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Using Music Training to Increase Social Responsiveness and Happiness in Children with Autism

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USING MUSIC TRAINING TO INCREASE SOCIAL RESPONSIVENESS AND HAPPINESS IN CHILDREN WITH AUTISM

A Master's Thesis

Presented to

The Graduate College of

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In Fulfillment

Of the Requirements for the Degree

Master of Science, Applied Behavior Analysis

By

Meghan Talarico

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Psychology

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ABSTRACT

Social skills are imperative for individuals' success in their daily lives because they are applied in areas such as shared interests and cooperative work and play. This study was a replication with extension of the study on a musical treatment of social skills by Finnigan and Starr (2010). The purpose of the present study was to determine the effects of musical and non-musical interventions on the sharing and turn-taking behavior of five children with autism. The participants were four boys and one girl between the ages of 4- and 8-years-old who had a diagnosis of autism and were receiving ABA therapy in a clinic setting. A single-subject, alternating treatment design was used to analyze the effectiveness of the intervention. Two conditions, a musical and non-musical condition, were tested. Both consisted of 15 minutes of treatment in which the participants would be given opportunities to share and take turns with the therapist and 15 minutes of generalization for participants to interact with each other and other peers. A baseline phase, alternating treatment phase, and adapted treatment phase were used. Participants 1 and 3 displayed increased target behaviors in musical interventions. For Participant 5, target behaviors increased in non-musical interventions. Participant 2 engaged in similar responding in both conditions, and Participant 4 displayed no increase above baseline in target behavior under either condition. Data were not conclusive but suggest musical interventions could be successful for some students.

KEYWORDS: autism spectrum disorder, music therapy, musical interventions, sharing, turn-taking, social responsiveness, social skills

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I dedicate this thesis to my husband, Joe Talarico.

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INTRODUCTION

Since 1943, when Kanner published his paper, "Autistic Disturbances of Affective Contact," Autism Spectrum Disorder (ASD) has been an important area for both research and practice (Kanner, 1943). Over the past two decades, the National Center on Birth Defects and Developmental Disabilities (2020) has reported an increase in the diagnosis of autism from 1 in 150 children in 2000 to 1 in 54 in 2018. Multiple reasons for this increase are hypothesized. Rice et al. (2012) describes "several potential explanations for an increase in the observed prevalence of ASDs, including better analytic tools, better identification and screening methods, changes in diagnostic criteria, increased awareness among parents and clinicians, and changes in the availability of services" (Rice et al., 2012, p. 3). While the exact cause of the increase in children diagnosed with ASD remains unknown, the growing prevalence and awareness of the diagnosis necessitates a need for more evidence-based interventions.

Autism is a neurodevelopmental disorder that affects social communication and social interaction. It is marked by restricted and repetitive behaviors (American Psychiatric Association, 2013). Social deficits make up most components in the diagnosis of autism. The DSM-5 diagnostic criteria for the diagnosis of autism include deficits in social communication such as back and forth communication, sharing emotions or interests, responding to social interactions, initiating social interactions, little to no verbal or nonverbal communication, reduced eye contact, and unusual body language. Deficits in social interactions include difficulty playing cooperatively and imaginatively with peers, decreased interest in peers, difficulty developing and maintaining relationships, and inability to adapt to new or novel social situations. Restricted and repetitive behaviors are marked by repetition and stereotypy in movements,

speech, and object use. It is also demonstrated by an inflexibility and emphasis on routines to the point of being ritualistic behavior. Other markers of restricted and repetitive behaviors are an intense, fixed interest on objects and topics and higher or lower sensitivity to sensory input than typical (American Psychiatric Association, 2013).

The social deficits experienced by children with autism can interfere with their ability to interact socially in typical settings such as school, work, or the community. Social deficits tend to make daily living tasks more difficult than for individuals with neurotypical development. Simple routines such as classroom morning preparation present multiple problems for children with autism. For example, most morning routines begin with greeting peers and the teacher. A child who has difficulty initiating or responding to social interactions often enters school or other community settings only to encounter difficult or aversive interactions. If they have difficulty sharing interests with others, they are more likely to engage in solitary play instead of social play because they are not using the skills to allow flexibility in social situations. The social significance of addressing these skills increases when considering that many of these individuals will engage in fewer social relationships, report higher cases of loneliness, and have more difficulty regulating social behavior in school (Weiss, 2013, p.33-34, Rotheram-Fuller et al., 2010, p. 1227-1234).

LITERATURE REVIEW

Common Social Skills Interventions

As one of the main components of autism spectrum disorder, social skill deficits are important to address with evidence-based interventions. There are numerous interventions designed to increase the frequency of effective social behaviors. One such method, video modeling, consists of an adult or peer modeling an appropriate social skill in a video for children to observe. The individual who will be practicing the skill watches the video and then is prompted to engage in the behaviors modeled. Feedback and reinforcement are frequently utilized to further increase gains in social behavior. In order to encourage generalization to new settings, effective programs will introduce variability into the modeling procedure. Video modeling is a commonly used social skills training method because, "many students with ASD are visual learners, enjoy watching videos, and attend well to a model presented in a video clip" (Weiss, 2013, p. 37).

The use of Rule Cards has also been widely implemented for children with receptive verbal behavior to reduce social deficits. Rule Cards range in physical size and include a summary of strategies the student can use when facing particular social problems. Often the rule card includes a reinforcement function by incorporating pictures of the individual's favorite cartoon character acting out the steps. The first step when using rule cards is to describe the specific behaviors expected of the child. The individual is then given a rule card that includes a 2- to 4-point summary of the expected behaviors. Before entering a situation that could require the strategy, the summary is either read by the individual or is read to the individual by a caregiver. The script on the card can be gradually faded by systematically reducing the salient

elements until they are completely eliminated as the individual becomes more proficient using the social strategy (Weiss, 2013).

Another widely studied technique is Behavioral Skills Training (BST), which has been used for many years to aid in the acquisition of numerous skills. In a component analysis study, Ward-Horner and Sturmey (2012, p. 75) describe BST as an "effective training package that consists of instructions, modeling, rehearsal, and feedback." This sequence of instruction, modeling, rehearsal, and feedback allows for effective behavioral shaping. When analyzing the components separately, feedback was found to be the most effective component resulting in 80% of the successful acquisition of behavior when used alone. Modeling was found to be the second most effective component followed by instruction. Rehearsal seemed to have the least effect on its own (Ward-Horner and Sturmey, 2012). However, when used as a package intervention, BST has been shown to have excellent results in the acquisition of behavioral skills (Miles and Wilder, 2009; Schaefer and Andzik, 2020).

Finally, Social Stories, developed by Carol Gray, have been used widely for many years to reduce problem behaviors and increase effective social behaviors in children with autism. Social Stories consist of several lines of directive, descriptive, perspective, and affirmative text that explain how the individual should behave in the given situation (Crozier and Tincani, 2007; Gray and Garand, 1993). In contrast to rule cards, the behavioral expectations are read in their entirety each time the Social Stories intervention is used. They are popular due to the ease with which caregivers can be trained to use the social stories. According to Weiss (2013), "Social Stories are often used to convey behavioral expectations for multielement situations (which change frequently), for fear situations, and to reduce challenging behaviors" (Weiss, 2013, p. 38). Crozier and Tincani (2007) found that Social Stories led to a 64% increase in appropriate

social behavior for one participant and an increase in frequency of unprompted social interactions with peers for a second participant. Verbal prompts were programmed into the third participant's treatment to further increase appropriate social behavior after social stories alone were insufficiently effective. While social stories remain a widely used intervention, the evidence for their effectiveness has been decidedly inconsistent (Reynhout and Carter, 2006; Kokina and Kurn, 2010; Reynhout and Carter, 2011; Parry-Cruwys et al., 2016). However, supporters have questioned the treatment integrity of critical studies. Clearly, more research is needed to confirm that social stories can be an effective and generalizable intervention.

Music in Autism

Music has been widely incorporated into the treatment of children with autism (de Mers et al., 2009; Kim et al., 2009; Kim et al., 2008). Music has been used to increase intraverbal behavior in children who exhibit limited or no verbal behavior (Lim and Draper, 2011). It has been shown to increase maintenance of relevant information in children and adults (Wolfe and Hom, 1993). In one study, preschool students acquired verbal information about phone numbers and addresses more quickly when a familiar melody was played than when the information was given through spoken word (Wolfe and Hom, 1993). The repetitive nature of a melody could have some bearing on acquisition and maintenance of information (Kilgour et al., 2000). Treatments incorporating music have also been shown to increase appropriate social behaviors in children with autism (de Mers et al., 2009; Kim et al., 2009; Kim et al., 2008; Brownell, 2002; Kern et al., 2007; Finnigan and Starr, 2010).

De Mers et al. (2009) found that music therapy was effective in decreasing problem behaviors in three children with autism. According to the American Music Therapy Association

(2021), music therapy is an empirically validated intervention that includes "creating, singing, moving to, and/or listening to music" based on the individual needs of the clients receiving music therapy. The participants in the study were given music therapy to address the problem behaviors of hitting and screaming. The replacement behaviors of asking for a turn and sharing were addressed during music therapy with several musical games. For example, the game "Can You Find a Friend?" was played (de Mers et al., 2009). Participants were each given an instrument. During the game, they were asked to find a peer who had the described instrument and ask for a turn. The game "Loud and Quiet Journey" was a song that required participants to practice loud and quiet voices to address the behavior of screaming (de Mers et al., 2009). Behavior was scored for 10 minutes of play following the music therapy session. The researchers found that, after receiving music therapy, two of the participants exhibited a decrease in problem behaviors and increase in alternative behavior. The third participant also improved, but to a lesser degree. Maintenance probes, done three weeks later, showed a continued decrease in problem behavior and increase in replacement behavior. One limit to the study was that generalizability to new settings, such as classrooms, was not addressed.

A study on the effect of music therapy on social interaction, engagement, and compliance was conducted by Kim et al. (2009). Social interaction and compliance were observed more frequently in music therapy sessions than toy play sessions. No responses to demands were observed more frequently in toy play sessions than music therapy sessions. Studies have also been conducted on the effect of music therapy on joint attention in children with autism. An example of joint attention is two or more people attending to and interacting with the same object or event at the same time. In 2008, Kim et al. conducted a randomized control study to test the efficacy of improvisational music therapy for children with autism. The target behavior in the

study was joint attention behaviors. Using both improvisational music therapy and toy play, the authors found that children in the study exhibited more joint attention and social behaviors, such as turn-taking and eye contact, in the music therapy session than during the toy play session. Data from the music therapy sessions and toy play sessions show significant differences in the duration and frequency of both joint attention activities and effective social behaviors.

Brownell (2002) tested the effect of using social stories set to music as an intervention to reduce problem behavior by school-age children with autism. Social stories were written for the participants. Each story was set to a musical composition, and an ABC reversal design was used to determine the effectiveness of singing versus reading the social story. For one participant, the use of a musical social story was much more effective than reading a social story. The other participants had little variation between the social story being read or sung. While the results were not conclusive, this study did suggest that further work is needed to verify the effectiveness of musical interventions for children with autism.

