DOES A MUSIC-BASED NATURALISTIC DEVELOPMENTAL BEHAVIORAL INTERVENTION TARGETING DELAYS TO REINFORCEMENT REDUCE CHALLENGING BEHAVIOR FOR STUDENTS WITH ASD DURING DELAYS TO PREFERRED ITEMS?

by

MADELYNNE PAIGE HELLEMN

(Under the Direction of Jessica Torelli)

ABSTRACT

Individuals with autism spectrum disorder (ASD) often engage in challenging behaviors when faced with situations that require a tolerance for delay (Hanley, 2014). While applied behavior analysis (ABA) based strategies have been widely researched to address tolerance for delay, research exploring naturalistic interventions to teach this skill has been limited. This study examined the effectiveness of Music Based- Naturalistic Developmental Behavioral Intervention (MB-NDBI) to teach tolerance for delay to preferred items across the school day in preschool-aged individuals with ASD. Findings indicate that MB-NDBI increased waiting without challenging behavior and promoted the generalization of skills across settings. These results suggest that integrating music into a behavioral intervention framework is a promising and contextually relevant strategy to develop waiting skills in young children with ASD.

INDEX WORDS: Naturalistic Developmental Behavioral Intervention, Applied Behavior Analysis, Music Therapy, Autism, Tolerance of Delay

USING MUSIC-BASED NATURALISTIC DEVELOPMENTAL BEHAVIORAL INTERVENTION TO INCREASE WAITING SKILLS IN PRESCHOOL STUDENTS WITH AUTSIM SPECTRUM DISORDER

By

MADELYNNE PAIGE HELLEMN

B.M., The University of Georgia, 2023

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirement for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2025

DOES A MUSIC-BASED NATURALISTIC DEVELOPMENTAL BEHAVIORAL INTERVENTION TARGETING DELAYS TO REINFORCEMENT REDUCE CHALLENGING BEHAVIOR FOR STUDENTS WITH ASD DURING DELAYS TO PREFERRED ITEMS?

by

MADELYNNE PAIGE HELLEMN

Major Professor:	Jessica Torelli
Committee:	Rachel Cagliani Ellyn Evans

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
May 2025

DEDICATION

I would like to take a moment to dedicate this thesis to my strongest supporters. Kennedy, Adrien, and CJ, “thank you” will never be big enough words to express my gratitude and love for you three. I truly would not have made it to this point without your friendships, some days it was the only thing that got me out the door in the morning. Your minds are the brightest I know, and I can’t wait to see what you do next.

Tom and Patti, your love and support for me have been a constant source of strength for me. Tom, your kindness, wisdom, and encouragement have shaped me in more ways than I can count, and I am forever grateful to have you in my life. Patti, your spirit lives on in every melody I sing, and I will always carry your love with me.

Mom, Dad, Maw-Maw, B-dad, and Popi thank you for always reminding me to follow the music and to never give up on my dreams. You have always been my biggest supporters, and I hope I make you proud. I love you very much.

Jake, my partner for life, thank you for your unwavering support in everything I do, and for standing by my side through every challenge. I am endlessly grateful for you.

To the music therapists, your work is a testament to the power of music. Your dedication inspires me daily.

Lastly, to all the educators, therapists, and researchers devoted to improving the lives of children with autism, may this work serve as a small piece of the meaningful change you bring to the world every day.

ACKNOWLEDGEMENTS

There are several people I would like to acknowledge and extend the biggest thank you to. First and foremost, I would like to thank Dr. Jessica Torelli. Dr. Torelli, thank you for all the time you have devoted to me throughout my time in this program, as an advisor, mentor, and supervisor. Thank you for always taking the time to answer questions, provide support, and push me to advocate for what I think is important. Your guidance has been invaluable, and this project would not have been possible without you.

I would like to thank my committee members and other university faculty members for their endless support. Dr. Rachel Cagliani and Dr. Ellyn Evans for your expertise and feedback that shaped a project I am truly proud of. Thank you, Dr. Joel Ringdahl, Dr. Kevin Ayers, Dr. Georgette Morgan, for your guidance and support throughout this program.

Lastly, Thank you to Roy Joyner, my mentor, for always reminding me to think like a music therapist. I would also like to acknowledge my cohort and friends in this program who were always willing to lend a helping hand.

Table of Contents

CHAPTER 1

INTRODUCTION

Prevalence of Challenging Behavior in Individuals with Autism

Waiting is a fundamental aspect of daily life that is expected of individuals across all settings, ages, and populations. For neurotypical children, waiting is often facilitated through social expectations and self-regulation strategies (Romero-Ayuso, 2022). However, individuals with autism spectrum disorder (ASD) often engage in impulsive and challenging behaviors related to delays, including aggression, disruption, self-injurious behavior, etc., that these strategies may not mediate (Rung& Young, 2015; Hanley et al., 2014). These challenging behaviors limit participation in structured activities and increase stress for caregivers and educators (Hanley, Iwata, & Thompson, 2001; Lee, 2014). Given the pervasiveness of waiting-related challenges in ASD, effective interventions are needed to teach tolerance for delayed reinforcement while reducing challenging behaviors associated with waiting (Markovich, 2020).

Applied Behavior Analysis Approaches to Increase Tolerance of Delay

Applied behavior analysis (ABA) is a widely recognized science on which evidence-based approaches for individuals with ASD have been developed, focusing on systematically altering environmental variables to influence socially significant behaviors via individualized interventions (Baer et al., 1968). ABA offers an abundance of research related to behavioral interventions that address tolerance for delay. Common methods for addressing tolerance of delays to reinforcement through behavioral interventions include compound schedules, such as

chained and tandem schedules of reinforcement, and other behavioral methods, such as progressive delay schedules and concurrent activities (e.g., Ghaemmaghami et al., 2016; Hanley et al., 2014; Snyder et al., 2024).

A chained schedule is a compound schedule in which reinforcement is delivered only after a sequence of two or more behavioral components is completed, with each component signaled by a schedule correlated stimuli (Torelli & Pickren, 2023). A tandem schedule is identical in procedure to that of a chained schedule, except it does not include schedule-correlated stimuli (Torelli & Pricken, 2023). When used in combination with progressive delay schedules, in which the therapist systematically increases the response requirement, this, in turn, increases the time in which the individual must tolerate delay (Ghaemmaghami et al., 2016; Jessel et al., 2018). Another method used to increase delay tolerance is using concurrent activities during delays. Using concurrent activities during periods of delay to reinforcement can reduce individuals' perseverance on delayed reinforcers (Dixon et al.,2003). Though these interventions are often successful in reducing challenging behavior, research is limited in the evaluation of the effects of a naturalistic approach to increasing tolerance of delay.

