The Impact of Music Therapy on Language Acquisition in Children with Nonverbal Autism

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A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2023

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial fulfillment of the requirements for graduation from the Honors Program of Liberty University.

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Abstract

Through an experimental method, the researcher investigated whether children with autism spectrum disorder (ASD) are more likely to develop verbal communication skills after consistent exposure to songs with lyrics. Six children with nonverbal ASD were exposed to the same song with lyrics, with the goal of increased vocalization and language acquisition. Over nine sessions, subjects were pulled to participate in the experiment. The researcher played the song for the participants, recording the responses from each trial and categorizing them as either full words, verbal approximations, or miscellaneous verbalizations. The findings of the study suggest that there is a relationship between music and language acquisition in children with nonverbal autism spectrum disorder.

The Impact of Music Therapy on Language Acquisition

in Children with Nonverbal Autism

Autism spectrum disorder (ASD) is a complex developmental disorder involving a broad range of characteristics including difficulties with social interactions, repetitive behaviors, and communication. According to the National Autism Association (2020), an estimated 40% of individuals diagnosed with autism have nonspeaking or nonverbal autism, meaning that they either do not talk, or say only a few words. This can pose issues in that some can struggle to effectively communicate their needs to others and often experience social deficits.

Through an experimental method, the researcher investigated whether children with ASD are more likely to develop verbal communication skills after consistent exposure to songs with lyrics. The purpose of the study is to attempt to bridge the gap of the communication deficit in children with nonverbal autism, using a form of music therapy. Music has become a common therapeutic tool for both neurotypical and neurodivergent people but has been found to be of particularly good use to individuals with ASD. A connection between music and language acquisition in children with nonverbal autism could significantly impact the way neurodivergent children are taught to speak. Music therapy would be simple to administer in most any setting—at school, a behavioral therapy clinic, or at home—and could be readily available to people of various social, cultural, and economic demographics.

For the purposes of this experiment, each child over the age of two years, with a formal autism diagnosis, who did not functionally speak or use consistent verbal communication was considered to have nonverbal autism. The process of language acquisition is extensive. In this

study, consistent exposure is defined as each participant being subjected to the same song in every trial, for the entirety of the study.

Music and Language Acquisition

To investigate the effect of short-term musical training on the development of neural and linguistic communication skills, Carpentier et al. (2016) conducted research. The findings of the study suggest that musical training can cause improvements in neural processing in the regions of the brain that are used for linguistic processing and making music. They also noted that musical training might help to develop the neural networks used for auditory processing, working memory, and attention, which are all necessary to develop to improve upon linguistic and communication skills. The results of this study are beneficial in that they suggest that music can be used to develop language and communication skills, but it would be beneficial to expand upon this research by investigating music as a language acquisition device for alternate populations, such as children with nonverbal ASD.

Similar research was conducted by Brandt et al. (2012), who also investigated the relationship between music and the development of language, but they did so specifically in relation to early childhood development. The authors noted a growing interest in the potential for music training to contribute to cognitive development, but more specifically, language skills. They addressed the positive correlations between music and phonological awareness, vocabulary, and the ability to read, discussing that exposure to music might contribute to the development of the neural systems used to process language. Ultimately, the researchers suggested that musical training can positively impact the linguistic development of young children and would likely be a valuable tool to aid in this process. This article shares the

potential benefits to of music to linguistic development but does not reference a specific process through which linguistic progress can be made, nor does it reference neurodivergent populations. As with the previous study, it would be beneficial to conduct further research to test the best specific music therapy process, and to include neurodivergent populations.

In a comparable study, Cohrdes et al. (2016) aimed to investigate the connection between music and language, proposing that the first likely influenced the development of the latter. Unlike other research, a specific population of children was not sampled, and memory was not discussed in detail. However, the authors noted that because both music and language are forms of human communication, they share several cognitive processes. The results of the study found that these cognitive processes related to music can be used to encourage the development of language skills. This is due to the neural networks that are shared between music and language. While the implications of this study shared with the forementioned research the suggestion that music could be used to encourage the development of language skills, further research could be conducted to determine whether this would be applicable to children with nonverbal ASD.

The work of Fritz et al. (2019) served a parallel function, aiming to investigate the effect of musical meaning on the acquisition of words in adults. Unlike in other studies, researchers used functional magnetic resonance imaging to measure the brain activity of participants as they listened to novel words that were paired with either musical or environmental sounds. The results of the study found that when additional musical meaning was added to the novel words presented, there was greater functioning in the linguistic regions of the brain, which suggests that music may help the language acquisition process. The authors added that this relationship was likely mediated by the brain's language processing network. While this research was conducted

specifically in reference to speaking adults, its implications might suggest that exposure to music could have the potential to enhance the language development process in early years. This research could be expanded upon by investigating this relationship in the context of children with nonverbal ASD.