Kern et al. (2007) conducted a study to investigate how composed songs would affect a child's independence in completing classroom morning and greeting routines. For this study, two songs were composed to increase social behaviors with peers and teachers in the child's classroom. The songs described the morning and greeting or entry routine of the classroom. Teachers presented these songs, relating the steps of the routine, during morning greeting or entry times. A single subject withdrawal design was used to analyze the effects of treatment. For one child, the song increased social behaviors and helped him follow the morning routine. For the other child, increasing the number of peers who greeted him through the use of the song prompted more effective social behaviors during morning routine. The results of this study

provided evidence that young children respond to melodies. Therefore, including songs into daily patterns or routines can increase engagement and act as a prompt for expected behavior.

Finnigan and Starr (2010) conducted a study to determine the effectiveness of musical interventions for improving social behavior of individuals with ASD (Finnigan and Starr, 2010). Using an alternating treatment design, the researchers tested the effectiveness of musical and non-musical interventions to increase appropriate social behaviors and decrease inappropriate social behaviors. The effects on the two targeted social behaviors were assessed, social responsive behavior and social avoidant behavior. Social responsive behavior was described as age-appropriate, social interactive behaviors such as engaging in imitation of the therapist or caregiver, making eye contact with the therapist, and turn-taking. Social avoidant behaviors were behaviors that allowed the child to avoid the social task such as eloping, avoiding eye contact, pushing away the therapist or caregiver, and pushing away therapy materials. The researchers alternated between musical and non-musical interventions. In musical interventions, the therapist played a simple melody on the guitar and sang a song scripted to prompt socially responsive behavior. In non-musical interventions, the therapist talked with the participant, using a script that prompted socially responsive behavior. Socially responsive behaviors occurred more frequently during the musical intervention than in the non-musical intervention across all phases. Inversely, the participant displayed a decrease in the frequency of socially avoidant behaviors in the musical intervention compared to the non-musical intervention across all phases. The authors concluded that, while more research is needed to establish musical interventions as empirically validated, music shows promise as an intervention for increasing effective social behaviors in children with autism.

The purpose of the current study was to compare the effects of music and spoken scripts on socially appropriate behaviors of children with autism. Limitations of Finnigan and Starr's (2010) study were addressed in two ways. First, the current study included five participants and three additional intervention sessions, with a generalization session following intervention to assess maintenance of the social responsive behaviors. Additionally, a measure of participant happiness, defined as observing the child smile, laugh appropriately, and enjoy themselves, was collected to address issues related to social validity in the original study.

METHOD

Participants

Participants consisted of five children with a diagnosis of autism spectrum disorder (4 boys and one girl). All five children received Applied Behavior Analysis (ABA) services in a clinic setting three to five days each week.

Participant 1 was Billy, a 4-year, 2-month-old boy with autism. He received ABA therapy in a clinic setting for four hours a day, three days a week. Billy met the criteria for Autism Spectrum Disorder as specified in the DSM-V (American Psychiatric Association, 2013). The Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2) was administered, and his composite score fell into the Autism classification range. The Vineland Adaptive Behavior Scales, 3rd edition (Vineland-3) was also administered, and Billy's adaptive behavior composite score was 67 which is in the 1st percentile for his age. His score in fine motor skills was 75 which is in the 5th percentile. His score in communication was 64 (1st percentile), and Billy's score in socialization was 68 (2nd percentile). His score in daily living skills was 73 which is considered moderately low and is in the 4th percentile.

Participant 2 was Tommy, a 5-year, 1-month-old boy with autism. He received ABA therapy in a clinic setting for eight hours, three days a week and four hours, one day a week. Tommy met the criteria for Autism Spectrum Disorder as specified in the DSM-V (American Psychiatric Association, 2013). The ADOS-2 was administered, and Tommy's social interaction and communication skills indicated he was within the Autism classification range. The Vineland-3 was administered, and Tommy's adaptive behavior composite score was 65 which is in the 1st percentile. His score in fine motor skills was 71. His score in communication was 65 (1st

percentile), and Tommy's score in socialization was 68 (2nd percentile). His score of 56 in daily living skills was in the 1st percentile range and considered a weakness for Tommy.

Participant 3 was Frank, a 6-year, 9-month-old boy with autism. He received ABA therapy at an ABA clinic for 2.5 hours each day, five days a week for the first nine sessions. Then he transitioned to attending the clinic for four hours, three days a week. Frank met the criteria for Autism Spectrum Disorder as specified in the DSM-V (American Psychiatric Association, 2013). The ADOS-2 was administered, and Frank's composite score was in the Autism classification range. The Vineland-3 was administered, and Frank's adaptive behavior composite score was 74 which is in the 4th percentile for his age. His score in motor skills was 83. His score in communication was 79 (8th percentile) demonstrating an area of strength for Frank, and his score in socialization was 74 (4th percentile). His score of 74 in daily living skills was in the 4th percentile representing a weakness for Frank.

Participant 4 was Monica, a 6-year, 11-month-old girl with autism. She received ABA therapy at a clinic for 2.5 hours a day, five days a week for the first 29 sessions then transitioned to attending the clinic for four hours a day, five days a week. Monica met the criteria for Autism Spectrum Disorder as specified in the DSM-V (American Psychiatric Association, 2013). The ADOS-2 was administered, and Monica's overall score fell within the Autism classification range. She exhibited a high level of symptoms associated with autism spectrum disorder. The Vineland-3 was administered, and Monica's adaptive behavior composite score was 76 which is in the 5th percentile for her age. Her score in motor skills was 78. Her score in communication was 82 (12th percentile) showing an area of strength for Monica, and her score in socialization was 79 (8th percentile). Her score of 74 in daily living skills was in the 4th percentile and was considered a weakness for Monica.

Participant 5 was Steven, a 7-year, 8-month-old boy with autism. He received ABA therapy at a clinic for 2.5 hours each day, five days a week for the first 30 sessions. He, then, began to attend therapy for four hours a day, five days a week. He also participated in speech and language therapy, occupational therapy, and physical therapy through his public elementary school. After the Childhood Autism Rating Scales, 2nd edition (CARS-2) was administered, it was determined that Steven met the criteria for Autism Spectrum Disorder as specified in the DSM-V (American Psychiatric Association, 2013). His raw composite score from the CARS-2 was 51 which is in the severe category (37 or higher). The Vineland-3 was also administered, and Steven's adaptive behavior composite score was 61 which is lower than the 1st percentile. His score in motor skills was 42. His score in communication was 45 (>1st percentile) representing a weakness for Steven, and his score in socialization was 62 (1st percentile). His score of 65 in daily living skills was in the 1st percentile indicating a strength for Steven.

Steven participated in music therapy from December 2019 through February 2020. The music therapy addressed five goals, using two-word expressions to mand or request things, identify colors, engage in joint play, wait until prompted or given a turn to play the instruments, and sit in his chair. Parents reported that Steven responded well to music therapy. However, therapy was discontinued due to health concerns associated with the COVID-19 pandemic.

Setting

All interventions occurred in four therapy rooms at the ABA clinic attended by the participants. Room 1 had a small couch and chair, a child-sized table with four chairs, and numerous toys in opaque boxes or on shelves around the room. It also had a one-way observation window. Room 2 had one child-sized table with chairs, a bookshelf, and a piano. Games were

stored in a cabinet in the bookcase, and toys were stored on a shelf out of reach of the participants. A small observation window was located in the door. Room 3 had a play kitchen and grocery store, a dollhouse, a child-sized playhouse, one child-sized table with chairs, and several toys in clear plastic containers or on shelves out of the reach of the participants. A one-way observation window was located next to the door. Room 4, used for generalization settings, had cubbies containing toys in opaque boxes, soft mats, and bean bag chairs. The room was larger and more open than the other three rooms.

The toys for the intervention were placed in a plastic container on a table in the room (see Figure 1). The participant and therapist started each session by sitting at the table. The whole intervention session could be conducted at the table, but if the client got up, the therapist followed them. When the child stopped and oriented to the therapist, they would continue with the intervention.

Figure 1: Intervention tubs, set on the table before each session. The toys for the musical intervention were on the left side and the toys for the non-musical intervention were on the right side as indicated by the labels.

Materials

Six neutral toys were chosen for the interventions after a multiple stimulus without replacement (MSWO) preference assessment was conducted. Ten stimuli were used in the preference assessment: wood blocks, a toy car, a ball, two maracas, six plastic sea animals, playdough, stacking rings, a helicopter, crayons and paper, and a puzzle.

The toys were ranked in a least-to-most preferred hierarchy. The two most highly preferred and least-preferred overall were removed from the study. The toy car, sea animals, stacking rings, and crayons and paper were each chosen as neutral stimuli for four of the five participants (80%). The wood blocks, ball, and puzzle were each chosen neutral stimuli for three of the five participants (60%). The playdough and helicopter were each chosen as neutral stimuli for two of the five participants (40%). The maracas were never chosen as neutral stimuli (0%).

Because 80% of participants chose the toy car, sea animals, stacking rings, and crayons and paper as neutral stimuli, all four were included in the study. The wood blocks, ball, and puzzle were chosen as neutral stimuli by 60% of participants, but only two of these were needed. The researcher checked to see how often one of these stimuli were ranked as a low preferred item. The puzzle was only ranked as a low preference item for one participant and was included in the study. The wood blocks and ball were both ranked as a low preference item for two participants. The wood blocks were chosen as the final stimulus because sharing and turn-taking with the blocks would be more novel to the participants than throwing a ball back and forth, a common activity in treatment. Three of the six toys were randomly assigned to each intervention using a dice roll (see Table 1).

Table 1. Toys used in each intervention session

Musical Intervention	Non-musical Intervention
1. car	1. puzzle
2. stacking rings	2. six plastic sea animals
3. wooden blocks (assorted shapes)	3. crayons and paper

Research Design

This study used an alternating treatment with non-concurrent multiple baseline design to analyze the effectiveness of the intervention. Participants 1, 2, and 3 started their alternating treatment phase in session six. Participants 4 and 5 started their alternating treatment phase in session eight.

On day one, Participants 1, 2, and 5 received the non-musical intervention and Participants 3 and 4 received the musical intervention. Treatments were then alternated between musical and non-musical to counterbalance the effect of the interventions. No more than three sessions of one intervention were conducted in a row. Participant 1 (Billy) and 2 (Tommy) each attended the clinic during the afternoon shift and followed a similar schedule during therapy. They were placed on the same schedule to compare their responding during subsequent generalization sessions. Participants 3 (Frank) and 4 (Monica) both attended therapy during the evening shift for the first nine sessions and often interacted during organized play activities. They were placed on the same schedule to compare their rates of responding during subsequent generalization sessions. Participant 5 (Steven) attended the evening shift as well. He was placed on a different schedule to compare his responding to Participants 1 and 2. Participant 1 (Billy) and Participant 5 (Frank) both attended the clinic only three days a week (following session

nine). Once each week, they both received one musical and one non-musical intervention in a single day.