Naturalistic Developmental Behavioral Intervention (NBDI)

Naturalistic Developmental Behavioral Interventions (NDBI) represent a merging of ABA and developmental science that focuses on naturalistic teaching strategies, developmental practices, and behavioral interventions to support individual goals such as communication (Kasari et al., 2006), reduction of challenging behavior (McGee & Daly, 1998), cognition, (Schreibman et al., 2015), and others. At its core, NDBIs maintain the integrity of ABA's core values by seeking to address socially significant behaviors through environmental and behavioral mechanism by systematically embedding learning opportunities into a naturalistic, child-directed

environment, which can lead to quicker learning, reduced dependency on prompts, and improved generalization for individuals with ASD (Baer et al., 1968; Schreibman et al., 2015).

Music-Based NDBI (MB-NDBI)

A growing avenue for naturalistic teaching is using music. Music is a ubiquitous experience that offers an exploration of fostering community, social interaction, and learning that begins in infancy and continues into adulthood (Lense & Camarata, 2020). Music therapy is an approach to treatment led by a board-certified music therapist (MT-BC) and uses music-based interventions to address various non-musical individualized goals (AMTA, 2019). Music therapy, particularly neurologic music therapy (NMT), practices under neurologic hypotheses that suggest musical experiences can transfer to non-musical skills due to the neurological engagement elicited by music (Patel, 2011). While music therapy literature is limited in relation to teaching tolerance of delays, music has inherent properties that promote waiting skills and tolerance. Music enhances predictability by providing structured rhythmic patterns and auditory feedback that can help individuals anticipate and regulate during delays, using music as a natural cue for waiting as well as a naturalistic approach to demand fading or increasing delays (Adalde et al., 2014). Research also suggests joint music-making can promote waiting, impulse control, and attentional regulation (Adalde et al., 2014). This suggests structured musical activities could serve as concurrent tasks during delay periods**,** naturally reinforcing waiting skills while supporting reciprocal play and turn-taking (Adalde et al., 2014; Lense & Camarata, 2022). Music therapy research also explores the idea of music as contingent reinforcement (Standley, 2012). Music is often inherently reinforcing and elicits intrinsic enjoyment, motivation, and social connection. Due to its intrinsic reinforcing properties, music-based interventions can increase participation, promote prolonged engagement, and provide concurrent activities during delays.

Integrating music therapy within an NDBI framework, termed Music-Based Naturalistic Developmental Behavioral Intervention (MB-NDBI), combines evidence-based behavioral strategies with the inherent engagement of musical activities. By embedding compound schedules, progressive delays, and reinforcement contingencies within structured music-based activities, MB-NDBIs create naturalistic opportunities for teaching tolerance for delays to reinforcement via structured musical activities such as interactive songs, musical pauses, and instrument play, which are used to create controlled waiting opportunities while simultaneously creating a fun and interactive environment for children.

Purpose of Current Study

Few studies have evaluated the effects of music-based intervention on the reduction of challenging behavior, and at the time of this study, no research has evaluated the effects of MB-NDBI on tolerance for delays to reinforcement. This study extends prior research by embedding ABA methods, specifically schedules of reinforcement, progressive delay schedules, and visual supports, into a music-based NDBI framework. Thus, the primary aim of this study was to evaluate whether an MB-NDBI targeting delays to preferred items reduced challenging behavior for preschoolers with ASD during delays.

Research Question(s):

1. Does MB-NDBI targeting delays to reinforcement reduce challenging behavior for preschoolers with ASD during delays to preferred items?
2. Do the effects of MB-NDBI targeting delays to reinforcement reduce challenging behavior in generalization settings?

CHAPTER 2

METHODS

Participants

Recruitment

This study included three male participants, all of whom were enrolled in and recruited from a university-led school readiness program and receiving full-time applied behavior analysis (ABA) services. Additionally, three other students participated as confederates during intervention. Informed consent to participate in the research was provided by each child's guardian in accordance with the university's institutional review board policies for recruitment and obtaining consent.

Researchers conducted all components of the study in a university-led ABA school readiness program located in the southeastern region of the United States. The program was overseen by faculty and staff with doctoral-level degrees in special education and applied behavior analysis (ABA), all of whom held board-certified behavior analyst (BCBA-D) certifications. The classroom lead therapists were two doctoral candidates in special education with master's degrees in ABA and held BCBA certification. Classroom staff included a rotation of master's students pursuing degrees in ABA. The author, a master's student in ABA, served as the lead therapist in all sessions and held music therapy board certification (MT-BC).

Inclusion Criteria

Researchers conducted pre-baseline sessions to assess participants' eligibility for inclusion in the study. They administered three probe trials to evaluate tolerance for a 30-s delay. Participants qualified for inclusion if they exhibited challenging behavior during at least one of the three trials. Researchers assigned students who did not meet the inclusion criteria to serve as confederates during the intervention. They randomly assigned confederates to dyads, except for Henry and his confederate, who were paired due to their mid-semester enrollment.

Marvin

The first participant, Marvin, a 3.5-year-old black male, was diagnosed with autism spectrum disorder (ASD) and a speech impairment. He exhibited challenging behaviors including screaming, crying, elopement, and aggression (e.g., hitting, biting) when a preferred item or activity was removed. On the Verbal Behavior Milestones Assessment and placement protocol (VB-MAPP; Sundberg, 2008), Marvin received a score of nine in the milestones domain, an 81 in the barriers domain, and a zero on the early echoic skills assessment (ESSA). He communicated using the Picture Exchange (PE) (Frost & Bondy, 2002). At the time of the study, Marvin was able to mand for preferred items and discriminate from an array of two pictures icons.

Leonard

The second participant, Leonard, a 5-year-old black male, was diagnosed with ASD and a speech impairment. He engaged in aggression (e.g., hitting, biting, grabbing), self-injury (head to surface and hand to head), disruption, and elopement. On the VB-MAPP (Sundberg, 2008) Leonard received a score of 14 in the milestone domain, a 67 in the barrier’s domain, and a zero on the early ESSA. He communicated using the Picture Exchange (PE). At the time of the study,

Leonard, was able to mand for preferred items and discriminate from an array of three items. On the Developmental Profile 3 (DP-4; Alpern 2020), Leonard received a score of 40 in the cognitive domain, a score of 57 in the adaptive domain, and a score of 50 in the PSL domain.

Henry

The third participant, Henry, a 3.5-year-old mixed-race male, was diagnosed with ASD and a speech impairment. He exhibited challenging behaviors such as screaming, crying, elopement, and aggression (e.g., hitting, biting), particularly during the removal of preferred items or activities. On the VB-MAPP (Sundberg, 2008) Henry received a score of 22.5 in the milestone domain, a 36 in the barrier's domain, and a one on the early ESSA. He communicated using the Picture Exchange (PE). At the time of the study, Henry could mand for preferred items but could not discriminate between picture icons.