The Clark-and-Pass processing approach was examined by Lakshmanan and Graham (2016), who investigated information processing within human cognition. While their research was broader in its approach than the aforementioned studies, investigators similarly sought whether music and language acquisition could aid in the generalization of this method. Ultimately, the findings of the study suggest that the Clark-and-Pass processing approach can be used to explore human cognition in the context of language acquisition and music. This means that this method can be applied to use music to help develop linguistic skills. The implications of this study are significant in that they suggest that music can be used as a language acquisition device, but this study could be expanded upon by considering alternative methods and applying them to more unique populations, such as that of children with nonverbal ASD.

Extensive research has been conducted, suggesting a relationship between music therapy and the development of linguistic communication skills, but there exists a lack of literature applying this to children with nonverbal autism spectrum disorder. The researcher hypothesized that after nine sessions of exposure to music with lyrics, children with nonverbal ASD would display an increase in verbal communication.

Music and Autism Spectrum Disorder

A culmination of research involving music therapy in children with ASD was studied by Vaiouli and Andreou (2017), and while their findings suggest that there are connections between

children's participation in musical activities and the development of their social behavior and language, all this research was conducted in a theoretical sense. Psychologists have yet to apply these concepts and perform experimental research on children with ASD to test this theoretical connection. It would be beneficial to the future of the language acquisition process and behavioral therapy as a whole, to conduct further research and determine whether music can be used to develop more effective verbal communication in children with nonverbal ASD.

Likewise, in a study conducted by Blank (2019), the researcher investigated the use of music therapy as treatment for children with autism spectrum disorder, specifically during early childhood years. The results of the study suggest that music therapy tends to have a positive impact on several developmental processes in children with ASD. More specifically, the participants showed progress toward goals of social interaction, communication, and behavioral regulation. This study showed that music can be a beneficial and potentially therapeutic tool for children with ASD, even regarding communication, but there is a lack of research supporting this being applied specifically children with nonverbal ASD. It would be beneficial to investigate whether music possesses the same capability to increase the functionality of communication in this way within a more niche population.

The impact of music therapy on children with autism spectrum disorder was investigated by Broder-Fingert et al. (2017). Similar to the forementioned researchers, they found several positive effects on various developmental aspects such as social skills, behavior modification, and communication. They noted that this was likely due to the ability of music therapy to engage several areas of the brain which involve emotional and social processing, which are often at a deficit in individuals with ASD. Although this study found that music therapy can aid in the

development of social and emotional processing in children with ASD, this research could be expanded upon by investigating, more specifically, the impact of music therapy on children with nonverbal ASD.

Researchers analyzed the effectiveness of music therapy on individuals with various mental health conditions, including autism spectrum disorder (ASD), depression, insomnia, dementia, and schizophrenia, in Gassner and Mayer-Ferbas (2021). Like in the previously mentioned studies, the authors found that music therapy can be used as an excellent intervention for those with ASD as it provided a positive impact on social interactions, sleep quality, mood, and communication. The implications of this research suggest that music could be used to aid in the linguistic development of children with autism spectrum disorder. This article does not, however, include individuals who were classified as nonverbal. This distinction could provide important information in future research.

The effectiveness of improvisational music therapy in children with ASD was investigated by Geretseggar et al. (2012). More specifically, this work sought to discover whether music therapy would have an impact on the social and communicative skills of children with this diagnosis. The study utilized a control group who did not receive exposure to music therapy and compared their social and communication skills to those who received it. The findings of the study suggest that music therapy can positively impact the social and communicative skills on children with autism spectrum disorder. It would be beneficial to see whether these results are also applicable to those with ASD who are nonverbal.

The greatest gap in the literature is the application of experimental research connecting the concept of music therapy to the language acquisition of children with autism spectrum

disorder. While music therapy has been commonly utilized while working with children with ASD, it has not been used specifically to aid in the language acquisition process.

Implications

This study attempted to bridge the gap displayed by the communication deficit in children with nonverbal autism, using children's music with lyrics. The researcher aimed to discover whether after being exposed to music with lyrics, children with nonverbal autism are more likely to develop verbal communication skills. Knowledge of this could significantly impact the way neurodivergent children are taught to speak.

Method

Participants

The participants consisted of children between the ages of 2 and 12 with autism spectrum disorder (ASD) who previously received a "nonverbal" label from a psychiatrist. None of the subjects had recorded prior experience with music therapy, as to limit extraneous variables. Participants were recruited from ABA Results, a behavioral therapy center in southwest Florida, after being identified by the program director as meeting the criteria for the study and each receiving a recruitment letter and parental consent form. For the purpose of confidentiality, their names have been omitted from this study and were replaced with pseudonyms.

