing, repeating previously heard words or phrases, and making “raspberry” noises with his tongue and lips. Duration of stereotypy was measured continuously using second-by-second recording, via the Countee© application. These data were converted to percentage of the session with stereotypy by dividing the total duration of stereotypy that occurred in all trials in the session by the total duration of trials in the session and then multiplying by 100.
During the preference assessments and the academic performance evaluation observers collected data on a trial-by-trial basis. During the tangible, edible, and music preference assessments data were collected on *item selection* which was defined as any instance in which the participant touches one of the presented stimuli with his or her hand. We calculated the percentage of trials in which each item was selected by dividing the number of trials in which each item was selected by the total number of trials in which the item was presented and then multiplying by 100.

Finally, during the academic task performance evaluation we assessed speed of acquisition of novel academic skills and latency to respond to mastered academic tasks. *Speed of acquisition* was defined as the number of trials required to meet mastery criterion whereas *latency to respond* was defined as the time elapsed, in seconds, from task presentation until task completion. During this evaluation, we collected data on a trial-by-trials basis on the participant’s performance. During the skill acquisition evaluation, performance on each trial was categorized as correct independent, correct prompted, or incorrect responses. Responses were scored as *correct independent* when the participant completed the task correctly without requiring a prompt from the therapist. Responses were categorized as *correct prompted* when the participant completed the task correctly but only after receiving a prompt from the therapist. Finally, *incorrect responses* included trials in which the participant completed the tasks incorrectly, either with or without a prompt from the therapist, as well as trials in which the participant did not respond within 5 s of the instruction to begin the task. These data were summarized as the percentage of trials with each type of responses and the total number of trials required to mastery. During the second evaluation, latency to perform the prescribed task, data
were collected on the latency to perform the tasks and these data were summarized as the mean latency, in seconds, per session, as well as the overall mean latency across all sessions.

**Interobserver Agreement (IOA) and Procedural Integrity (PI)**

Interobserver agreement and procedural integrity were measured on at least 33% of sessions across phases and participants by having trained observers independently reviewed and scored videos of the sessions. During the competing items assessment and functional analysis, interobserver agreement data were calculated using the proportional agreement method. This method involved dividing the session into 10-s intervals, dividing the smaller value by the larger value in each interval, adding the values for all of the intervals, dividing by the number of intervals, and then multiplying by 100 to attain a percentage. For the remaining phases (i.e., tangible preference assessment, music preference assessment, skill acquisition evaluation, and evaluation of latency to complete mastered tasks), IOA was calculated on a trial-by-trial basis by dividing the number of trials with agreement by the total number of trials and multiplying by 100 (see Table 1). We collected IOA on at least 33% of the sessions, and the mean IOA across participants was 93.2% (range, 79.2-100%).

Data on procedural integrity were collected using a task analysis that described the procedures (see Appendices A, B, and C). The task analysis specified the steps the therapist was required to complete during each assessment (e.g. “therapist delivers correct reinforcer”). Treatment integrity scores were determined by calculating the number of steps completed correctly, dividing by the total number of steps, and then multiplying by 100 (see Table 1). We collected PI on at least 33% of the sessions, and the mean PI across participants was 100%.
Experimental Design

This study consisted of a series of assessments including preference assessments, a competing items evaluation, a functional analysis, and an academic task evaluation. A multielement design was used for both the functional analysis and competing items assessment. The preference assessment was completed in a paired-stimulus format (Horrocks & Higbee, 2008). Finally, an adapted alternating treatments design was employed during academic task evaluation that utilized equivalent tasks in the different conditions in order to directly compare the effects of the treatment on skill acquisition (Sindelar, Rosenberg, & Wilson, 1985).