Setting and Materials

Researchers conducted all sessions and probes within the participants' classroom and playground. Pre-baseline, baseline, post-session, and terminal probes all took place in the play centers of the classroom. The two play centers were approximately 2 m x 1.5 m and included a variety of preferred leisure items (blocks, Legos, action figures, action figures, sound boards, whiteboards and markers, fidgets, etc.). Leisure items were stored in plastic bins on the bookshelves located in play centers. Generalization probes were conducted during other times during the day when participants had access to preferred items (e.g., recess and small group instruction). The playground was a fenced-in area that was approximately 14 m x 10 m and included a sand pit with a variety of toys (shovels, buckets, colanders, sand molds, etc.), a large swing set with slides, swings, and climbing walls, and various other leisure items (balls,

scooters, wagons, toy kitchen). Small group instruction was typically a craft activity at a 1.2 m x .6 m rectangular-shaped table in the center of the classroom.

MB-NDBI sessions took place at the front of the classroom on a 1.2 m x 0.9 m alphabet rug. Two small chairs were placed on the rug, facing the front of the classroom, for the participant dyad while a classroom staff member sat on the rug next to each student to assist with managing behavior and instrument play. A divider, approximately 1.5 m tall by 2 m long, was placed directly behind the rug to minimize distractions from other students during the sessions. The lead therapist sat in front of the rug facing the students. During the sessions, the lead therapist led the students in a variety of musical activities aimed to increase participants' tolerance for delay using a variety of instruments (drums, egg shakers, guitar, a green frog maraca, speaker, bubbles, scarves, xylophone, ukelele, etc.)

Response Definitions and Measurement System

Student Behavior: Challenging Behavior

The primary dependent variable in this study was challenging behavior during probes of delays to preferred items or activities. Data collectors recorded whether challenging behavior occurred. Challenging behavior included a) aggression, b) self-injury, c) disruption, d) elopement, e) screaming or crying, and f) dropping or flopping to the ground. Full definitions are available in Appendix A.

Data collection system

Observers used paper and pencil data sheets for all data collection. Data collectors used trial-based recording to document occurrences of challenging behavior within each trial, with the indication of a + or –, during probes. The trial was scored indicating the occurrence (+) or non-occurrence (-) of challenging behavior during the duration of the trial. Observers then divided the

number of trials with challenging behavior by the sum of trials per session. Thus, each data point represents the total percentage of trials in which challenging behavior occurred within a session.

Procedural fidelity

Observers collected procedural fidelity data with all participants across probes during baseline and intervention and during MB-NDBI sessions. During probe sessions, the procedures measured were a) set up of the evocative situation, b) prompt delivery, c) consequence delivery, and d) number of trials. For MB-NDBI sessions, observers collected procedural fidelity during instruction and embedded teaching trials. Researchers measured these procedures; a) secure group attention, b) description of the skill, c) presentation of the visual, d) model the skill with another therapist, e) role play with each student present, f) error correction, and g) praise. During embedded teaching trials, the procedures measured were a) evocative situation, b) gestural prompt, c) verbal prompt, d) consequence delivery, and e) number of trials. Procedural fidelity was collected on 45.97% of probes and 60% of MB-NDBI sessions. Mean fidelity was 100% for probes and MB-NDBI sessions.

Inter-observer Agreement (IOA)

Before conducting the study, observers received behavior skills training (BST; Parsons et al., 2012), including the following procedures. First, the author met with the data collectors to review the study's procedures and data collection systems and to answer any questions related to data collection. Second, the data collectors practiced collecting data with the author by role-playing scenarios in the classroom in which the author provided descriptions of sessions and acted out scenarios, allowing the observers to collect data within a controlled setting. Following the role-play, the author provided feedback and answered any additional questions.

A second observer simultaneously and independently collected data on 69% of all sessions, 72.5% of probe sessions (baseline, intervention, generalization, and terminal probes). IOA was calculated using a point-by-point agreement method, with each coded response identified as an agreement or disagreement. An agreement was scored when both individual observers agreed on the presence or absence of student behavior during a given trial. Observers calculated IOA for each session by dividing the number of agreements by the total number of opportunities, then multiplying by 100. The percentage of agreement across all probe trials was 100% (baseline, intervention, generalization, and terminal probes).

Experimental Design

This study used a non-concurrent multiple baseline design across participants (Watson & Workman, 1981) to evaluate the effects of MB-NDBI on reducing challenging behaviors during delays to preferred items. Participants were randomly assigned to tiers and dyads, except Henry, who, along with his partner, joined the class later. The study was conducted over 3.5 months. Dyad 1 completed intervention prior to Dyads 2 and 3 beginning baseline. Dyad 3 began baseline when Dyad 2 was in intervention.

I used a non-concurrent multiple baseline design instead of a concurrent multiple baseline design due to feasibility concerns related to collecting research data with multiple children in the classroom at one time. I staggered recruitment and enrollment to reduce the challenge of simultaneously collecting data for multiple dyads in one classroom setting. Additionally, a response-guided approach to phase changes ensured that intervention was implemented only after a stable baseline was established to enhance internal validity (Ledford & Zimmerman, 2022).

Procedures

Pre-baseline

Prior to baseline, pre-baseline probes were implemented with each potential participant to identify a need for intervention. All pre-baseline probes took place during play centers in which the participant had free access to preferred tangible items and activities. Pre-baseline probes consisted of three trials in which the participants were engaged with a highly preferred item. After the participant was engaged with the item for at least 30 s, the therapist removed the item and stated, “My turn.” If the participant did not engage in challenging behavior for 60 s, the therapist returned the removed item. If the participant did engage in challenging behavior, the therapist immediately returned the removed item. Participants qualified to participate in the study if they engaged in challenging behavior in at least one of three trials. Participants who did not qualify for the study were randomly assigned to a dyad as a confederate for intervention.

Probes

During probes, participants were given either two or three opportunities to tolerate a delay. If the participant responded consistently to the first two trials (i.e., engaged in challenging behavior during both or neither trial), the third trial was omitted (Robison et al., 2020). If the participant responded inconsistently in the first two trials, the therapist conducted a third trial.

Baseline and intervention probes took place during play centers. Generalization probes occurred after every third probe and took place during other preferred activities (i.e., small group activity and recess). During probes, participants had access to highly preferred items and activities to create an evocative situation where the student encountered a delay to a preferred item. While the participant was engaged with a preferred item, the therapist would remove the item, stating, “My turn with [item],” initiating the delay. If the participant did not engage in

challenging behavior for 30–60 s following the removal of the item, the teacher would return the item to the participant. If the participant did engage in challenging behavior during the trial, the therapist returned the item contingent on challenging behavior.