Dependent Variables

Dependent variables consisted of the social behavior of sharing and turn-taking and the subjective happiness of the participants. Sharing and turn-taking were defined as offering to let a peer or caregiver play with the same toy as the participant at the same time or separate times, cooperatively playing with a toy such as throwing a ball back and forth or playing with a toy farm, and allowing others to touch, look at, and make suggestions about how to play with a toy with no maladaptive behaviors. Non-examples include individuals attempting to impact or control the play of peers or caregivers in proximity or engaging with the same or similar toys without cooperating in play.

Happiness was defined as observing the child smile, laugh appropriately, and enjoy themselves (Green and Reid, 1999). A happiness rating scale was used to rate the happiness of the participant from 0 (unhappy) to 4 (happy). If the participant was yelling, crying, refusing to participate, tantruming, screaming, eloping, throwing toys, exhibiting frustration, or displaying a negative affect for the whole duration of the session, the session was marked as a 0 on the rating scale. Engaging in these behaviors for half (or less than half) of the whole duration of the session and displaying neutral behaviors for half (or more than half) of the session resulted in a score of 1. If the participant was not observably happy or unhappy, smiled or frowned occasionally, displayed no major indices of happiness or unhappiness, and had a neutral affect for the whole duration of the session, a score of 2 was assigned. If the participant was smiling, laughing appropriately, engaging with the therapist, playing, and displaying a positive affect for half (or

more than half) of the session and displaying a neutral affect for half (or less than half) of the session, a score of 3 was assigned. Finally, a 4 on the happiness rating scale meant they were smiling, laughing appropriately, engaging with the therapist, playing, and displaying a positive affect for the whole duration of the session. The child's scheduled therapist used the rating scale at the end of each session to rate the happiness of the child (see Figure 2).

0	1	2	3	4
Client is: • yelling • crying • refusing to participate • tantruming • screaming • eloping • throwing toys • frustrated • negative affect For whole duration of session	Client is: • yelling • crying • refusing to participate • tantruming • screaming • eloping • throwing toys • frustrated • negative affect For duration less than or equal to half of session (</=15m) and a neutral affect for greater than or equal to half of the session (>/=15m)	Client is: • Not happy or unhappy • May smile or frown occasionally • No major indices of unhappiness • No major indices of happiness • Neutral affect For whole duration of session	Client is: • Smiling • Laughing appropriately • Engaging with therapist • Playing • Positive affect For duration more than or equal to half of session (>/=15m) and a neutral affect for less than or equal to half of the session (</=15m)	Client is: • Smiling • Laughing appropriately • Engaging with therapist • Playing • Positive affect For whole duration of session

Figure 2: Happiness rating scale, used to identify the happiness of the participants during intervention and generalization phases

Independent Variables

In the current study, the independent variable was the use of music during the social intervention. Familiar melodies reported to be reinforcing to the participant by caregivers and therapists were used.

Treatment Integrity and Social Validity

Interobserver agreement (IOA) was taken for 32% of total sessions by a BCBA or a

BCBA supervisee at the clinic. IOA was calculated at 93.9%. Internal Review Board (IRB) approval was received on February 24, 2021, before the start of this investigation, receiving approval number IRB-FY2021-433 (see Appendix A). A social validity survey was given to the participants' parent or guardian following the completion of the study (see Table 2).

Table 2. Social validity survey results

Questions [1]	Billy	Tommy[2]	Frank	Monica	Steven
The target behavior (taking turns with toys, sharing in cooperative play with toys, etc.) was beneficial for my child.	3		4	4	4
Music is a preferred activity for my child.	4		3	4	4
I have noticed an increase in turn-taking and/or sharing by my child.	3		3	3	4
I have noticed an increase in allowing others to touch, look at, and make suggestions about play.	3		3	3	4
My child appears to be happy when prompted to share or take turns with toys or activities.	2		3	3	4
Overall, the intervention was effective for increasing sharing and turn-taking by my child.	3		3	1	4
I would recommend this treatment to other parents.	3		4	4	4

[1] Rated using this scale: 1 – disagree ; 2 – somewhat disagree ; 3 – somewhat agree ; 4 – agree
[2] Participant withdrew from the study before the social validity survey was completed

Procedures

The participants each received 30 minutes of treatment, four times each week. Fifteen

minutes of treatment was administered one-on-one by the child's therapist. The last 15 minutes of the treatment occurred with the participants and other peers in a group setting to allow for generalization of the target behavior. Sessions were conducted at the ABA clinic the children attended and administered by their typically scheduled therapist. Three rooms were used for the 15-minute therapy interventions, and one room was used for the 15-minute generalization sessions.

Data was taken by an observer during the session. IOA data was taken by another therapist and scored independently. The generalization setting occurred immediately following the intervention and took place in the same room for all participants. Three phases of treatment were used to determine the effectiveness of the intervention, baseline, alternating treatment, and adapted treatment.

Baseline. During the baseline phase, participants were given a chance to play with each of six toys for three minutes. The therapist observed the child and scored an "I" for independent if the child shared or took turns with a peer or therapist in the room without prompting. A "P" for prompted was scored if the child shared or took turns after one modeling, gestural, or verbal prompt. Therapists scored an "N" for no response if the child did not share with a peer or therapist in the room. An opportunity to share was counted if a peer or therapist was within .61 meters of the participant for more than 20 seconds or if a peer requested to have a turn with the item. If peers were not present during observation, the therapist remained within .61 meters of the participant to provide opportunity for sharing behavior. The therapist did not place any demands on the participant to share during this phase. The baseline phase was conducted until the data reached a stable baseline allowing for a non-concurrent multiple baseline design.

Alternating Treatment Phase. The musical and non-musical interventions were

conducted using an alternating treatment design. Musical interventions began by requesting assent from the participants using the visual assent form (see Figure 3). The therapist would say, "First we will sing together. Next, we will play with our friends. Last, we will have free time. Are you ready?" Participants could indicate assent by answering, "Yes" and then participating in the intervention. They could also refuse assent by saying "No" or refusing to participate in the session. If participants refused assent, their therapist waited five minutes before presenting the visual assent form a second time. If assent was still not attained, the therapist waited five more minutes then asked again. Upon the third refusal of assent, the session was terminated, and the therapist scored the session as "refused assent" on the scoring sheet.

Figure 3: Participant assent form for musical interventions

Upon receiving assent, the first of three toys was presented, and a five minute timer was initiated. The therapist then sang a simple, familiar melody with lyrics written to encourage the

target behavior of sharing and turn-taking (see Appendix B). This process was repeated for all three toys over a duration of 15 minutes (see Figure 4)

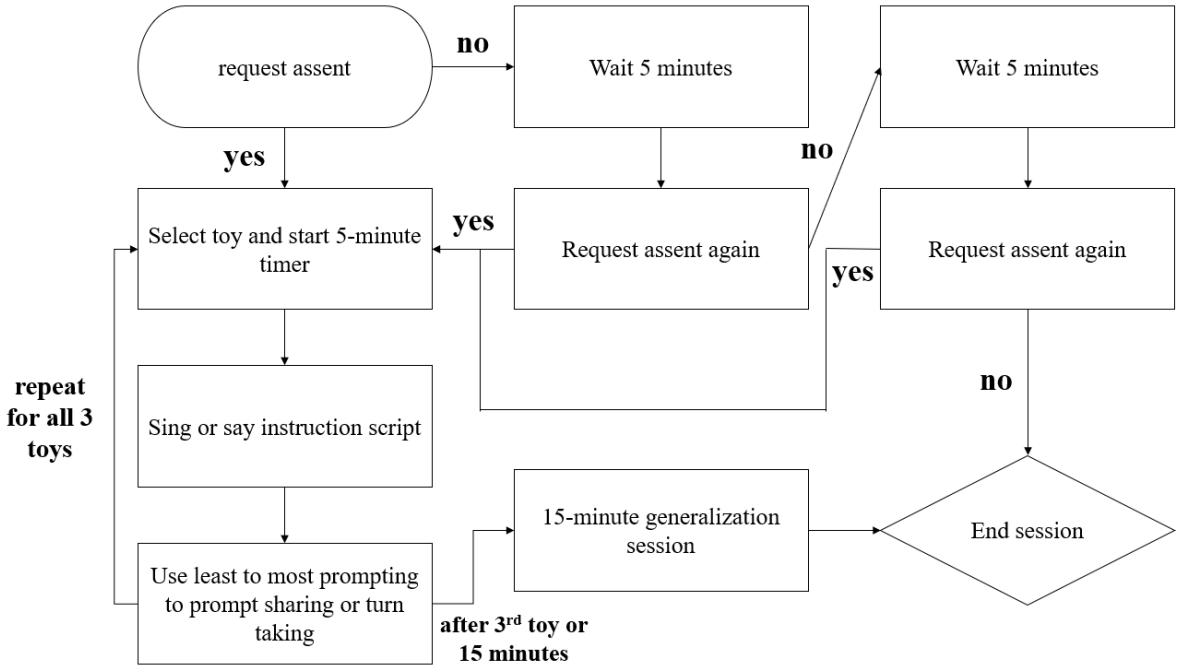


Figure 4: Task analysis of musical and non-musical interventions

Most-to-least prompting, modeling, gestural prompt, then verbal prompt, was used to prompt the children if they did not engage in the target behavior. For example, the therapist first drove the car to a participant. Then, if the child did not drive the car back to the therapist, the therapist held out their hands to catch the car and waited for the child to share. If the child still did not drive the car to the therapist, the therapist verbally prompted, “my turn.” There were no programmed responses for refusal to share. If the participant did share, they were reinforced with social praise, “Good sharing.” on a continuous reinforcement (CRF) schedule. A tangible reinforcer was also used starting in session eight. The ratio of reinforcement with the tangible varied from a CRF schedule to a variable ratio of 4 (VR4) for each participant.

Immediately following the intervention phase, participants engaged in a 15-minute generalization phase. During this phase, the participants were taken into the generalization room with peers. The toys used in the session were readily available within the participants' reach along with toys peers were currently using. All other toys were stored away in opaque gray bins out of reach of the participants. The therapists observed the participant they were working with and recorded how often the participant engaged in unprompted sharing and turn-taking with peers. The therapists prompted the participants to share and take turns only when they needed to intervene to prevent any disruptive behaviors.

The non-musical intervention was conducted in the exact same way as the musical intervention, sans music. Therapists used the visual assent form to request assent (see Figure 5) before starting each session. For each session, the therapist used the provided script to prompt the target behavior. However, no music, melody, or singing was used (see Appendix B). The generalization phase was again conducted immediately following the non-musical intervention phase.

Adapted Treatment Phase. The adapted treatment phase was conducted to rule out any bias in the results due to toy preference. In this phase, the most effective intervention, musical or non-musical, was used for all the toys. If musical interventions had been more effective, then the participant would begin to engage in only musical interventions and alternate between toy set one (musical) and toy set two (non-musical). If non-musical interventions had been more effective, then only non-musical interventions would be used and toy sets would be alternated between sessions. Adapted treatment interventions were also followed by a 15-minute generalization session.