General Procedure

Prior to evaluating the effects of continuous access to auditory stimulation on performance of academic tasks we conducted a series of assessments including a tangible preference assessment, music preference assessment, functional analysis, and competing items assessment. A modified version of the Reinforcer Assessment for Individuals with Severe Disability (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) was used to interview caregivers or another person who has known the child for at least six months about the participant’s

<table>
<thead>
<tr>
<th></th>
<th>Auto Screen</th>
<th>Preference Assessments</th>
<th>Functional Analysis</th>
<th>Skill Acquisition</th>
<th>Latency Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of sessions/score</td>
<td>% of sessions/score</td>
<td>% of sessions/score</td>
<td>% of sessions/score</td>
<td>% of sessions/score</td>
</tr>
<tr>
<td>Nate</td>
<td>92.9%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>(range, 76.4-79.2)</td>
<td>(range, 95.1-95.2)</td>
<td>(range, 91.6-88.7)</td>
<td>(range, 97%-87.6)</td>
<td>(range, 97% 95.2%)</td>
</tr>
<tr>
<td>Chad</td>
<td>95.2%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>(range, 83.7)</td>
<td>(range, 97.5%)</td>
<td>(range, 88.7)</td>
<td>(range, 95%)</td>
<td>(range, 97.5%)</td>
</tr>
</tbody>
</table>
preference towards edibles, tangibles, and music (Appendix E). Items identified in this interview were included in the subsequent assessments.

**Participant screening.** Participant screening assessments included two 5-min probes and an automatic screening assessment (Querim et al., 2013). During the first probe session the participants were seated across from the therapist, and an easy task was presented every 15 s. Compliance with the task resulted in praise and access to an iPad or toy for 15 s whereas errors resulted in an error correction procedure (i.e., representing the S^D^, prompting the correct response, and then delivering reinforcement). The second probe session involved the participant wearing headphones for the entire session while they had free access to toys. We then completed the automatic screen assessment per the procedures described by Querim et al. This assessment consisted of three 5-min alone (Nate) or no interaction (Chad) sessions. During these sessions participants were seated at a table however Nate was alone in the room whereas the therapist was present in the room during the sessions completed with Chad. No consequences were provided for any behavior. If stereotypy persisted during these sessions, it was presumed that it was maintained by automatic reinforcement. See Table 2 and Figure 1 for results of these assessments.
Tangible and edible preference assessment. Paired-stimulus preference assessments (Fisher et al., 1992; Horrocks, & Higbee, 2008) were conducted to identify highly preferred and low to moderately preferred tangible and edible items. Each stimulus was presented with each other two times, once on the left side and once on the right, to control for possible side preference (See appendix C). Prior to the start of the preference assessment, forced exposure trials were completed during which the participant were allowed to engage with each item for 15 s or consume each of the food items. During each trial of the preference assessment the items were placed approximately 0.3 meters apart and the participant was given the instruction “pick the one you like most” as done by Horrocks and Higbee (2008). After the participant selected one of the stimuli, the item that was not selected was removed and the selected stimulus was made available for 15 s or until it was consumed. The item was then removed and the next trial

<table>
<thead>
<tr>
<th></th>
<th>Nate</th>
<th>Chad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>3 yrs</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>ASD</td>
<td>ASD</td>
</tr>
<tr>
<td>Communication</td>
<td>Limited vocals (1-2 word requests)</td>
<td>Limited vocals (1-2 word requests)</td>
</tr>
<tr>
<td>Automatic Function</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5 min Sitting at table</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5 min with Headphones</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Target stimuli set</td>
<td>Neigh/Horse-Bray/Donkey; Cluck/Chicken-Meow/Cat; Quack/Duck-Oink/Pig</td>
<td>Fast-Slow; Night-Day; Up-Down</td>
</tr>
</tbody>
</table>

Table 2

Participant Information, Results of Auto Screening and Prerequisite Assessment, and Target Stimuli
was presented after a 5-s interval. This process was repeated until all possible stimulus pairs (controlling for side preference) were presented.

Music preference assessment. A music preference assessment was conducted to assess preference for different genres of music following the procedures described by Lanovaz, Rapp, et al. (2012). Five different songs were assessed with each participant. Two or three of the songs were selected based on the results of the RAISD and the remaining songs were chosen by the researcher after exposing the participant to a variety of additional genres of music (Appendix E). If caregivers did have information about specific songs or indicate that their child does not have a preference towards specific genres, the researcher exposed the participant to a variety of music and then selected five songs that were not associated with any problem behavior or rejecting response.