Intervention: Music-based Naturalistic Behavioral Developmental Intervention (MB-NBDI)

Following the baseline condition, I introduced MB-NBDI to each dyad, which included instruction and teaching trials. The format for each session consisted of the waiting song, a movement activity with embedded musical pauses, a musical story, an improvisational activity, and a goodbye song. These sessions lasted approximately 15 min, with each activity lasting approximately 2-3 min. Each session started in a half circle with the participants in chairs facing the therapist. At the beginning of each session, the therapist used Behavior Skills Training (BST; Parsons et al., 2012) to teach tolerance for delays using the waiting song (see Appendix F for sheet music). The waiting song consisted of the therapist providing instruction for the skill, modeling the appropriate response with another therapist, rehearsing with each participant, and delivering feedback to participants. The therapist first established the students' attention by strumming a I-IV-V chord progression on the guitar and saying, "All eyes on me." While continuing to strum, the therapist greeted each participant and provided descriptive praise to the students for looking in the therapist's direction. Once both students' attention was established, the therapist began the waiting song (see Appendix F). "*We're going to learn to wait our turn; we're going to learn to wait our turn."* The therapist then briefly described how to wait your turn while holding up a visual prompt of two open hands, positioned with palms facing forward with "wait" in bold letters placed above the hands (see Appendix G). "Okay, friends, when a friend or teacher has something that we want, we just have to wait for our turn by keeping a calm and safe body." Visual prompts were present throughout the session. The therapist then provided a

model with an accompanying therapist to act as a student. During the model, the accompanying therapist engaged with the guitar while the primary therapist continued to sing the waiting song. The primary therapist then removed the guitar while the accompanying therapist modeled waiting for their turn with the item without engaging in challenging behavior. Following the completion of the chorus, the primary therapist offered the guitar to the accompanying therapist again stating, "Great job, waiting for your turn with the guitar again." This was then followed by an opportunity for each student to practice the skill with the therapist following the same format as the prior model. If challenging behavior occurred, the therapist introduced additional prompts to wait in a sequence order of visual + gestural followed by gestural + vocal within a five-second inter-prompt interval. The visual + gestural prompt involved the therapist holding the visual prompt up to the participant and pointing at the visual. The gestural+ vocal prompt involved the therapist holding up the sign to the participant and stating, "Remember, we have to wait for our turn".

Following the instruction song, each session consisted of three additional activities, which included six teaching trials embedded across activities (two activities per participant, per activity). The order of these activities following the hello song was a movement activity, a musical story, and an improvisational activity. Lastly, the sessions ended with a goodbye song that did not provide opportunities to practice delays but a conclusion to the session (see Appendix H). During teaching trials (see Appendix J for the list of songs used during teaching trial activities), the participants engaged in musical play in which a preferred song, item, or instrument was removed for 15–30s to create an evocative situation for tolerance for delay and would be returned to the participant contingent on the non-occurrence of challenging behavior. A

visual prompt was provided throughout the session, and additional prompts were provided if challenging behavior occurred.

Terminal Probes

Following low, stable rates of challenging behavior with the implementation of MB-NDBI sessions, Marvin and Henry participated in terminal probes. The terminal probes aimed to identify how long the participants could tolerate delays. Terminal probes lasted either five min. or until the emission of challenging behavior. Terminal probes took place in play centers and followed the same format as baseline and post-session probes.

CHAPTER 3

RESULTS

The research questions addressed in this study were: 1) Does a MB-NDBI targeting delays to reinforcement reduce disruptive behavior for students with ASD during delays to preferred items? And 2) Do the effects of MB-NDBI targeting delays to reinforcement reduce challenging behavior in generalization settings? I graphed data following each session and used visual analysis (i.e., level, trend, variability, consistency, immediacy, and overlap) within and across tiers following the completion of the study to infer a functional relation between MB-NDBI and a decrease in challenging behavior during delays to reinforcement. Figure 1 shows the results for all three participants.

During baseline, Marvin exhibited high levels of challenging behavior in response to delayed access to preferred items, engaging in challenging behavior during 70% to 100% of trials (*M* = 90%). Following the introduction of MB-NDBI, Marvin demonstrated a decrease in challenging behavior that maintained at zero levels for most of the intervention (*M* = 11.82%). Generalization probes indicated successful tolerance for delays across untrained settings, behavior with no challenging behavior during probes (M = 0%). During terminal probes, Marvin tolerated five-minute delays to reinforcement without engaging in challenging behavior.

Leonard exhibited consistently high levels of challenging behavior during baseline (*M* = 95.71%). Following the introduction of MB-NDBI, challenging behavior decreased but remained variable (*M = 12.67%*). Despite the variability during intervention, generalization probes

demonstrated a decreasing trend in challenging behavior during probes in novel settings (*M* = 26.6%).

Henry exhibited high rates of challenging behavior during baseline, ranging from 70% to 100% (*M* = 95.71%). Following the introduction of MB-NDBI, Henry demonstrated an immediate decrease in the level of challenging behavior (*M* = 9%). Generalization probes showed consistent, low levels of challenging behavior in novel settings (*M* = 11%). Terminal probes indicated that Henry successfully tolerated five-minute delays without engaging in challenging behavior (*M* = 0%).

When analyzing data across tiers in the multiple baseline design, we observed a functional relation in which MB-NDBI decreased challenging behavior when access to preferred tangible items was delayed. Descriptively, we observed a functional relation between MB-NDBI and decreased challenging behavior when access to tangible items was delayed across generalized settings.