Figure 5: Participant assent form for non-musical interventions

Measurement

The behaviors addressed in this study were sharing and turn-taking, as well as subjective happiness. The parents of all participants indicated that sharing and turn-taking were behaviors they would like to see their child engage in more frequently. Therapists observed that participants avoided sharing and taking turns, rarely shared or took turns with therapists and peers independently, and engaged in aggressive or escape behaviors when a peer or therapist attempted to join play.

Baseline and generalization phases were scored with paper and pen using a frequency count to record how often sharing and turn-taking occurred during each 3-minute interval. An average rate per minute was calculated by dividing the frequency of sharing during each 3-minute segment by three. The totals of these calculations were then averaged to find the average rate per minute of sharing and turn-taking.

Partial-Interval-15-min. scoring with paper and pen was used to score musical and non-musical intervention phases. Each intervention had three, 5-minute phases, and a different toy was presented for each phase. An observer scored the partial interval data while the therapist ran the intervention. The observer scored a "+" if sharing occurred during the 15-second interval and a "–" if sharing did not occur.

Generalization was scored in the exact same way as baseline. Happiness was scored using a happiness rating scale (see Figure 2).

RESULTS

Billy

Results for Billy are presented in Figure 6. The baseline phase and all generalization sessions were recorded as an average rate of responding-per-minute, plotted on the left y-axis. Data from Billy's musical and non-musical treatments were scored as a rate and tracked on the right y-axis. Data was collected for 36 sessions, plotted on the x-axis. During baseline, Billy displayed unprompted sharing once during a single session. In the other four sessions, he did not engage in any sharing or turn-taking with his therapist or peers. Billy had similar levels of engagement during both musical and non-musical interventions. Though variable, Billy displayed higher rates of responding in generalization following musical interventions than generalization following non-musical interventions. Billy showed a marked change from baseline to intervention phases. He engaged in sharing and turn-taking about .2 times per minute (mode) in musical generalization, with a range of 0 to 1.67 times per minute. During non-musical generalization phases, he engaged in sharing and turn-taking about.06 times per minute (mode), with a range from 0 to 1 (see Figure 6).

Because Billy displayed higher average rates of responding per minute in musical versus non-musical generalization phases, he participated in a musical adapted treatment phase. During adapted treatment phases, he showed a preference for crayons and sea animals. He responded with more disruptive behaviors when completing the puzzle task. His responding remained the same as during intervention phases when working with musical intervention toys. He responded positively to the patterns of the songs and occasionally sang along with the investigator.

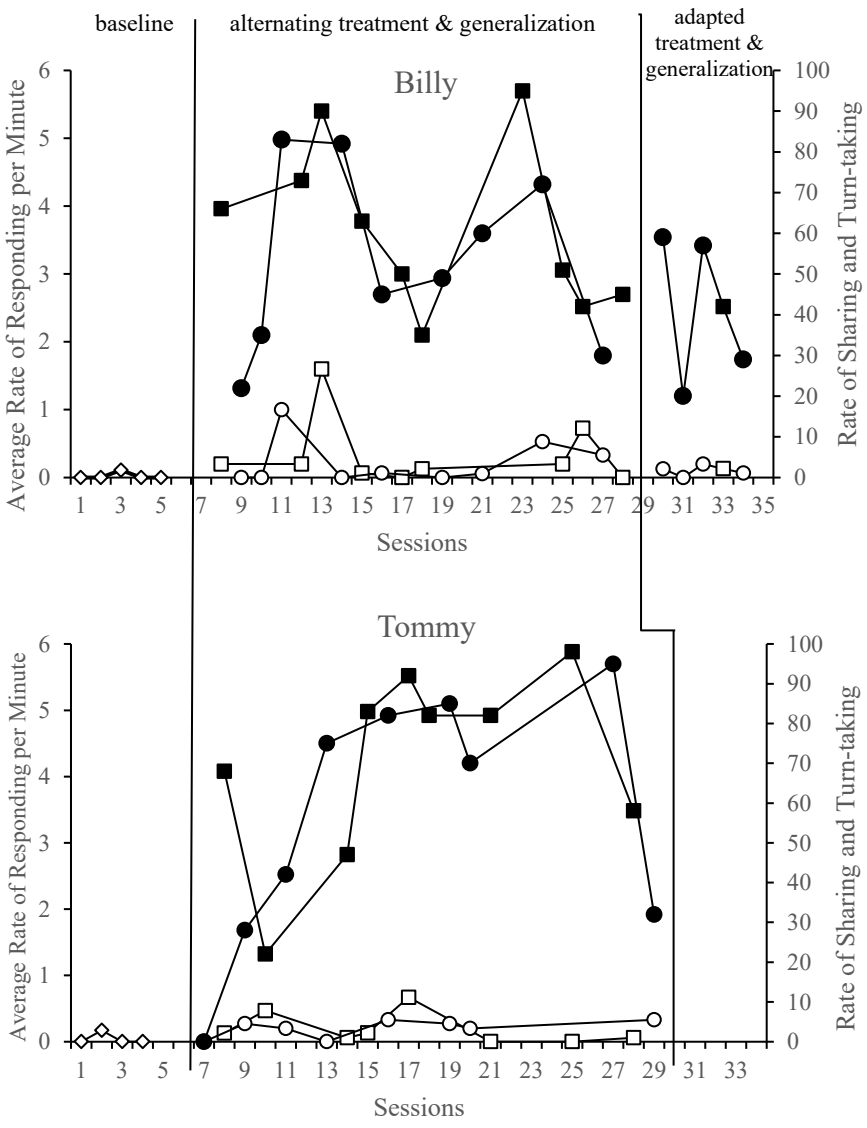
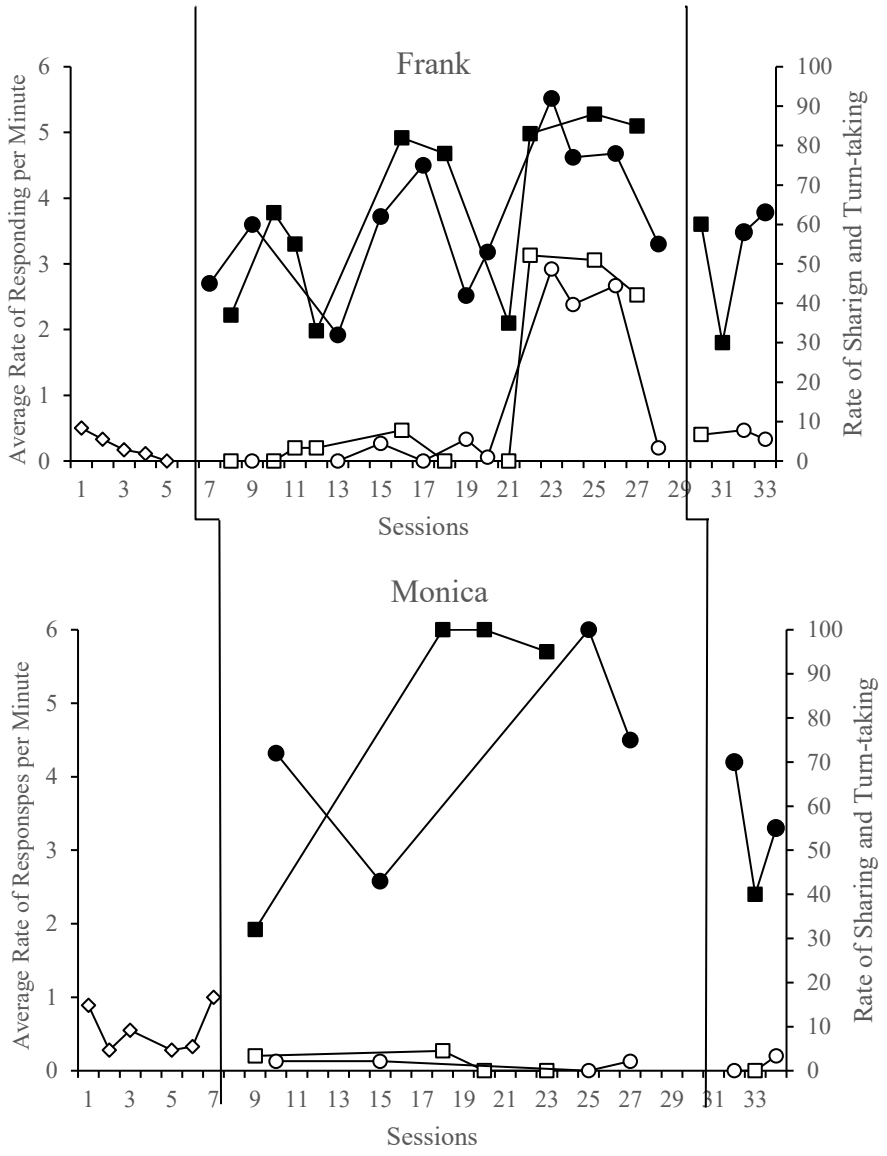


Figure 6: Average rate of responding per minute (during baseline and generalization phases) and rate of correct responses (during interventions). Open rhombuses indicate baseline sessions. Closed squares indicate musical intervention. Closed circles indicate non-musical interventions. Open squares indicate generalization following musical intervention. Open circles indicate generalization following non-musical intervention. In adapted treatment phase, closed and open squares and circles indicate the toys used in that session.



Figures 6 continued: Average rate of responding per minute (during baseline and generalization phases) and rate of correct responses (during interventions). Open rhombuses indicate baseline sessions. Closed squares indicate musical intervention. Closed circles indicate non-musical interventions. Open squares indicate generalization following musical intervention. Open circles indicate generalization following non-musical intervention. In adapted treatment phase, closed and open squares and circles indicate the toys used in that session.

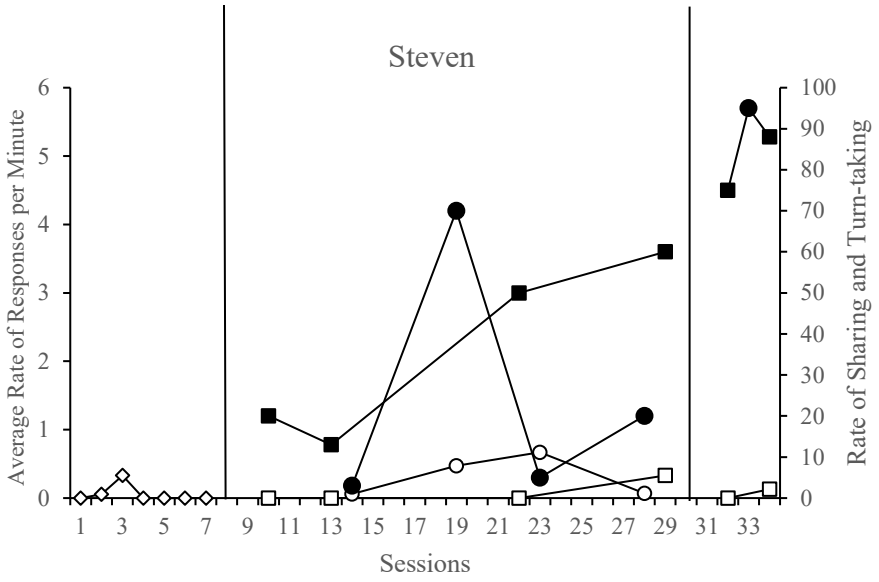


Figure 6 continued: Average rate of responding per minute (during baseline and generalization phases) and rate of correct responses (during interventions). Open rhombuses indicate baseline sessions. Closed squares indicate musical intervention. Closed circles indicate non-musical interventions. Open squares indicate generalization following musical intervention. Open circles indicate generalization following non-musical intervention. In adapted treatment phase, closed and open squares and circles indicate the toys used in that session.