We conducted a paired-stimulus music preference assessment using different colored cards corresponding to the various genres of music (Lanovaz, Rapp, et al., 2012). Cards were presented in pairs during each trial. In a similar fashion to the tangible and edible preference assessment, each stimulus was paired with one another twice, once on the left side and once on the right to control for possible side preferences (See Appendix C). Prior to the start of the preference assessment two forced exposure trials were completed during which the therapist prompted the participant to select each card, in a random order, and the corresponding song was played for 15 s after each selection. During each trial of the preference assessment, the cards were placed approximately 0.3 meters apart and the participant was given the instruction “pick the one you like most.” After the participant selected one of the stimuli, the card that was not selected was removed and the corresponding auditory stimulation for the selected card was played for 15 s. The card was then removed and another trial was presented after a 5-s inter-trial
interval. This process was repeated until all possible stimulus pairs (controlling for side preference) were presented. After the song(s) was selected, caregivers were asked if they can limit how much music they play with their children to avoid satiation.

**Functional analysis.** A functional analysis was conducted using procedures similar to Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Sessions included escape, play, attention, and alone (Nate) or no interaction (Chad) however briefer sessions (5 min) were conducted because research has shown that they are likely to produce same results as 15-min sessions (Wallace & Iwata, 1999). No interaction sessions were completed with Chad because he tried to leave the room and also engaged in engaged in other topographies of problem behavior when left alone in the room.

**Escape.** The escape condition consisted of demands being placed continuously and 30-s breaks being given following the occurrence of vocal stereotypy. Demands consisted of various vocal and motor imitation tasks as well as receptive identification and following simple instructions (i.e., “say hello,” “do this,” “touch your head” and “wipe the table”). If the participant echoed the instruction delivery by the therapist, no consequences were provided. A three-step prompting procedure (modeling, light touch on the forearm, and hand-over-hand) were used if the participant did not comply with the demand within 3 s of presentation. The therapist delivered neutral praise following independent compliance and continued to place demands. All other responses emitted by the participant resulted in no consequences.

**Play.** During the play condition the participant had access to verbal and physical attention in the form of brief physical contact and praise every 30 s independent of the occurrence of stereotypy. In addition, the participant had non-contingent access to two to three toys identified as preferred during the tangible preference assessment. Nate had access to Toy Food and Cars,
and Chad had access to Cars and Trains. Appropriate requests were reinforced if possible. No consequences were provided following stereotypy.

**Attention.** The attention condition consisted of a therapist engaging in another task while ignoring the participant, however, the participant had access to a low to moderately preferred toy. At the beginning of the session, the therapist provided a brief statement such as, “I’m going to sit over here and do some work.” Stereotypy resulted in brief response-related attention (e.g. “don’t say that” or “why are you making that noise?”) from the therapist paired with brief physical contact such as touching the participant’s shoulder. Attention was delivered as long as the participant was engaging in vocal stereotypy. All other responses emitted by the participant resulted in no consequences.

**Alone or no interaction.** During both the alone (Nate) and no interaction (Chad) conditions the therapist brought the child to the room and stated “Wait here. I’ll be right back.” During these sessions no consequences were provided for any responses emitted by the participant. In the alone sessions the therapist exited the room and monitored the participating through a live closed-feed camera. The therapist remained in the room during the no interaction sessions but sat at least 1.5 meters away from the participant.

**Competing items assessment.** Following the preference assessments, an assessment was conducted to assess the effect of highly preferred music and no music on stereotypy (Lanovaz, Rapp, et al., 2012). Each session lasted 5 min and the therapist was in a room with the participant (similar to the no interaction sessions). In addition, participants did not have access to any toys or social interaction throughout the session and no consequences were provided for any responses emitted by the participant. During sessions in which we evaluated the effects of music on stereotypy the prescribed music (high preferred) will play continuously through a stereo for the
entire 5 min. After each session, participants had free access to toys, other items, and attention for 5 min before beginning the next session. This procedure will continued until at least three sessions of each condition, high preferred music and no music, were conducted. The song “Pizza Time” was used with Nate and “Superstar” was used with Chad, and the song was consistent across phases. Music was considered to be a competing item if the level of stereotypy decreased by at least 50% of baseline.