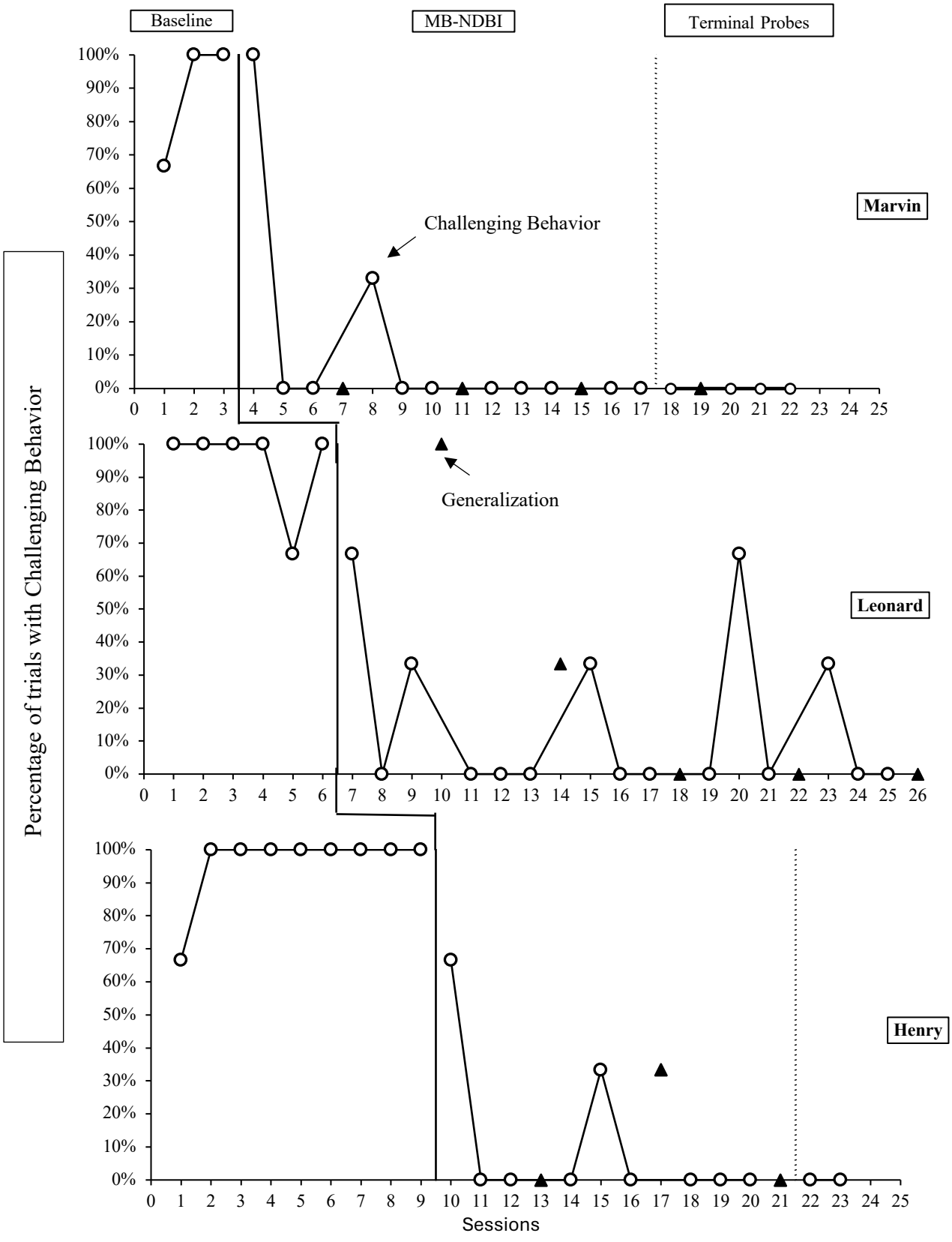

Baseline
MB-NDBI
Terminal Probes
Marvin
Challenging Behavior
Leonard
Generalization
Henry
Percentage of trials with Challenging Behavior
Sessions

Figure 1

Note. Figure 1 presents all participants' percentage of challenging behavior during probes.

CHAPTER 4

DISCUSSION

The purpose of this study was to evaluate the effects of MB-NDBI on the reduction of challenging behavior during delays to preferred items in preschool-aged children with autism spectrum disorder. The results of this study indicate MB-NDBI reduced challenging behavior during delays to reinforcement in young children with ASD. Across participants, high rates of challenging behavior were observed during baseline, followed by a decrease in challenging behavior after the introduction of MB-NDBI. By the end of intervention, all participants exhibited near-zero levels of challenging behavior during probes, suggesting participants' tolerance of delays improved across contexts.

The results of this study have two notable implications for clinical and educational practice. First, the findings provide initial evidence that music-based behavioral interventions can be used to enhance engagement and teach self-regulation skills. Music is a ubiquitous part of life that captures attention, provides structure, and offers a predictable and practical application for proving instruction and embedding opportunities for naturalistic learning, making it an ideal medium for increasing engagement in therapeutic and educational settings (Lense & Camarata, 2020). Furthermore, music is a readily available resource that is often already used within classrooms for instructional and leisure purposes (Brewer, 2012). Music can serve as a co-regulation tool, with music therapy research identifying music as a conduit for decreasing anxiety (de Witte et al., 2022; Foran, 2009). Second, embedding ABA interventions that focus on delay tolerance training, such as compound schedules, concurrent activities, and progressive

delay schedules, within naturalistic contexts may facilitate generalization and reduce prompt dependency. Rather than teaching tolerance for delay within highly structured settings, embedding opportunities for tolerance of delay into naturalistic settings, such as musical play, allows children to develop a learning history with waiting within a child-led and dynamic environment. This approach encourages children to apply waiting skills across various contexts and situations, thereby increasing the likelihood of spontaneous use without excessive prompting (Schreibman, 2015). Given the effectiveness of MB-NDBI in reducing challenging behavior, this approach may serve as a valuable addition to traditional ABA approaches to increasing tolerance of delay.

Limitations

Although the findings are promising, two limitations should also be considered. First, generalization probes were not conducted during baseline. Thus, I could not infer the presence or absence of functional relations between MB-NDBI and decreased challenging behavior in generalization settings. However, descriptive data showing either consistently low levels or a decreasing trend in challenging behavior during generalization probes relative to baseline levels suggesting an improvement in generalized tolerance of delays. Second, I used a nonconcurrent multiple baseline design, which may limit the ability to control for history threats (Kennedy, 2022). Historically, the nonconcurrent multiple baseline design was considered less rigorous than its concurrent alternative due to limited control of maturation, testing, and history threats to internal validity (e.g., Gast et al., 2018). Recently, researchers have revisited this design and argued these threats are well controlled for in the nonconcurrent design when (1) baseline phases

are temporally distinct (i.e., include different numbers of days), (2) baseline phases have substantially different numbers of sessions, and (3) phase changes across tiers occur on sufficiently offset calendar days (Slocum et al., 2022). In addition to meeting these considerations, I further increased the rigor of the nonconcurrent design in three ways, following Ledford & Zimmerman (2022) recommendations. First, I reported the results of all participants who met the inclusion criteria, reducing mortality threats. Second, I used a response-guided approach, which aligns with recommendations to balance methodological rigor with ethical considerations and maintain strong internal validity. Third, I explicitly reported using the nonconcurrent design and reported any concurrence during the study (see Appendix K).

Future Research Directions

The study included only three participants, limiting the generalizability of the results. Future research should replicate these findings to determine whether the effects of MB-NDBI are consistent across a broader population of young children with ASD. Additionally, long-term maintenance data were not collected, making it unclear whether tolerance for delay skills maintains over time without continued intervention. Future studies should examine whether the effects of MB-NDBI persist beyond the intervention period.

Furthermore, future research should focus on contexts in which MB-NDBI is most effective compared to other established interventions for increasing delay tolerance, such as contingency-based progressive delays and functional communication training. Researchers should examine how different settings, skill levels, and behaviors impact the success of MB-NDBI compared to other behavioral strategies. Additionally, future studies could examine the extent to which music-based interventions influence engagement and motivation in children with ASD, as increased engagement may contribute to the intervention's effectiveness.

Conclusions

This study provides preliminary evidence that a MB-NDBI reduces challenging behavior during delays to reinforcement in young children with ASD. Integrating structured musical activities within an NDBI framework represents a promising and engaging approach to teaching waiting skills. Given the importance of tolerance for delay in social and academic settings, music-based behavioral interventions may offer a valuable addition to early intervention programs for children with ASD. Future research should continue to explore the long-term effectiveness and generalizability of MB-NDBI by replicating the intervention across a larger and more diverse group of children.

REFERENCES

Abalde, B., Lense, M. D., Keller, P. E., & Novembre, G. (2024). A framework for joint music making: Integrating behavioral, neural, and computational perspectives. *Psychological Bulletin.* https://doi.org/10.1037/bul0000419

Alpern, G. D. (2020). *Developmental Profile 4*. Western Psychological Services.