For three of the five baseline sessions, Billy was observed to be a four on the happiness rating scale (See Figure 7). For one of the baseline sessions, he was observed to be a one on the happiness rating scale. He displayed a higher happiness rating in musical than non-musical interventions for most of the sessions. His average happiness rating during musical interventions was 2.22 (mode = 3). His average happiness rating during non-musical interventions was 1.62 (mode = 2). His average happiness rating during his adapted treatment phase was 2.2.

Billy began working with a new therapist after session eight of this study. He had been with his previous therapist for eight months prior to this change. He continued to give assent to participate in the current study, but the changes in his therapist could have affected rates of responding or happiness ratings. A tangible reinforcer was given to Billy contingent on sharing

or turn-taking behavior on a continuous reinforcement schedule (CRF). He continued to display some disruptive behavior including flopping on the ground and crying. These were addressed by prompting him to ask for a break, then providing a 10 second break following his prompted request.

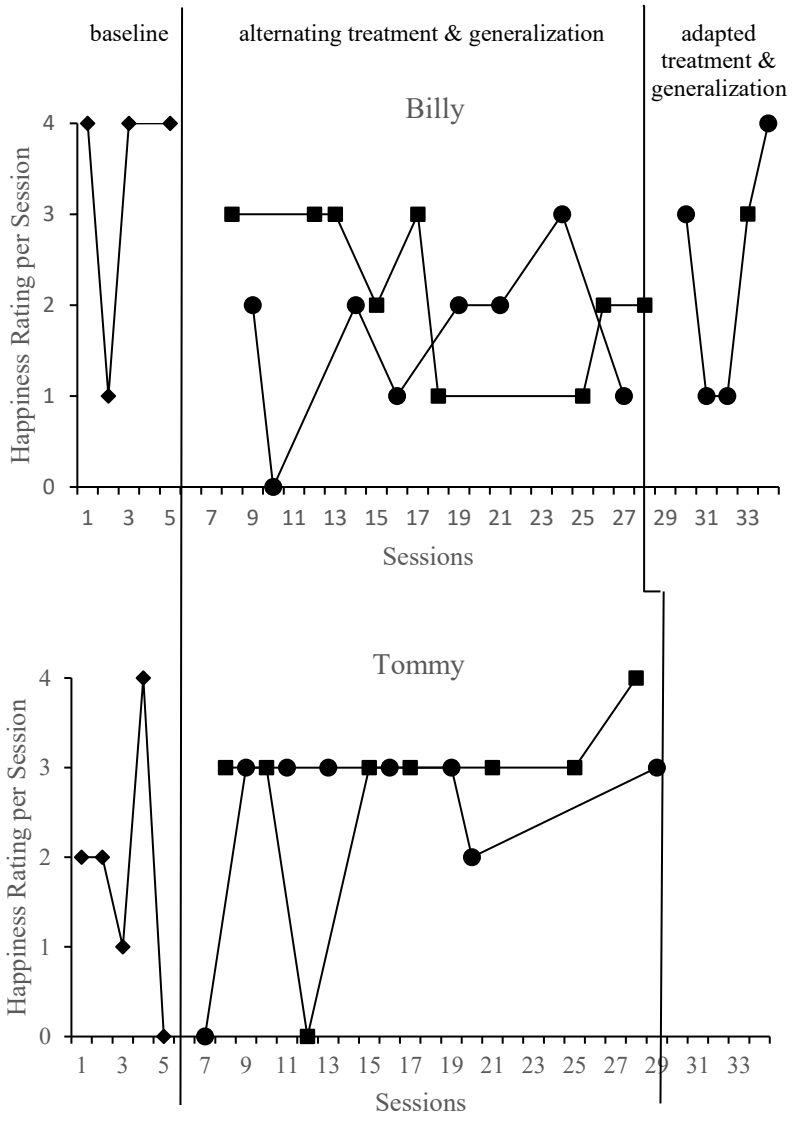


Figure 7: Happiness rating per session. Closed rhombuses indicate baseline. Closed squares indicate musical interventions, and closed circles indicate non-musical interventions. In the adapted treatment phase, closed squares and circles indicate which set of toys were used.

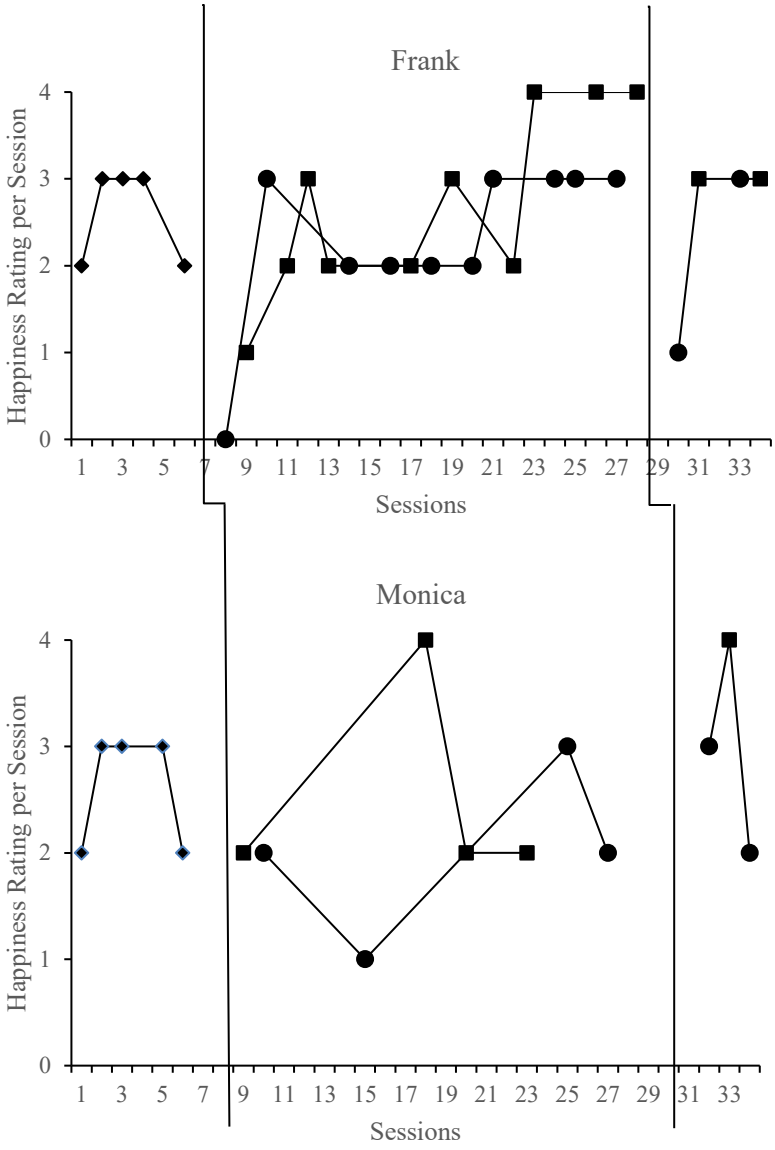


Figure 7 continued: Happiness rating per session. Closed rhombuses indicate baseline. Closed squares indicate musical interventions, and closed circles indicate non-musical interventions. In the adapted treatment phase, closed squares and circles indicate which set of toys were used.

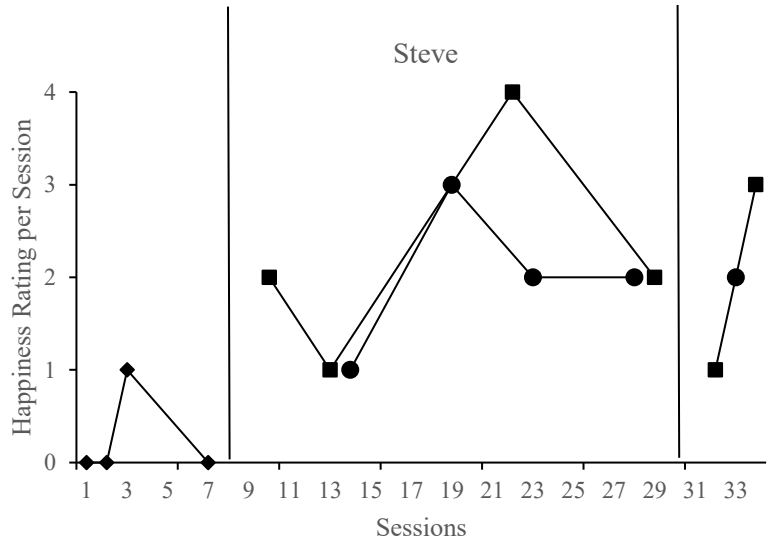


Figure 7 continued: Happiness rating per session. Closed rhombuses indicate baseline. Closed squares indicate musical interventions, and closed circles indicate non-musical interventions. In the adapted treatment phase, closed squares and circles indicate which set of toys were used.

Billy was observed to have minimal functional play with toys. In the later sessions, he followed along and played with toys more appropriately. However, he never engaged in functional play with the blocks, sea animals, or rings when unprompted. During generalization phases, he began to play within .30 meters proximity to peers and allow peers to move within .30 meters of and play with similar toys near him. He also often wandered the room flapping his hands and jumping.

Tommy

Results for Tommy are presented in Figure 6. In four of the five baseline sessions, Tommy did not engage in any sharing or turn-taking behavior. In one baseline session, he engaged in .17 sharing or turn-taking response per minute. He refused assent to participate during one baseline session.

During both intervention phases, Tommy engaged in similar rates of sharing and turn-taking (see Figure 6). He participated in nine of 12 musical intervention sessions and 8.5 of 11 non-musical intervention sessions. Tommy engaged in sharing and turn-taking in all but two of the musical generalization sessions. His average rates of sharing per minute in musical generalization were .06 and .13 (modes) with a range from 0 to .67. He also engaged in sharing and turn-taking in all but two of the non-musical generalization sessions with mode average rates of sharing per minute as .2, .27, and .33 (range = 0 to .33). He had two instances of very high rates of rates of responding in musical generalization phases but had more consistent average rates of sharing and turn-taking per minute in non-musical generalization phases. He withdrew from the study before completing the adapted treatment phase.

Tommy's happiness was recorded at variable rates between zero and four during baseline (see Figure 7). He was observed to display high levels of happiness throughout all intervention sessions with a marked increase from baseline. His average happiness rating during musical intervention sessions was 2.75 (mode = 3), and his average happiness rating during non-musical interventions was 2.5 (mode = 3).