**Evaluation of performance on academic tasks.** The purpose of this portion of the study was to evaluate the effects of continuous access to music on performance of academic tasks. We evaluated both acquisition of novel skills as well as performance of mastered tasks across three conditions, music played through headphones placed over ears, music played over the stereo, and no music. Academic tasks for each participant were selected from their current educational plan however novel stimuli were selected for this evaluation. A discrete trial teaching (DTT) format was employed and sessions consisted of 10 trials with a set of two stimuli assigned to each condition. Sample and placement of comparison stimuli were rotated across trials (see sample datasheet in Appendix A) and a small board was used to block the participant from observing the researcher’s arranging of the stimuli. A break of at least 2-min was provided between sessions and sessions were conducted in a quasi-random order. In addition, prior to beginning a session the participant was allowed to choose a preferred edible or toy to earn contingent on correct responding. Physical guidance was used as prompts. The prompt fading procedure consisted of a 2-s constant delay where step 1 was an immediate full prompt, step 2 was a 2-s delay full prompt; step 3 was a 2-s delay partial prompt, and in step 4 no prompts were provided. Prompts were faded across sessions if the participant correctly completed at least 80% of the trials in a session. The criterion to re-introduce a more restrictive prompt was two consecutive errors or
three total errors during a session. The mastery criterion was at least 80% correct and independent responses across three consecutive sessions. Sessions were conducted until the mastery criterion was met.

**Speed of acquisition evaluation.** During this phase acquisition of academic tasks was evaluated under three conditions, two conditions during which music was continuously available (via headphones or stereo) and a no music condition. Volume of music was determined by a brief assessment (see below) identifying the participant’s ability to respond to instructions while music was being played. Nate’s skill acquisition task consisted of matching printed animal sound (i.e., “quack”) to pictures of animals (i.e., duck). Chad’s task consisted of receptive identification of attributes. Each stimuli set consisted of two items therefore six stimuli (two per set; three total sets) were included for each participants (see Table 2). We attempted to control for difficulty levels by selecting stimuli with similar length and then randomly assigning them to one of the conditions. For Nate, we selected animal sounds with four (i.e., “meow”) or five (i.e., “cluck”) letters. We create stimuli sets by pairing a sound with four letters to a sound with five letters. Then each set was randomly assigned to one of the conditions. For Chad, we selected attributes with one syllable and separated them into pairs of opposite (i.e., “fast” and “slow”). The comparison stimuli were arbitrary symbols so these were also randomly assigned to a corresponding attribute. Baseline sessions were completed first to identify skills that the participants did not reliably perform.

**Volume Assessment.** A decibel meter was used to adjust the volume of the music to 60 decibels (dB), which has been identified as the volume of typical conversations (American Speech-Language-Hearing Association, 2017). Five simple mastered task demands were placed (such as “clap your hands”). The decibel level was considered appropriate if the participant
responded to 80% of the task demands. If the participant did not respond to at least 80% of the task demands, the decibel level was lowered by 1dB until the participant was able to respond to 80% of the task demands. The decibel was kept constant across all conditions by being measured directly inside the headphones and from one meter in front of the stereo.

**Baseline.** During each session all necessary materials were available. Prior to presenting a trial the researcher established attending which consisted of requiring the participant to face the therapist with hands folded or lying flat on the table/lap. The researcher then presented the sample stimulus and required the participant to emit an observing response (e.g., touching the sample). Next an instruction, “match,” and the comparison stimuli were presented simultaneously. During baseline no consequences were provided for correct or incorrect responses however praise and a preferred item were delivered for appropriate behavior every three to four trials. Each trial was followed by a brief 5-s intertrial interval and the session continued until all 10 trials were presented. Stimuli were selected for training if correct responding during baseline was at or below 50% of the trials.