American Music Therapy Association. (2015). American Music Therapy Association.

Brewer, B. C. (2012). *Music and learning: Integrating music in the classroom.* Johns Hopkins School of Education

de Witte, M., da Silva Pinho, A., Stams, G.-J., Moonen, X., Bos, A. E. R., & van Hooren, S. (2020). Music therapy for stress reduction: A systematic review and meta-analysis. *Health Psychology Review, 15*(2), 134–159. https://doi.org/10.1080/17437199.2020.1846580

Dixon, M. R., Rehfeldt, R. A., & Randich, L. (2003). The influence of a concurrent activity on perseveration during delay reinforcement. *The Psychological Record, 53*(4), 561–570. https://doi.org/10.1007/BF03395446

Foran, L. M. (2009). Listening to music: Helping children regulate their emotions and improve learning in the classroom. *Educational Horizons*, 88(1) 51-58.

Frost, L., & Bondy, A. (2002). *The picture exchange communication system training manual* (2nd ed.). Pyramid Educational Products, Incorporated.

Gast, D. L., Lloyd, B. P., & Ledford, J. R. (2018). Multiple baseline and multiple probe designs. In J. R. Ledford & D. L. Gast (Eds.), *Single case research methodology:*

Applications in special education and behavioral sciences (pp. 288–335). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315150666

Ghaemmaghami, M., Hanley, G. P., & Jessel, J. (2016). Contingencies promote delay tolerance. *Journal of Applied Behavior Analysis, 49*(3), 548–575. https://doi.org/10.1002/jaba.333

Hagopian L. P., Boelter E. W., Jarmolowicz D. P. (2011). Reinforcement schedule thinning following functional communication training: Review and recommendations. *Behavior Analysis in Practice*, 4(1), 4–16. https://doi.org/10.1007/bf03391770

Hanley, G. P., Jin, C. S., Vanselow, N. R., & Hanratty, L. A. (2014). Producing meaningful improvements in problem behavior of children with autism via synthesized analyses and treatments. *Journal of Applied Behavior Analysis, 47*(1), 16–36. https://doi.org/10.1002/jaba.106

Ledford, J. R., & Zimmerman, K. N. (2022). Rethinking rigor in multiple baseline and multiple probe designs. *Remedial and Special Education, 44*(2), 154–167. https://doi.org/10.1177/07419325221102539

Lee, S. (2014). Teaching Delayed Gratification: Reducing Temper Tantrums of Children with Autism Spectrum Disorders after Functional Communication Training.

Lense, M. D., & Camarata, S. (2020). PRESS-Play: Musical engagement as a motivating platform for social interaction and social play in young children with ASD. *Music Science, 3*, 1–20. https://doi.org/10.1177/2059204320933080

Newcomb, E. T., & Hagopian, L. P. (2018). Treatment of severe problem behavior in children with autism spectrum disorder and intellectual disabilities. *International Review of*

Psychiatry, 30(1), 96–109. https://doi.org/10.1080/09540261.2018.1435513

Parsons M. B., Rollyson J. H., Reid D. H. Evidence-based staff training: A guide for practitioners. Behavior Analysis in Practice. 2012;5:2–11. doi: 10.1007/BF03391819.

Robison, M. A., Mann, T. B., & Ingvarsson, E. T. (2019). Life skills instruction for children with developmental disabilities. *Journal of Applied Behavior Analysis*, *53*(1), 431–448. https://doi.org/10.1002/jaba.602

Romero-Ayuso, D., Espinosa-García, B., Gómez-Marín, E., Gómez-Jara, N., Cuevas-Delgado, C., Álvarez-Benítez, I., & Triviño-Juárez, J. M. (2022). A Pilot Study of Improving Self-Regulation and Social Interaction with Peers: An "Exciting School". *Children (Basel, Switzerland)*, *9*(6), 829. https://doi.org/10.3390/children9060829

Rung, J. M. & Young, M. E. (2015). Learning to wait for more likely or just more: greater tolerance to delays of reward with increasingly longer delays. *Journal of the Experimental Analysis of Behavior,* 103, 108-124.

Schreibman, L., Dawson, G., Stahmer, A. C., Landa, R., Rogers, S. J., McGee, G. G., & Halladay, A. (2015). Naturalistic Developmental Behavioral Interventions: Empirically validated treatments for autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(8), 2411–2428. https://doi.org/10.1007/s10803-015-2407-8

Slocum, T. A., Pinkelman, S. E., Joslyn, P. R., & Nichols, B. (2022). Threats to internal validity in multiple-baseline design variations. *Perspectives on Behavior Science.* https://doi.org/10.1007/s40614-022-00326-1

Snyder, S. K., Herrod, J. L., Whiteside, E. E., & Ayres, K. M. (2024). Functional communication training including discrimination and tolerance to denial for elementary-age students with

autism. *Focus on Autism and Other Developmental Disabilities, 39*(3), 163–174. https://doi.org/10.1177/10883576231223154

Sundberg, M.L. (2008) VB-MAPPVerbal Behavior Milestones Assessment and Placement Program: A Language and Social Skills Assessment Program for Children with Autism or Other Developmental Disabilities. Guide, AVB Press.

Sze, S., & Yu, S. (2004). *Educational benefits of music in an inclusive classroom.* Niagara University. ERIC. https://files.eric.ed.gov/fulltext/ED490348.pdf

Torelli, J. N., & Pickren, S. E. (2023). Using chained or tandem schedules with functional communication training: A systematic review. Behavior Modification, 47(1), 185–218. https://doi.org/10.1177/01454455221077420

APPENDIX

Appendix A

Participant Behavior Definitions

	Behavior Definitions	
Disruption		
1	Tantrums	Any instance in which the student is crying or whining after the removal of an item or engages in one or more of the behaviors listed below, accompanied by crying and whining.
2	Throwing/ Swiping	Any instance in which the student holds an item in one or both hands and releases the item through the air a distance of 3 inches or greater so that it lands more than 12 inches from another person or removes work materials form a reachable position of the teacher outside of appropriate toy play.
3	Grabbing	Any instance in which the student removes and item from another student and/or takes an item not currently within their possession
4	Drop/Flop	Any instance or attempt where the student's body goes from a standing or seated position to the floor when not instructed to do so.
Aggression		
5	Biting	Any instance or attempt where the students mouth opens and closes around another person's body.
6	Hitting	Any instance or attempt student's hand (open or closed fist) or foot comes into contact with another person from a distance of 3" or more.
7	Scratching	Any instance in which the student's nail comes into contact with another person.
8	Grabbing/ Pinching	Any instance in which the students hands/fingers open and close around another person's skin/body part
Self Injury		