Tommy engaged in multiple disruptive behaviors during sessions including scratching, hitting with an open hand, yelling, and shaking his head back and forth with his tongue out. To help decrease disruptive behaviors and increase sharing and turn-taking, a tangible reinforcer was introduced during session seven. Tommy was reinforced on a variable ratio schedule of four (VR4) during intervention sessions. The added reinforcer increased the amount of time he spent exhibiting appropriate behaviors. Tommy was observed to have difficulty differentiating between musical and non-musical intervention phases. The patterning of the spoken scripts imitated familiar melodies, and Tommy sometimes sang the familiar song while the therapist was

talking in non-musical interventions. He usually sang along during musical interventions. He displayed very similar rates of responding in all phases.

Frank

Results for Frank are presented in Figure 6. During baseline, Frank did engage in some sharing and turn-taking in the form of asking for help with the puzzle and allowing his therapist to take turns placing puzzle pieces on and make suggestions about which pieces to do next. He engaged in a range of rates from zero to .5 average sharing and turn-taking responses per minute. Frank's average score during baseline was .20 average responses per minute (see Figure 6).

Frank participated in 10 out of 11 musical intervention sessions and all non-musical intervention phases. He refused to participate in generalization following one adapted treatment phase session. Frank engaged in similar rates of sharing and turn-taking during musical and non-musical interventions with slightly higher rates in musical interventions. During musical generalization, Frank engaged in .2 responses per minute on average of sharing and turn-taking (range = 0 -3.13). The average rate of responses per minute during musical generalization was 1.07. In non-musical generalization sessions, the average rates of responding per minute was .88 (range = 0 - 2.92). Frank displayed a marked increase in sharing and turn-taking during generalization phases of sessions 22 through 26. In these phases, the therapists conducting the interventions completed the generalization sessions outside with water play which affected the fidelity of those sessions and established significant differences in data. Considering data just from generalization sessions run in the generalization room (sessions six-20 and 27 and 28), Frank displayed an increase in his average rate of responding per minute from baseline. The

higher increase was in musical interventions overall, so musical interventions were used in his adapted treatment phase. No preference for toys was observed in the adapted treatment phase.

Frank's happiness was reported to range from two to three during baseline (see Figure 7). During the alternating treatment phase, he was observed to have a slightly higher happiness rating during musical than non-musical interventions. In musical intervention phases, he had an average happiness rating of 2.7 (mode = 2). In non-musical interventions, he had an average happiness rating of 2.3 (mode = 3). In the adapted treatment phase, he had an average of 3.25 happiness rating (mode = 2). Overall, happiness was very similar across alternating treatment phases and few marked changes were observed.

After session nine, Frank switched from attending the clinic five nights a week for 2.5 hours to attending three afternoons a week for 4 hours. He also changed from having one primary therapist to having two primary therapists. Frank responded well to social reinforcers and social praise. This was paired with a token economy as reinforcement. He did display problem behaviors of refusal and verbal protests, especially when the therapist attempted to direct the play. For example, when playing with rings, Frank typically did the opposite of what the song asked (therapist put the blue ring on, participant put the green ring on). Frank would either ask the therapist to put all the rings on or put the blue ring on and ask the therapist to put the green ring on. In generalization sessions, he was observed to allow peers and therapists to make suggestions about play and would adapt play to include some of their ideas.

Monica

Results for Monica are presented in Figure 6. During baseline sessions, Monica engaged in some consistent sharing and turn-taking behaviors with the puzzle, car, and crayons. With the

puzzle and crayons, she asked the therapist to help her and allowed the therapist to make suggestions, take turns with putting puzzle pieces together, or take turns writing with the crayons. She sometimes asked the therapist to catch and pushed the car back forth with the therapist. Her average rate of responding per minute during baseline was .47 responses per minute (range = 0 -1) (see Figure 6).

Monica participated in four musical interventions and maintained a high rate of sharing and turn-taking with little variation. In two generalization sessions following musical intervention, Monica responded with an average rate of .2 and .27 responses per minute. However, her rates of sharing and turn-taking during musical generalization then dropped to zero. She also participated in four non-musical intervention sessions. Her rate of responses during these interventions were variable between 43 and 100. In non-musical generalization sessions, she engaged in lower rates of unprompted responding. She had a mode average rate of response per minute of .13 (range = 0 -.13). Monica refused assent to participate in both musical and non-musical intervention phases. During session 17, she gave assent to participate in one phase (car) of musical interventions. At the conclusion of the phase, she again refused assent to play with the other toys but engaged in generalization. A partial treatment model of playing with one toy instead of playing with three toys was continued throughout the remaining treatment sessions. Monica participated in 33% of sessions before the treatment phases were altered; she participated in 50% of intervention phases after the alteration.

Because Monica displayed a slightly higher average rate of responding per minute in musical generalization sessions, she participated in a musical adapted treatment phase. In the partial treatment phases starting in session 17, a clear preference for the car and sea animals was

established. She displayed less preference during adapted treatment phases when she played with sea animals (session 30), rings (session 31), and crayons (session 32).

Monica's highest happiness rating scores were observed during baseline with an average rating of 3.2 (mode = 3) (see Figure 7). During alternating treatment, she was observed to score slightly higher on the happiness rating scale during musical interventions versus non-musical interventions. However, she refused assent to 47% of all sessions. During musical interventions, she had an average happiness rating of 2.5 (mode = 2), and during non-musical interventions, she had an average happiness rating of 2 (mode = 2). During the adapted treatment phase, her average happiness rating was 3. No mode was found. Her observed happiness dropped during the alternating treatment phase with an increase during the adapted treatment phase.

Monica attended the clinic in the evening after attending a full day of school until session 30. She often chose to work for a tangible reinforcer (iPad, cookie, painting), then verbally refused assent as well as protesting with statements such as, "I don't want to share.", "I don't want to play with my friends.", "I don't like to share.", "No. It's mine.", and "It's for me." She used these verbal protests both to refuse assent and when prompted to share during intervention sessions she assented to. When she gave a verbal protest during a session, the therapist accepted her refusal to share and continued with the intervention. A token economy was used to reinforce completion of each of the three phases for each session. Upon receiving three tokens, she earned access to the tangible reinforcer she chose. She continued to refuse assent at high rates, so a partial treatment was implemented in which only one toy was presented for 5 minutes instead of 3 toys over 15 minutes.

Monica was observed to avoid unprompted and prompted interactions with peers. However, her therapists report that she has displayed an increase in sharing and turn-taking

spontaneously with peers and an increase in allowing others to make suggestions about play. Monica's high rates of sharing and turn-taking during baseline and intervention phases could be due to a forced choice of toys that was not present in generalization. While intervention toys were freely available during generalization, Monica usually chose to engage in isolated gross motor play around the room.

Steven

Results for Steven are presented in Figure 6. Steven participated in five out of seven baseline intervention sessions (see Figure 6). His average rate of sharing and turn-taking per minute was .056 with a range of zero (five sessions) to .33 (one session). Stephen participated in four musical sessions total with more sharing and turn-taking than in non-musical sessions. In the first three musical generalization sessions, he did not engage in any sharing or turn-taking with peers. He did share on an average of .33 times per minute in the final musical generalization session. Stephen also participated in four non-musical sessions with an average rate of .32 instances of sharing and turn taking per minute (range = .06 -.67). There was no mode average rate of response per minute for non-musical generalization. On the final non-musical generalization trial, he did not share or take turns. Because of his decreasing rate of responding during non-musical generalization, increasing rate of responding during musical generalization, higher rates of responding in musical interventions over non-musical interventions, and higher happiness rating in musical versus non-musical interventions, Steven was presented with a musical adapted treatment phase. Steven did show a preference for sea animals and rings during intervention phases. He chose to play with rings (session 30), crayons (session 31), and car

(session 32) showing reduced preference for other toys. He refused to participate in the generalization phase following the crayons.

Steven was observed to be a zero on the happiness rating scale for six out of seven baseline sessions (see Figure 7). The highest happiness rating observed during baseline was one. During alternating treatment phases, he was observed to have a marked increase in happiness ratings. However, Steven refused to participate in 50% of sessions. The average happiness rating score in musical interventions was 2.25 (mode = 2), and the average happiness rating score in non-musical intervention was two (mode = 2). His happiness rating during the adapted treatment phase was two with no mode established. His happiness was observed to have increased in alternating treatment and adapted treatment phases.

Steven refused assent for two out of five of baseline sessions, six out of 10 non-musical intervention sessions, and eight out of 12 of musical intervention sessions given. Overall, he has refused to participate in 50% of sessions. Multiple tangible reinforcers were offered on a continuous reinforcement schedule (CRF) including watching preferred music videos on a device, skittles, fruit snacks, and access to preferred toys. When asked to give assent, Steven refused verbally by saying, “No.” and by engaging in tantrum behavior, hitting his therapist with an open or closed hand, or throwing reinforcers and intervention materials. He often verbally protested transitioning to the intervention room. He would give verbal assent to the visual schedule but would not transition into one of the rooms used for the study. When he did assent to an intervention, he often refused that assent after an average of two minutes of the trial by throwing objects, yelling, or hitting his therapist’s hand with a closed or open hand, hitting the table with an open hand, or kissing his therapist’s hand. During sessions 14 and 15 he had an unfamiliar therapist subbing for his usual therapist. Starting in session 27, he began to see

multiple therapists. In session 19, Steven assented to participate in one phase (sea animals) of the non-musical session. Upon completion of the phase, he refused to engage with the other toys, but did participate in generalization. A partial treatment model of playing with one toy instead of playing with three toys was continued throughout the following sessions. Steven switched from evening to afternoon therapy in session 31. An immediate decrease in problem behavior was observed.

Comparing Generalization to Baseline

All participants engaged in high rates of sharing and turn-taking during the intervention phases. During the baseline phase, an average rate of unprompted sharing and turn-taking per minute was scored. The same score was taken during the generalization phase. To determine the effectiveness of the intervention, the generalization phases were compared with the baseline sessions. Four of the five participants showed an increase from baseline in average rates of responding per minute during generalization phases. One participant, Monica, did not show any increase from baseline during generalization phases. Two participants, Billy and Frank, had higher average rates of responding in musical generalization phases than non-musical generalization phases, although both musical and non-musical showed an increase from baseline. One participant, Tommy, showed very similar increases from baseline in both musical and non-musical intervention phases. One participant, Steven, showed an increase from baseline following non-musical intervention phases.

Happiness

Happiness was measured according to visual observation of physiological and behavioral responses. It was scored using a happiness rating scale (see Figure 2). For Billy, Monica, and Steven, happiness rating and rate of responding during non-musical intervention sessions were directly related. As responding rate increased, happiness increased and vice versa. All participants had some relation between rate of responding during musical interventions and level of happiness rating, though more variable.