**Training.** The same procedures as baseline will be implemented however prompts were provided as described previously. Correct responding resulted in access to praise and a preferred item. Incorrect responding resulted in an error correction procedure consisting of the instructor removing all stimuli and the re-presenting the trial while providing the most intrusive prompt. Reinforcement, in the form of praise and a preferred item, was delivered for correct responding during the error correction.

**Latency to perform tasks evaluation.** After stimuli were mastered during the previous phase, we conducted three additional sessions to measure the average latency to perform those tasks. During each trial we measured the time elapsed, in seconds, from the presentation of the
comparison stimuli to the emission of a response by the participant. All procedures were similar
to baseline except that correct and independent responding resulted in praise and access to a
preferred item. In addition, if the participant did not respond within one minute of the
presentation of the comparison stimuli, the trial was terminated, one minute was recorded as the
latency, and another began.
CHAPTER THREE:

RESULTS

Results for Nate and Chad are presented in Table 2 and Figures 1-9. Table 2 contains the results of the initial screening assessment. Both participants engaged in vocal stereotypy that persisted across multiple sessions. Nate engaged in vocal stereotypy for a mean of 51.6% of sessions (range, 48 to 56%) and Chad engaged in vocal stereotypy for a mean of 46.7% of sessions (range, 38 to 54%). Figure 1 includes the data from the initial automatic screening assessment as percentage of session with vocal stereotypy. Nate engaged in stereotypy at similar levels across the three sessions and stereotypy occurred on at least 40% of the sessions. Chad also engaged in similar, but somewhat more variable, levels of vocal stereotypy across these sessions. Given that vocal stereotypy persisted in the absence of consequence, these results suggest that both of their vocal stereotypy was marinated by automatic reinforcement.

Results of the preference assessments completed with Nate and Chad are shown in Figures 2 and 3, respectively and results of the functional analysis for both participants are depicted in Figure 4. Figures 2 and 3 depict percentage of trials with item selection whereas Figure 4 shows the percentage of session with vocal stereotypy. For Nate, Nacho Doritos®, toy food, and the songs “Pizza Time” and “Our God Reigns” were identified as highly preferred items because they were selected in 100%, 75%, and 75% of trials, respectively. For Chad, cars and the song “Superstar” were highly preferred items because they were selected in 87.5% and 75% of trials, respectively. As shown in Figure 4, both Nate and Chad engaged in the highest
levels of vocal stereotypy during the alone (Nate) and no interaction (Chad) conditions. Nate also engaged in vocal stereotypy at higher levels during the play condition in comparison to the attention and demand conditions and levels of stereotypy persisted during the final alone series. Chad engaged in low and similar levels of vocal stereotypy during play, demand, and attention conditions. These results further indicate that their vocal stereotypy was maintained by automatic reinforcement.

Results of the competing items assessment are shown in Figure 5 as percentage of session with vocal stereotypy. During the competing items assessment, Nate had access to the “Pizza Time” song and Chad listened to the song “Superstar”. During sessions without access to music, Nate engaged in vocal stereotypy during an average of 59% (range, 59 to 60%) of the sessions and his stereotypy decreased to an average of 14% (range, 10 to 20%) to the sessions when he had access to the song ‘Pizza Time”. Chad’s vocal stereotypy occurred during an average of 38% (range, 36 to 42%) of the sessions when he did not have access to music and his stereotypy decreased to an average of 17% (range, 13 to 24%) of the sessions when the song “Superstar” was played.

Results of the skill acquisition phase are shown in Figures 6 and 7. Figure 6 depicts percentage independent correct responding during baseline and training phases and Figure 7 includes the percentage of session with vocal stereotypy. As displayed in Figure 6, during baseline, both participants engaged in independent correct responding in less than 50% (range, 0 to 50%) of the trials. Once training consisting of prompts, prompt fading, error correction, and reinforcement was introduced, both participants acquired the acquisition tasks. Mastery criterion was met for both participants in the same number of training sessions per condition. Both participants required 12 training sessions per condition to meet mastery criterion. Nate’s
independent correct responding remained at zero throughout the sessions in which prompts were delivered (sessions 10-33), even when a time delay was inserted (session 19) between the delivered of the initial vocal instruction (i.e., “match”) to initiate the task and the prompt to complete the task. Chad’s emitted some independent responding during the initial training sessions.