9	Head to Surface	Any instance in which the students head comes into contact with a surface other than another person from a distance of 3 inches or more.
10	Hand to Head	Any instance in which the students open/ or closed hand comes into contact with their head from a distance of 3 inches or more
11	Self-Biting	Any instance in which the student's mouth opens and closes around ones own body.
Eloping		
12	Eloping	Any instance in which the student moves within 3 feet of the music area

Appendix B

Participant Characteristic's Chart

Table 1

Participant characteristics				VB-Mapp				DP-4		
Participant	**Age**	**Race/ Ethnicity**	**Diagnosis**	**Topographies of behavior**	**Milestones**	**Barriers**	**ESSA**	**Cognitive**	**adaptive**	**PSL-%**
Marvin	3.5	Black	ASD, speech impairment	Screaming/ crying, aggression (hitting, biting) Disruption, Elopement	9	81	0	n/a	n/a	n/a
Lenord	5	Black	ASD, speech impairment	Aggression (Hiting, biting, grabbing), self-injury (head to surface, hand to head, self-bite)	14	67	0	40	57	50
Henry	3.5	Mixed-Race	ASD, speech impairment	Screaming/ crying, aggression (hitting, biting), Elopement	22.5	36	1	n/a	n/a	n/a

Note: DP-4=Developmental Profile 4th edition; VM-MAPP=Verbal Behavior Milestones and Placement Program; EESA= Early echoic skills assessment

Appendix C

Summary of Probe Trials

Tolerance for Delay Probes		
Evocative Situation	A student is engaged in a preferred item or activity (i.e.: the leap frog game or letters). A teacher or peer requests a turn with the item. The teacher removes the item stating, "My turn" and indicates the item is no longer available.	
Target Response	The student waits for 30-90 seconds when the delay is imposed without engaging in problem behavior.	
Consequence	<u>Correct response</u> After waiting for designated time without problem behavior, the therapist return the item to the student. Teacher statement: "You can have [the item] back."	<u>Incorrect Response</u> If student engages in problem behavior, the teacher will return the item to the student, contingent on the PBx. Teacher statement: "You can have [the item] back."

Appendix D

Probe Data Sheets

Tolerance for Delay Probe Data Collection Form

Student:		Data collector name:
Date:		Prim/Reli:

Directions: For each trial, mark + for correct response, – for error. In addition, write PB if problem behavior occurs. Mark / when trial 3 is not presented (first two are both correct or incorrect). Highlight or circle disagreements on reliability form.

Phase (circle one)		Baseline / Post-Session / Follow-up/ Generalization			Baseline / Post-Session / Follow-up/ Generalization			Baseline / Post-Session / Follow-up/ Generalization			Baseline / Post-Session / Follow-up/ Generalization		
		1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Location		**Play**	**Recess**	**Other preferred location**	**Play**	**Recess**	**Other preferred location**	**Play**	**Recess**	**Other preferred location**	**Play**	**Recess**	**Other preferred location**
Trial	1												
	2												
	3												
Accuracy (correct / opps.)													
IOA by unit (agree / opps)													
Overall IOA (total agree / total opps x 100%)													

Appendix E

Probe Procedural Fidelity Form

Hellemn Thesis Last updated 08/27/2024

Procedural Fidelity Form
Baseline and Probes

Instructions: Check whether the therapist correctly (+) or incorrectly (-) implemented the given procedure for each trial.

Student:	**Date:**
Data collector:	Prim / Reli (circle one)

Location:		**Date:**		
Condition:	Baseline	Post Session Probe	Generalization	Follow-Up

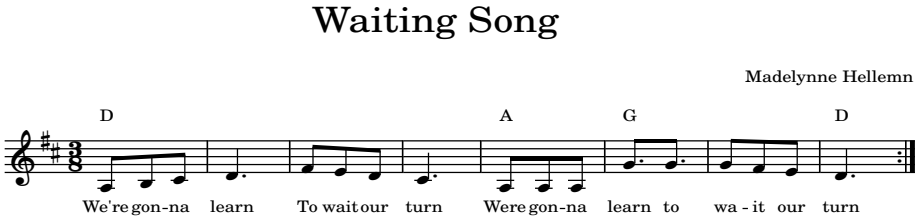
Trial	**1**		**2**		**3**		
	Correct	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**N/A**
Correct evocative situation							
No prompt delivered							
Correct consequence(s) delivery							
Correct delivery of 3rd trial (1 of 2 trials correct)							
Probe PF score = (yes)/(yes + no) x 100							

Location:		**Date:**		
Condition:	Baseline	Post Session Probe	Generalization	Follow-Up

Trial	**1**		**2**		**3**		
	Correct	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**N/A**
Correct evocative situation							
No prompt delivered							
Correct consequence(s) delivery							
Correct delivery of 3rd trial (1 of 2 trials correct)							
Probe PF score = (yes)/(yes + no) x 100							