Tommy and Steven displayed an increase in their average happiness rating from baseline to alternating treatment phase. For Steven, this increase was continued throughout the adapted treatment phase, though with one lower rating in session 30. Billy and Monica were observed to have lower rates of happiness from baseline phase to alternating treatment phases. Billy's happiness rating during alternating treatment phases remained variable between a one and a three. He exhibited an increase in happiness rating back to baseline levels during the adapted treatment phase in the final three sessions of the study. Monica showed an increase in happiness ratings from both baseline and alternating treatment phases during the adapted treatment phase.

Frank's rate of responding during interventions increased in musical interventions. His overall happiness rating was consistent. He scored a three for 42% of all sessions with a range from zero to four. Frank's schedule changed from attending therapy five days a week for 2.5 hours in the evening to attending three days a week in the afternoon for 4 hours. He also changed from one primary therapist to two primary therapists. These changes could have affected his happiness rating.

Comparison to Finnigan and Starr (2010)

Finnigan and Starr (2010) found that their participant displayed a higher increase in all social responsive behaviors, such as imitation, eye contact, and turn-taking, in musical sessions versus non-musical sessions. The participant engaged in social avoidant behaviors, such as eloping, pushing away therapy materials, and avoiding eye contact, less frequently in musical interventions than non-musical interventions. Their data suggest that musical interventions could provide an effective social skills intervention for children with autism.

In the current study, the results were less consistent. Three of the five participants demonstrated an increase in the target behavior during musical interventions. Of those three participants, one had very similar increases in sharing and taking turns during both musical and non-musical interventions. Two participants did not show an increase in the target behavior during musical interventions. While these data suggest that musical interventions can be effective as a social skills intervention, neither study was able to conclusively establish the effectiveness of this treatment.

DISCUSSION

The results of this study indicate that musical interventions can be effective for increasing sharing and turn-taking. Billy and Tommy engaged in higher rates of sharing and turn-taking than two of the other participants. They were two of the four participants reported to be highly reinforced by musical activities. Also, as the two youngest participants in the study, their age might have affected their willingness to participate and the high rates of sharing and turn-taking recorded during sessions.

Frank also engaged in high rates of sharing and turn-taking during both musical and non-musical sessions. He was older than Billy or Tommy and was not reported to prefer musical activities. However, he responded to social interaction with and social praise from his therapist more than the other participants. If the therapist was smiling and modeling with a positive affect and high energy, he would smile and participate most of the time. For example, during the "Make a Rainbow" script, the therapist clapped, jumped, tapped the table, wiggled her shoulders, and jumped around during different parts of the song. He would often imitate the movements and play along. Monica and Steven had lower rates of sharing and turn-taking. Monica verbally protested sharing, playing with her friends, and the repetition of the song. For example, "I don't want to play with my friends," "No, no friends," "I don't want to share," "No thanks. That's not for me," and "I don't want to hear it again." In her typical therapy sessions, she was observed to attend to a non-preferred task for an average of 10 minutes. She could have reached ratio strain during the intervention phase because the intervention phase was 15 minutes long, exceeding her typical average and straining her attention. Steven did not participate in non-preferred activities for longer than five minutes during therapy and could have reached ratio strain during the 15-

minute intervention phase. Partial treatments were delivered during some alternating treatment sessions and all adapted treatment sessions for Monica (sessions 17-36) and Steven (sessions 19-36) to reduce ratio strain and increase the number of times they gave assent to participate. Monica participated in 33% of sessions before the treatment phases were altered. She participated in 50% of intervention phases after partial treatments were initiated. Steven also participated in 33% of intervention sessions before the partial treatments were used. He participated in 38% of intervention sessions after the partial treatments were introduced.

During the study, participants were given the opportunity to provide their assent to participate before each session. Assent was requested using a visual assent form with a script that was read by the therapist (see Figures 3 & 5). If a participant refused assent, the session was not conducted. The high rates of refusal for assent was a limitation in this study because it limited the amount of data collected in the study for Monica and Steven (see Figure 8). Monica's high rates of refusal could have been because she verbally protested the repetition of the scripts, verbally protested playing with her friends when the assent forms were presented, and could have reached ratio strain quickly. Steven had limited functional play skills, refused to transition to intervention rooms and away from rooms with more access to preferred items, and could have reached ratio strain during interventions. Reinforcement measures were changed and adapted to increase the rates of assent and happiness as well as reinforce the target behavior. For Billy, Tommy, and Frank altering reinforcement increased the number of sessions they assented to participate in.

Initially, the therapists used social praise ("Good sharing.") as the reinforcer delivered contingent on sharing and turn-taking for all participants. However, this proved to be ineffective for all participants. Instead, preferred tangible reinforcers were offered to each participant.

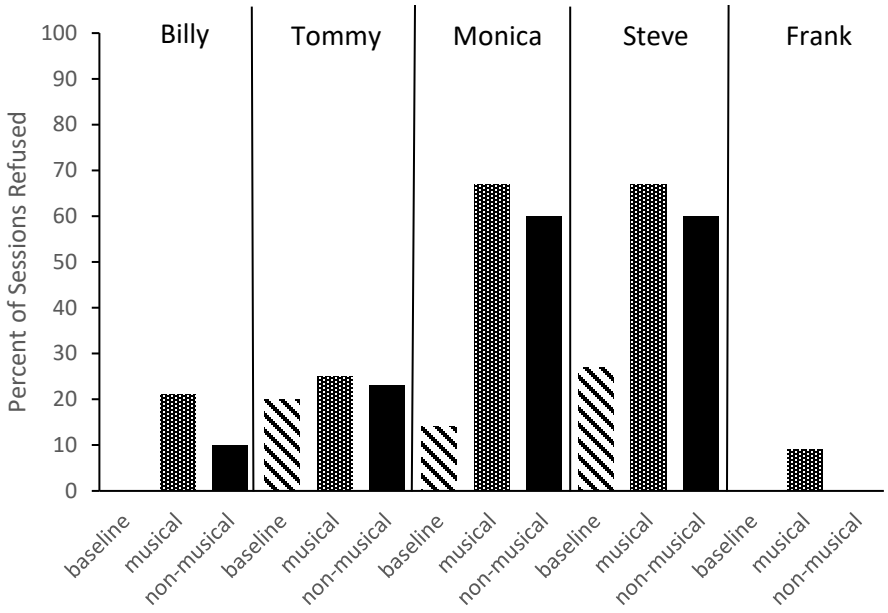


Figure 8: Percentage of refusal of assent across participants and interventions

Monica and Frank had their visual assent form rearranged to say, “First we will play/sing together. Next, we will have [reinforcer] and free time. Last, we will play with our friends. Are you ready?” This allowed them to work for tokens and earn a preferred reinforcer for a duration of 5 to 10 minutes immediately following the intervention session. They would then transition to generalization. Billy, Tommy, and Stephen were reinforced with preferred tangible reinforcers. Billy was reinforced on a continuous reinforcement schedule (CRF). Tommy was reinforced on a variable ratio schedule of 4 (VR4), and Steven was reinforced with a CRF schedule first then a variable ratio schedule of 2 (VR2) later in the study.

Another limitation of this study was that the songs and teaching scripts for the interventions directed the participants to play with toys functionally. The participants usually played with the puzzle and blocks functionally. Monica and Frank played with the stacking rings, car, and crayons functionally as well. Billy, Tommy, and Steven did not play with the toys

functionally during independent play. Because the scripts asked them to play with the toys in a functional manner (driving the car, coloring a rainbow with the crayons, stacking the rings, and pretending with the sea animals), these participants experienced an extra level of demand from the therapist. Not only was the demand in place to share, but the demand to play with the toy in a specific manner that was unfamiliar and unusual for the participant was also in place. This may have been a limitation because the participants were less likely to engage socially with the therapist and more likely to engage in disruptive behavior leading to lower counts of sharing and turn-taking. Future studies should probe for functional play of toys as a prerequisite skill to sharing and turn-taking.

A fourth limitation involved the inconsistent presence of therapists during the intervention. Absences and schedule changes affected which therapists worked with each participant. Because of this, therapists who had been trained using a BST model by the investigator were training therapists who had not been trained using a BST model by the investigator and were then implementing the treatment. This could have lowered the treatment integrity for some of the therapists.

Two of the participants had schedule changes. Several had absences, and three had therapist changes. The changes in therapists and schedules affected the participants' happiness and willingness to engage with their therapist. It would have been ideal for each participant to engage in the intervention with the same therapist every time for continuity, control of treatment integrity, and control of client responses to different therapists.

A fifth limitation was the patterning of spoken scripts. The scripts were patterned to allow them to be easily converted to the musical intervention during adapted treatment phases. However, the similarity between the patterning of the musical intervention scripts and the spoken

intervention scripts could have reduced their effectiveness as a clear discriminative stimulus (S^D) between interventions. Without a clear S^D, the participants may not have made any distinction between the interventions, thus lowering the likelihood that the data would show a clear difference between the two interventions.

Future research would benefit by conducting reinforcer assessments and providing programmed reinforcers to the participants. Probes for the functional use of toys or creating play scripts that do not place a demand for the functional use of play are also suggested by the results. Researchers could establish clear S^Ds for musical and non-musical sessions such as using instruments in musical versus non-musical or having one therapist conduct musical and another conduct non-musical. Finally, future research could compare the effects of musical versus non-musical interventions with participants of different ages.

Overall, participants gave their assent more often for non-musical than musical interventions. Billy and Frank increased in independent sharing and turn-taking at a higher rate during the musical intervention session, and Steven, increased during non-musical sessions. Tommy had similar rates of responding during both musical and non-musical interventions. Monica showed no increase above baseline following either intervention session. Happiness was consistently higher in musical than non-musical interventions for all participants.

The results suggest that musical interventions can be effective for increasing sharing and turn-taking. The variations in these data do not allow a clear conclusion to be drawn about which intervention was more effective. The data do indicate that discrete trial training (DTT) with patterned scripts could help increase sharing and turn-taking in generalization settings. The data also suggest that musical interventions could result in higher rates of assent to interventions from

young children. With more research, musical interventions could prove to be an enjoyable, effective social intervention to meet the increasing demand for children with autism.

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APPENDICES

Appendix A. Human Subjects IRB Approval

To:
Michael Clayton
Psychology

RE: Notice of IRB Approval
Submission Type: Initial
Study #: IRB-FY2021-433
Study Title: Using Music Training to Increase Social Responsiveness and Happiness in Children with Autism
Decision: Approved

Approval Date: February 24, 2021

This submission has been approved by the Missouri State University Institutional Review Board (IRB). You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented. Should any adverse event or unanticipated problem involving risks to subjects or others occur it must be reported immediately to the IRB.

This study was reviewed in accordance with federal regulations governing human subjects research, including those found at 45 CFR 46 (Common Rule), 45 CFR 164 (HIPAA), 21 CFR 50 & 56 (FDA), and 40 CFR 26 (EPA), where applicable.