In addition, as shown in Figure 7, throughout the training phase of the skill acquisition evaluation vocal stereotypy occurred during a mean of 63.6% (range, 49.2 to 76.4%) of the sessions for Nate and 35.1% (range, 24.9 to 42.1%) of the sessions for Chad when participants did not have access to music. In addition, when music was played over the headphone, vocal stereotypy occurred during a mean of 23.3% (range, 8.4 to 53.7%) of the sessions for Nate and a mean of 22% (range, 10 to 27.9%) of the sessions for Chad. Finally, when music was placed on the stereo vocal stereotypy occurred during a mean of 21.1% (range, 5.4 to 32.6%) of the sessions Nate and 24.7% (range, 19.2 to 31.1%) of the sessions for Chad. These data suggest that access to music decreased overall levels of vocal stereotypy during these sessions but similar levels were observed across the two conditions with access to music.

Results of the latency evaluation are shown in Figures 8 and 9. Across the three sessions, Nate required a mean of 5.56 s (range, 5.2 to 6.1s) to complete the task when music was played over the headphones, 3.9 s (range, range 3.9 to 4.1s) when music was played on the stereo, and 2.6 s (range, 1.3 to 4.5s) in the no music condition (Figure 8). Chad required a mean of 12.5 s (range, 4.7 to 22.6s) to complete the task when music was played over headphones, 21.5 s (range, 4.1 to 12.5s) when music was played on the stereo, and 4.7 s (range, 3.5 to 6.7s) in the no music condition (Figure 8). These data suggest that, in general, the latency to perform the mastered tasks was smaller when participants did not have access to music and that the latency
was similar across the two music conditions for Chad whereas Nate’s latency was bigger in the stereo condition in comparison to the headphones condition. Finally, during this evaluation Nate’s vocal stereotypy occurred in an average of 25.9% (range, 19.4 to 32.4%) of the sessions without music, 31.3% (range, 28.4 to 35.8%) of sessions with music via headphones, and 24.3% (range, 21.2 to 28.2%) of sessions with music played in the stereo. Chad engaged in vocal stereotypy in a mean of 26.2% (range, 18.7 to 32.6%), 26.1% (range, 20.3 to 29.8%), and 25.9% (range, 18.7 to 32.6%) of the no music, headphones, and stereo conditions, respectively.
CHAPTER FOUR:

DISCUSSION

The purpose of this study was to evaluate the effects of matched stimulation in the form of music on vocal stereotypy and acquisition of and latency to perform academic tasks. In this study participants had access to preferred music shown to reduce vocal stereotypy either via headphones or through a stereo. During the skill acquisition evaluation, both participants, Nate and Chad, acquired the skills in the same number of sessions regardless of whether they had access to music, and the mode of access to music. In addition, during the latency evaluation, both participants performed the mastered tasks more quickly when they did not have access to music as compared to the two music conditions. Finally, access to music, in either modality, during both the skill acquisition and latency evaluation decreased vocal stereotypy but increased the latency to perform tasks, in comparison to the no music condition.

In this study, access to music decreased vocal stereotypy and did not hinder skill acquisition. Based on findings of previous studies (e.g., Lanovaz, Rapp, et. al., 2012), music suppressed vocal stereotypy likely because it produced similar auditory stimulation as that produced by the participant’s own vocal stereotypy. That is, music was a “matched” competing item. In addition, access to music did not hinder skill acquisition likely because listening to music was not incompatible with performing the target task, matching a sample to one of the comparison stimuli. However, access to music increased both participants’ latency to perform mastered tasks even though vocal stereotypy occurred at higher levels during the sessions in
which the participants did not have access to music. This finding was bewildering and future research should attempt to identify the factors responsible for this outcome.