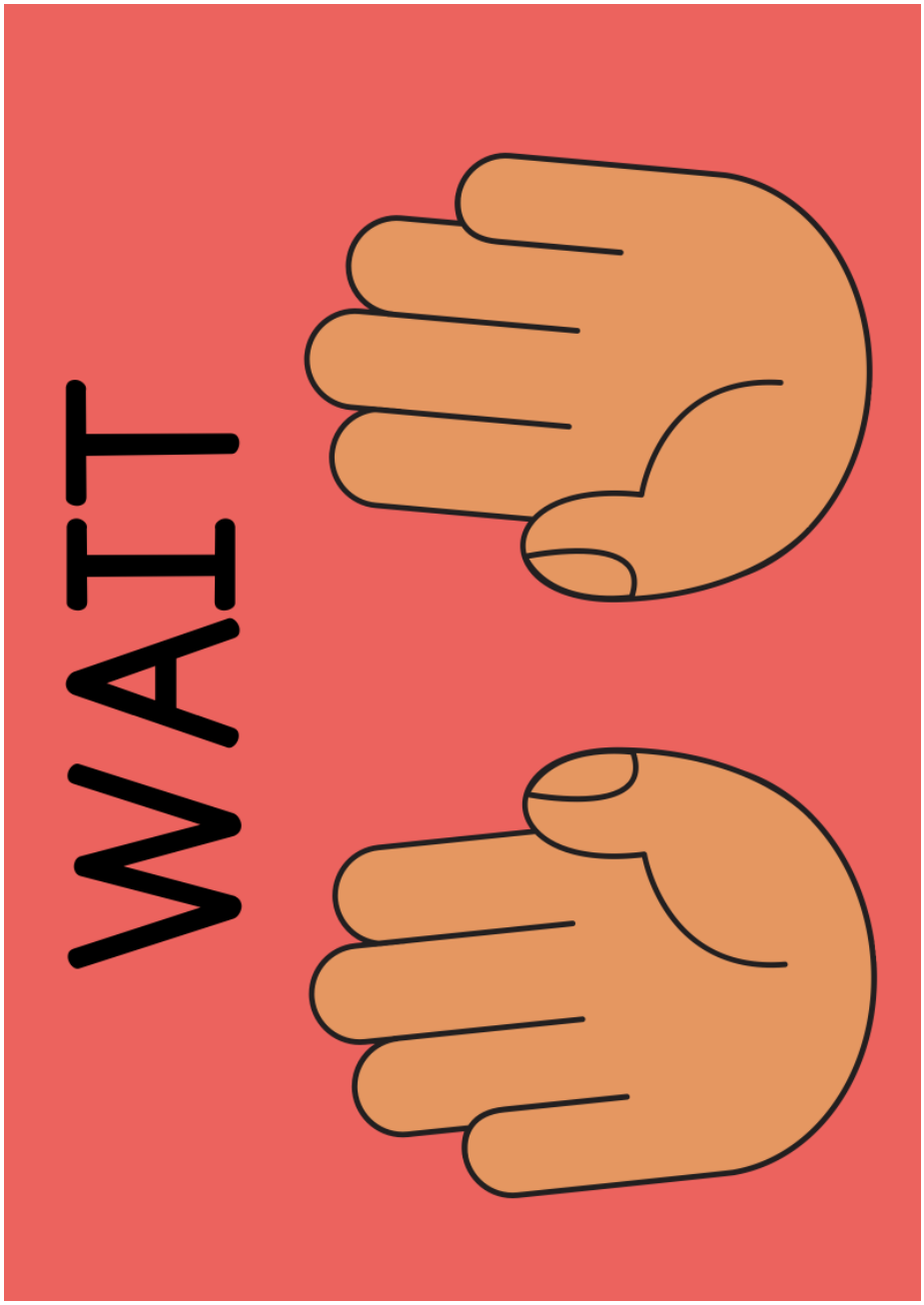
Appendix F

Waiting Song Score



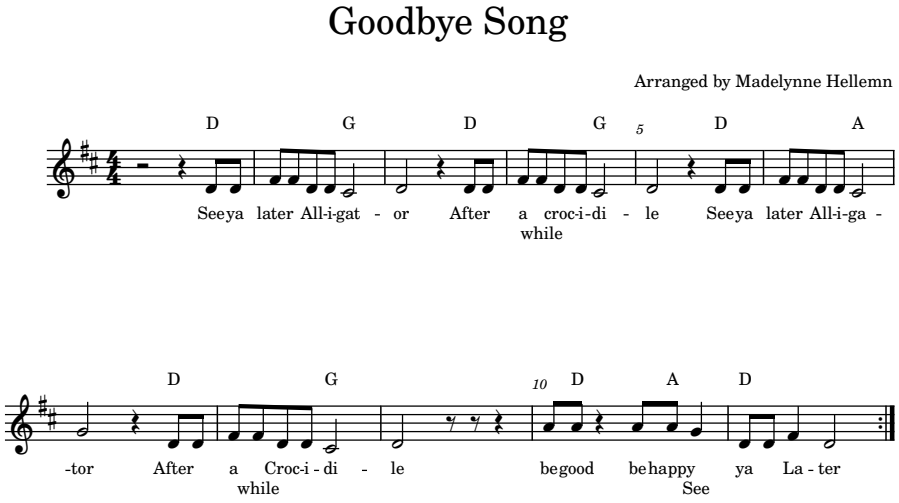
Appendix G

Waiting Visual



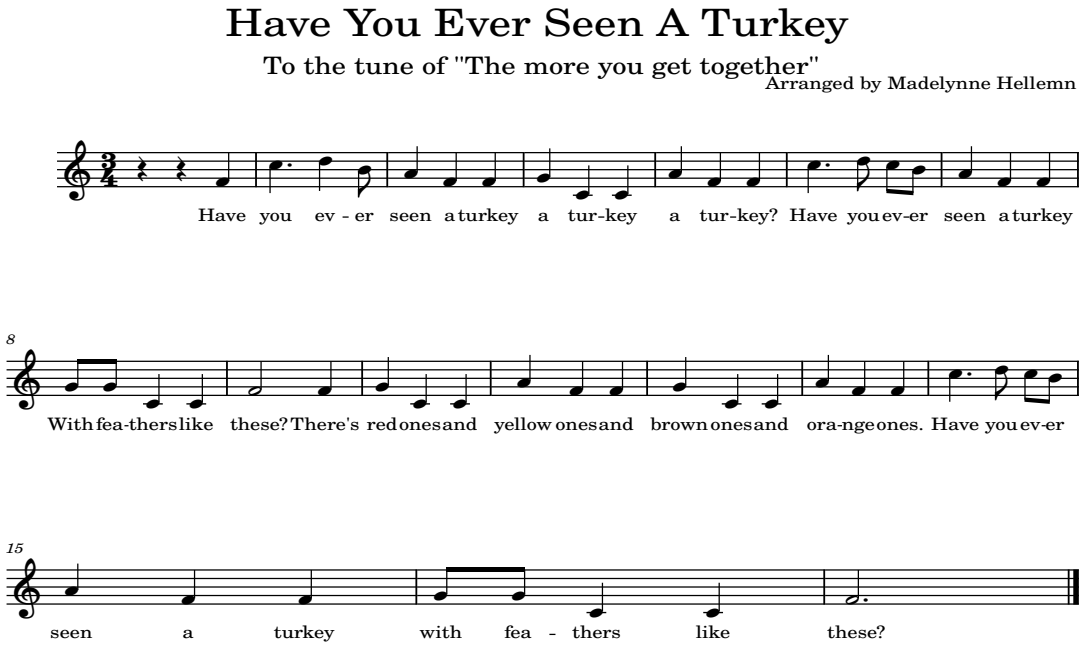
Appendix H

Goodbye Song Score



Appendix I

Other Scores



Appendix J

List of Songs Used During MB-NDBI Sessions

MB-NDBI Teaching Trial songs	
Musical Movement	
Song	Composer/Original Source
Hawaiian Rollercoaster Ride	Alan Silversrti and Mark Keali'I Ho'omalu
Down by the Bay	Traditional Childrens Song
I Want Candy	The Strangeloves (1965)
Fruit Salad salsa	Laurie Berkner
Trepak	P. Tchaikovsky
Colors of the Wind	Alan Menken and Stephen Schwartz
Sleigh Ride	Leroy Anderson (1948)
All I Want is You	Barry Louis Polisar
Musical Story	
Five little monkeys	Traditional Childrens Song
Five little pumpkins	Traditional Childrens Song
Five little speckled frogs	Traditional Childrens Song
Have you ever seen a turkey?	Traditional Childrens Song
Down by the Bay	Traditional Childrens Song
Instrument Improvisation	
I've got a beat	Original
Prelude in C major	J.S. Bach
Baby Music	Junior Enstien
Mazurka in C major- Dang Thai Son	F. Chopin
It's You I Like	Fred Rogers
The nutcracker, Op. 71: I. Overture	P. Tchaikovsky
Little Drummer Boy (instrumental)	Katherine Kennicott Davis
Witch's Brew	Derek Fiechter

Appendix H

Non-Concurrent graph