Researchers Associated with this Project:
PI: Michael Clayton
Co-PI:
Primary Contact: Meghan Talarico
Other Investigators:

Appendix B. Teaching Scripts

Script for Crayons	Notes about teaching / prompting target behaviors
<u>Rainbow</u>	
I'll draw a rainbow With my crayons I need all Six colors Red, orange Yellow, green Blue and violet. Red, orange Yellow, green Blue and violet.	Pass colors to client as you say them. Hold out hands for client to pass colors back to you.
I'll draw a rainbow With my crayons I need all Six colors clap, orange Yellow, green Blue and violet. clap, orange Yellow, green Blue and violet.	Draw a red rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, then pass colors to the client as you say them. Hold out hands for client to pass colors back to you.
I'll draw a rainbow With my crayons I need all Six colors Clap, stomp Yellow, green Blue and violet. Clap, stomp Yellow, green Blue and violet.	Draw orange rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, stomp, then pass colors to the client as you say them. Hold out hands for client to pass colors back to you.
I'll draw a rainbow With my crayons I need all Six colors Clap, stomp wiggle, green Blue and violet.	Draw yellow rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, stomp, wiggle shoulders, then pass colors to the client as you say them. Hold out hands for client to pass colors back to you.

Clap, stomp wiggle, green Blue and violet. I'll draw a rainbow With my crayons I need all Six colors Clap, stomp wiggle, wave Blue and violet. Clap, stomp wiggle, wave Blue and violet. With my crayons I need all Six colors Clap, stomp wiggle, wave Tap and violet. Clap, stomp wiggle, wave Tap and violet. With my crayons I need all Six colors Clap, stomp wiggle, wave Tap and jump around. Clap, stomp wiggle, wave Tap and jump around.	Draw green rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, stomp, wiggle shoulders, wave, then pass colors to the client as you say them. Hold out hands for client to pass colors back to you. Draw blue rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, stomp, wiggle, wave, tap, then pass colors to the client as you say them. Hold out hands for client to pass colors back to you. Draw purple rainbow arc on the paper. Leave crayon in reach of client so they can draw if they want to. Clap, stomp, wiggle, wave, tap, and jump around. Gather up the crayons to repeat the song. Repeat song until timer goes off. When the timer goes off, stop singing. Say, "Time is up." and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, "Time is up." ask them if they would like more time or to clean up.

Script for Puzzle	Notes about teaching / prompting target behaviors
I Can Find Out What You Are	
Puzzle Puzzle, there you are Can you show me what you are? In all the pieces you are now. I cannot tell how you'll turn out. Puzzle puzzle, there you are. How I wonder what you are.	Sing and let client look at pieces. Hold out hand for pieces. Set all of the pieces they give you right side up. Once you set it down, hold out hand for client to share another piece with you.
Puzzle Puzzle, there you are Can you show me what you are? Look at all the pieces now. I cannot tell how you'll turn out. Puzzle puzzle, there you are. I will find out what you are.	Continue to turn all of the pieces they give you right side up. Hand the client pieces that are similar colors or go together. Do not give any other prompts. Clients may start putting the pieces together themselves at this point, but also may not. Either result is fine.
Puzzle Puzzle, there you are Can you show me what you are? Find the ones that are alike. I cannot tell how you'll turn out. Puzzle puzzle, there you are. I will find out what you are.	If they ask for help, use this prompting hierarchy: gesture, model, verbal, partial physical, full physical Match a piece on the puzzle. If the client has a puzzle piece in their hand, wait for them to fit the piece, then fit another piece yourself (turn-taking). If the client is not already holding a piece, give them a piece then wait for them to fit it.
Puzzle Puzzle, there you are Can you show me what you are? Match the pieces, like with like I cannot tell how you'll turn out. Puzzle puzzle, there you are. I will find out what you are.	Match a piece on the puzzle. If the client has a puzzle piece in their hand, wait for them to fit the piece, then fit another piece yourself (turn-taking). If the client is not already holding a piece, give them a piece then wait for them to fit it. Repeat song until timer goes off.
Puzzle Puzzle, there you are Can you show me what you are? What picture will you show me?	When the timer goes off, stop singing. Say, "Time is up." and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, "Time is up." ask them if they would like more time or to clean up.

I cannot tell how you'll turn out. Puzzle puzzle, there you are. I will find out what you are.	

Script for Sea Animals	Notes about teaching / prompting target behaviors
<u>We Will Swim</u>	If the client will not hand the sea animal to you when you hold out your hand, use the prompt "my turn." If they still will not hand you the animal, use your hands in similar gestures and continue the song (wave, jump, swish, etc.)
In the water, We will swim Bubble, bubble, bubble And while we swim We'll find a [sea animal] Bubble, bubble, bubble	Lay the sea animals out in a line before starting the song. Say the name of one of the sea animals below. Pause to allow client to select the sea animal you say. If they do not, use a gestural prompt (point to the correct sea animal). If they still do not take it, say the name of the sea animal and hold it out to them. If they have not taken it, continue with the song.
Starfish: With a wave-wave here And a wave-wave there Here a wave, there a wave Everywhere a wave-wave	Hold out hand for starfish and wait for client to hand it to you. Model waving starfish's arms. Hand starfish back to client.
Dolphin: With a jump-jump here And a jump-jump there Here a jump, there a jump Everywhere a jump-jump	Hold out hand for dolphin and wait for client to hand it to you. Model making dolphin jump. Hand dolphin back to client.
Turtle: With a swish-swish here And a swish-swish there Here a swish, there a swish Everywhere a swish-swish	Hold out hand for turtle and wait for client to hand it to you. Model making turtle swim. Hand turtle back to client.
Fish: With a squirt-squirt here And a squirt-squirt there Here a squirt, there a squirt Everywhere a squirt-squirt	Hold out hand for fish and wait for client to hand it to you. Model squishing fish. Hand fish back to client.

Crab: With a clap-clap here And a clap-clap there Here a clap, there a clap Everywhere a clap-clap Octopus: With a wiggle-wiggle here And a wiggle-wiggle there Here a wiggle, there a wiggle Everywhere a wiggle-wiggle. In the water we will swim. Bubble, bubble, bubble.	Hold out hand for crab and wait for client to hand it to you. Model clapping crab's claws. Hand crab back to client. Hold out hand for octopus and wait for client to hand it to you. Model wiggling the octopus around. Hand octopus back to client. Repeat song until timer goes off. When the timer goes off, stop singing. Say, "Time is up." and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, "Time is up." ask them if they would like more time or to clean up.

Script for Stacking Rings	Notes about teaching / prompting target behaviors
<u>Five Little Rings</u> (tune of 5 Little Ducks☆) The five little rings Fell off one day They started to roll away No, no rings, Come back, back, back I put the blue one back on the stack. The five little rings Fell off one day They started to roll away No, no rings, Come back, back, back You put the green one back on the stack. The five little rings Fell off one day They started to roll away No, no rings, Come back, back, back I put the yellow one back on the stack. The five little rings Fell off one day They started to roll away No, no rings, Come back, back, back You put the orange one back on the stack. The five little rings Fell off one day They started to roll away No, no rings, Come back, back, back We put the red one back on the stack. The five little rings Fell off one day	Take rings off of the toy and lay out in your work space. Use response blocking by moving the rings away from the client if they try to put them all on before you are ready. Put the blue ring on the stack. Client puts the green ring on the stack. Put the yellow ring on the stack. Client puts the orange ring on the stack. Try having both you and the client put the ring back on the stack together.

They started to roll away No, no rings, Come back, back, back We put the all of them back on the stack.	Take turns putting the rings back on the stack. Repeat song until timer goes off. When the timer goes off, stop singing. Say, “Time is up.” and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, “Time is up.” ask them if they would like more time or to clean up.

Script for Toy Vehicle	Notes about teaching / prompting target behaviors
<u>Vrm Vrm</u> (tune of Baby Shark☆)	If client does not drive the car to you when you say "drive to me" and hold out your hand, say "my turn while holding out your hand. If they still will not give you a turn, continue with the song and try again at the next prompted place.
Drive the car Vrm-vrm, vrm, vrm, vrm-vrm	Hand child the car
Drive to me Vrm-vrm, vrm, vrm, vrm-vrm	Hold out hand. Child drives car to you
Drive around Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car around.
Drive to you Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car back to the child
Drive it far Vrm-vrm, vrm, vrm, vrm-vrm	Child drives the car
Drive to me Vrm-vrm, vrm, vrm, vrm-vrm	Hold out hand. Child drives the car to therapist
Back and forth Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car back and forth
Drive to you Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car back to the child.
Drive around Vrm-vrm, vrm, vrm, vrm-vrm	Child drives the car.
Drive to me Vrm-vrm, vrm, vrm, vrm-vrm	Hold out hand. Child drives the car to therapist
Drive it far Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car far away
Drive to you Vrm-vrm, vrm, vrm, vrm-vrm	Drive the car back to the child
Back and forth	Child drives the car around Repeat song until timer goes off.

	When the timer goes off, stop singing. Say, “Time is up.” and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, “Time is up.” ask them if they would like more time or to clean up.

Script for Blocks	Notes about teaching / prompting target behaviors
<u>Stacking Up</u> (tune of If You Are Happy and You Know It☆)	If client does not hand you a block when you hold out your hand, say "my turn" while holding out your hand. If they still will not share, continue the song and try again at the next prompt. *It is ok if the construct does not resemble what we are singing about.
If you want to make a tower, Stack blocks up. If I want to make a tower, Stack blocks up. If you want to make a tower, Then you build it higher-higher. If we want to make a tower, Stack blocks up.	Hold out hand for a block and place on the stack once client hands it to you. Hold out hand for a block and place on the stack once client hands it to you. Rearrange blocks so you can start a new construct.
If you want to build a castle, Stack blocks up. If I want to build a castle, Stack blocks up. If you want to build a castle, Then you build it higher-higher. If we want to build a castle, Stack blocks up.	Hold out hand for a block and place on the stack once client hands it to you. Hold out hand for a block and place on the stack once client hands it to you. Rearrange blocks so you can start a new construct.
If you want to make a bridge, Stack blocks up. If I want to make a bridge, Stack blocks up. If you want to make a bridge, Then you build it higher-higher. If we want to make a bridge, Stack blocks up.	Hold out hand for a block and place on the stack once client hands it to you. Hold out hand for a block and place on the stack once client hands it to you. Rearrange blocks so you can start a new construct.
If you want to build a house, Stack blocks up. If I want to build a house, Stack blocks up. If you want to build a house, Then you build it higher-higher	Hold out hand for a block and place on the stack once client hands it to you. Hold out hand for a block and place on the stack once client hands it to you.

If we want to build a house, Stack blocks up.	
	Rearrange blocks so you can start a new construct.
If you want to make a tree, Stack blocks up. If I want to make a tree, Stack blocks up. If you want to make a tree, Then you build it higher-higher. If we want to make a tree, Stack blocks up.	Hold out hand for a block and place on the stack once client hands it to you. Hold out hand for a block and place on the stack once client hands it to you.
	Repeat song until timer goes off. When the timer goes off, stop singing. Say, “Time is up.” and start to clean up. If the client asks for more time, give them one more minute. If they do not respond to your prompt, “Time is up.” ask them if they would like more time or to clean up.