The current study extended previous research on the use of music as a treatment for vocal stereotypy by examining the effects of access to music on skill acquisition and performance of mastered tasks. This appears to be the first study to complete this type of investigation. Findings of the current study are similar to that of previous research (e.g., Lanovaz, Rapp, et al., 2012; Saylor, Sidener, & Reeve, 2012) showing that non-contingent access to music reduces vocal stereotypy. For instance, Saylor et al., evaluated the effects of noncontingent access to music, white noise, and recordings of vocal stereotypy, and found that music and the recordings of the stereotypy was effective at suppressing the vocal stereotypy. In addition, similarly to results of the study completed by Lanovaz, Rapp, et al., in this study access to a preferred song was found to reduce vocal stereotypy. However, we did not investigate whether preferred music was more effective in reducing stereotypy than low preferred songs. Findings of Lanovaz, Rapp, et al. suggest that this may be these case, at least for some participants. Thus additional research should investigate whether preferred music may lead to greater suppression of vocal stereotypy in comparison to non-preferred music and whether the addition of a music preference assessment is advantageous in the identification of auditory stimulation that competes with vocal stereotypy.

In addition, in the study the mode (i.e., headphone, stereo) of access to music was investigated. This evaluation was completed because we hypothesized that performance of tasks would be better when music was played in the stereo because the participants would be more likely to hear instructions in this condition in comparison to the headphone condition. This also appears to be the first study to evaluate whether mode of access to music impacts levels of stereotypy and task performance. In previous research on the use of non-contingent access to
Results of the current study have various clinical implications. First, in cases where vocal stereotypy appears to interfere with completion and/or acquisition of academic tasks, our results suggest that providing access to music should decrease vocal stereotypy and not have a negative impact on performance of the academic tasks. Second, listening to music is not incompatible with performing of a variety academic tasks such as matching, sorting, and other tasks involving physical activities. Thus, this intervention can be used across most of the educational programs. In addition, access to music is likely less stigmatizing and disruptive and easier to implement than other effective interventions for vocal stereotypy such as RIRD (e.g., Ahearn et. al., 2007), RC (e.g., Rapp et. al., 2009), and DRO (e.g., Gunter et. al., 1993). Thus it should be considered as the initial intervention for vocal stereotypy (Cook, Rapp, & Brogan, 2018). Finally, although the latency to perform mastered tasks was similar across the three conditions, each session consisted of 10 trials. A minor difference observed in a brief session can reflect a much bigger difference when we consider the cumulative number of trials completed with a client across an entire day or week of clinical programming.

Although results of the current study are promising, the current study has some limitations and several questions about the impact of music on task performance remain unanswered. For instance, in the current study, the tasks selected for acquisition included an initial vocal instruction, “match”, but it is possible that due to the participant’s history with similar tasks, their performance of the task was under control of the presence of a sample and comparison stimuli. It is unclear whether results would have differed in the tasks required attending and interpretation of vocal stimuli (e.g., listening to and responding to questions about
a passage; answering social questions; recalling past events). Thus future research should investigate the impact of access to music on the performance of these tasks. In the current study, overall latency to perform the mastered tasks was short and although some differences were observed across the three conditions, the differences were minor. However, the tasks included in this study were simple matching tasks that could be completed in few seconds. Future studies should evaluate the impact of access to music on performance of more complex tasks, requiring a longer period of time to complete such as daily living skills, chores, and vocal tasks.

Additional limitations of the current study include the limited number of participants, lack of replication within participants, and lack of social validity data from participants and parents. In regards to including few participants, this limits the generality of the results. Future research should replicate the current procedures with additional participants of various ages, diagnoses, and across a variety of academic tasks. In this study, we attained replication across participants of the results of the skill acquisition evaluation and partial replication of the results of the latency evaluation. Future research should complete similar evaluations multiple times with each participant to determine the generality of findings across differing academic tasks completed with the same participant. Finally, in the current study we attempted to collect social validity data from parents but they did not return to the PI the completed forms. Given the similar results across conditions, it would be beneficial to assess whether participants displayed a preferred towards one of the conditions. This would help clinicians in selecting an intervention in cases where no differences in treatment effects are observed.
REFERENCES


Figure 1. Percentage of the sessions with vocal stereotypy during the alone (Nate) and no interaction (Chad) sessions of the automatic screening assessment.
Figure 2. The percentage of trials in which each edible, toy, or music was selected during the preference assessments completed with Nate.
Figure 3. The percentage of trials in which each toy or music was selected during the preference assessments completed with Chad.
Figure 4. Percentage of session with vocal stereotypy during the functional analyses completed with Nate and Chad.
Figure 5. The percentage of session with vocal stereotypy during the competing items assessments completed with Nate and Chad. Nate had access to the song “Pizza Time” whereas Chad had access to the song “Superstar.”
Figure 6. The percentage of independent correct responses per session across each condition of the skill acquisition evaluation for Nate and Chad.
Figure 7. The percentage of session with vocal stereotypy during each condition of the skill acquisition evaluation for Nate and Chad.
Figure 8. The average latency, per session, to complete the mastered tasks during the latency evaluation completed with Nate and Chad.
*Figure 9.* The percentage of session with vocal stereotypy during each session of the latency evaluation completed with Nate and Chad.
APPENDICES
Appendix A
Sample treatment integrity data sheet for the skill acquisition tasks

<table>
<thead>
<tr>
<th>Trial</th>
<th>SD</th>
<th>Placement</th>
<th>Correct SD</th>
<th>Correct Comparison</th>
<th>Correct Consequence Delivered</th>
<th>Correct Prompt</th>
<th>Participant response</th>
<th>Correct consequence</th>
<th>SR+ within 5 s of responding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>B</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>B</td>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B

Sample Competing Items Assessment Procedural Integrity and IOA data Sheet

Participant/Session: ________________ Therapist: ________ Observer: ____________

| Stimulus 1  | High Pref Music A |
| Stimulus 2  | High Pref Music B |
| Stimulus 3  |                    |
| Stimulus 4  |                    |
| Stimulus 5  |                    |

<table>
<thead>
<tr>
<th>Child is seated at table</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stereo is on the table</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Room is clear of other items</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Therapist is seated across from table from the participant (if required)</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial</th>
<th>Stimulus</th>
<th>Stimulus played for 5min</th>
<th>Duration Stereotypy</th>
<th>IOA</th>
<th>5min break between sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>No Music</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>6</td>
<td>No Music</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>9</td>
<td>No Music</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>Y</td>
</tr>
</tbody>
</table>

PI: ___/21 * 100 = ___ %

IOA: Proportional Agreement from Countee
Appendix C

Procedural Integrity and IOA Data Sheet for Tangibles, Edibles, and Music Preference Assessments

Participant/Session: ________________  Therapist: ___________  Observer: ___________

<table>
<thead>
<tr>
<th>Stimulus 1</th>
<th>Therapist has data sheet</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulus 2</td>
<td>Therapist has writing utensil</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Stimulus 3</td>
<td>Therapist has music pictures</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Stimulus 4</td>
<td>Therapist has music device</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Stimulus 5</td>
<td>Therapist has timer</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Therapist is seated across from table from the participant</td>
<td>Y</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial</th>
<th>Placement</th>
<th>Each Stimulus played 15s</th>
<th>Correct Placement</th>
<th>Correct Consequence</th>
<th>Consequence played for 15s</th>
<th>5-10 seconds between trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 2</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>2</td>
<td>5 4</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>3</td>
<td>3 1</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>4</td>
<td>2 4</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>5</td>
<td>4 5</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>6</td>
<td>3 2</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>7</td>
<td>1 5</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>8</td>
<td>3 4</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>9</td>
<td>5 1</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>10</td>
<td>1 4</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>11</td>
<td>2 3</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>12</td>
<td>3 5</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>13</td>
<td>4 2</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>14</td>
<td>5 2</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>15</td>
<td>4 3</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>16</td>
<td>2 5</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>17</td>
<td>1 3</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>18</td>
<td>4 1</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>19</td>
<td>5 3</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
<tr>
<td>20</td>
<td>2 1</td>
<td>Y N Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
<td>Y N</td>
</tr>
</tbody>
</table>

PI: ___/106 * 100 = ___%  IOA: ___/20 * 100 = ___%