Jake was a two-year-old with ASD, who had been receiving applied behavior analysis (ABA) services for nine months. He had prior experience receiving therapy from the researcher and began pairing with her approximately three months prior to the start of research. He had no known exposure to music as a therapeutic tool, but his primary registered behavior technician (RBT), articulated his affinity for music. A previous preference assessment completed by Jake's

Board-Certified Behavior Analyst (BCBA), noted no tangible preferred items to be used as reinforcers. Throughout the course of the study, the researcher used verbal praise as positive reinforcement for verbalizations.

Rachel was a three-year-old with ASD, who began receiving ABA services for approximately one year at the time of the study. While the participant was familiar with the researcher before the start of the research period, she had little experience working with her directly, and had not yet paired with her at the start of the study. The client had no known exposure to music therapy, nor a noted affinity for music as a preferred item. The participant's RBT articulated that she exhibited a pattern of noncompliance and often engaged in elopement when seeking the function of escape from an undesired task, noting that her preference assessment found an affinity for food toys. The researcher used the Premack principle of, "First music, then food toys," to encourage the compliance of the child, then provided her access to food toys as positive reinforcement for verbalizations.

Robert was a three-year-old with ASD, who at the start of research, had been receiving ABA services for eighteen months. The child was a current client of the researcher, had previously paired with her, and therefore possessed a noteworthy level of comfortability. The client had no known experience with music therapy, nor an affinity for music as a preferred item. A previous preference assessment completed by his BCBA listed bubbles and verbal praise as preferred items, and both were used for the duration of the study as positive reinforcement for verbalizations made.

Max was a seven-year-old with ASD who had been receiving ABA services for two years prior to the start of research. At this time, the child was familiar with the researcher, but had not

previously worked directly with her as a client and had not yet paired with her. The participant had no known previous experience with music therapy, nor a noted affinity for music. His previous preference assessment listed dinosaur toys as preferred items, and his RBT advocated that he exhibited a pattern of noncompliance and often engaged in elopement when seeking to escape from a nonpreferred task. The researcher used the Premack principle to articulate to the child that he would receive access to the dinosaur toys as reinforcement for complying with the task of verbalization.

Oscar was a seven-year-old with ASD who had been receiving ABA services for four years prior to the beginning of the study. He had previous experience as the researcher's client and had developed a level of comfortability working with her through the pairing process. The participant had no known experience with music therapy. Because the participant's previous preference assessment listed a specific song as a preferred item, the researcher used the Premack principle to express to the client that he could listen to his *Madagascar* song after he complied with the task of verbalizing along with the researcher's music.

Zealand was a two-year-old with ASD who had been receiving ABA services for six weeks prior to the start of the study. He had no previous experience with the researcher and had not yet paired with her when research began. The client had no known exposure to music therapy, nor a known affinity for music as a preferred item. His RBT advocated that he often exhibited a pattern of noncompliance, engaging in elopement when seeking to escape from a nonpreferred task. Knowing this, the researcher used the Premack principle to articulate to the child that he would receive access to a break as positive reinforcement for compliance with the task of verbalization.

Materials

The materials necessary for this experiment were a paper and pencil for data collection, and a laptop computer that contained the selected song with lyrics to play for the participants. To limit confounding variables, the same song was used for each trial and across participants for the duration of the study. *Cocomelon's* The Wheels on the Bus was selected, as it contained repetitive sounds and short words that the researcher suggested would be beneficial for the participants to attempt to emulate. For the participants whose RBT had previously specified a preferred item for which he or she worked well, the researcher also brought this material to be used as positive reinforcement for that child. These additional items included food toys, bubbles, dinosaur toys, and *Madagascar* music, respectively.

Procedure

In this experiment, six children with nonverbal ASD were exposed to a children's song with lyrics in an effort to encourage the language acquisition process by supporting utterances and the formation of spoken words. The experiment took place over a fixed period of three weeks, and the number of sessions was selected to reflect this amount of time. Nine total sessions were completed, three per week for three weeks, to give the participants time to be exposed to new language through music, then be given a day to resonate on the new information, and then to be exposed to this language once again.

In the week prior to the beginning of the study, the researcher set aside approximately 30 minutes per participant for five days, to pair with each one individually. At the end of the week, participants were each given a baseline assessment which involved the researcher playing the designated song with lyrics for each child one time while written recording any audible reactions

of the participants. The purpose of this baseline methodology was to observe the participants' initial reactions to the song, without having received verbal or physical prompting from the researcher, or any positive reinforcement for audible reactions. The researcher documented any voicings made by the child, classifying each under one of three categories: full words, verbal approximations, or verbalizations. Data recorded under the category of full words was comprised of the entirely correct pronunciation of all syllables within a word. Verbal approximations included markers which were rough estimations of parts of a word. Verbalizations involved any babbling or guttural sounds made which did not recognizably resemble any word. The data was recorded by hand both qualitatively, with the specific utterances quoted, and quantitatively, with the number of utterances within each category listed. These baseline results served as the foundation for the rest of the study.

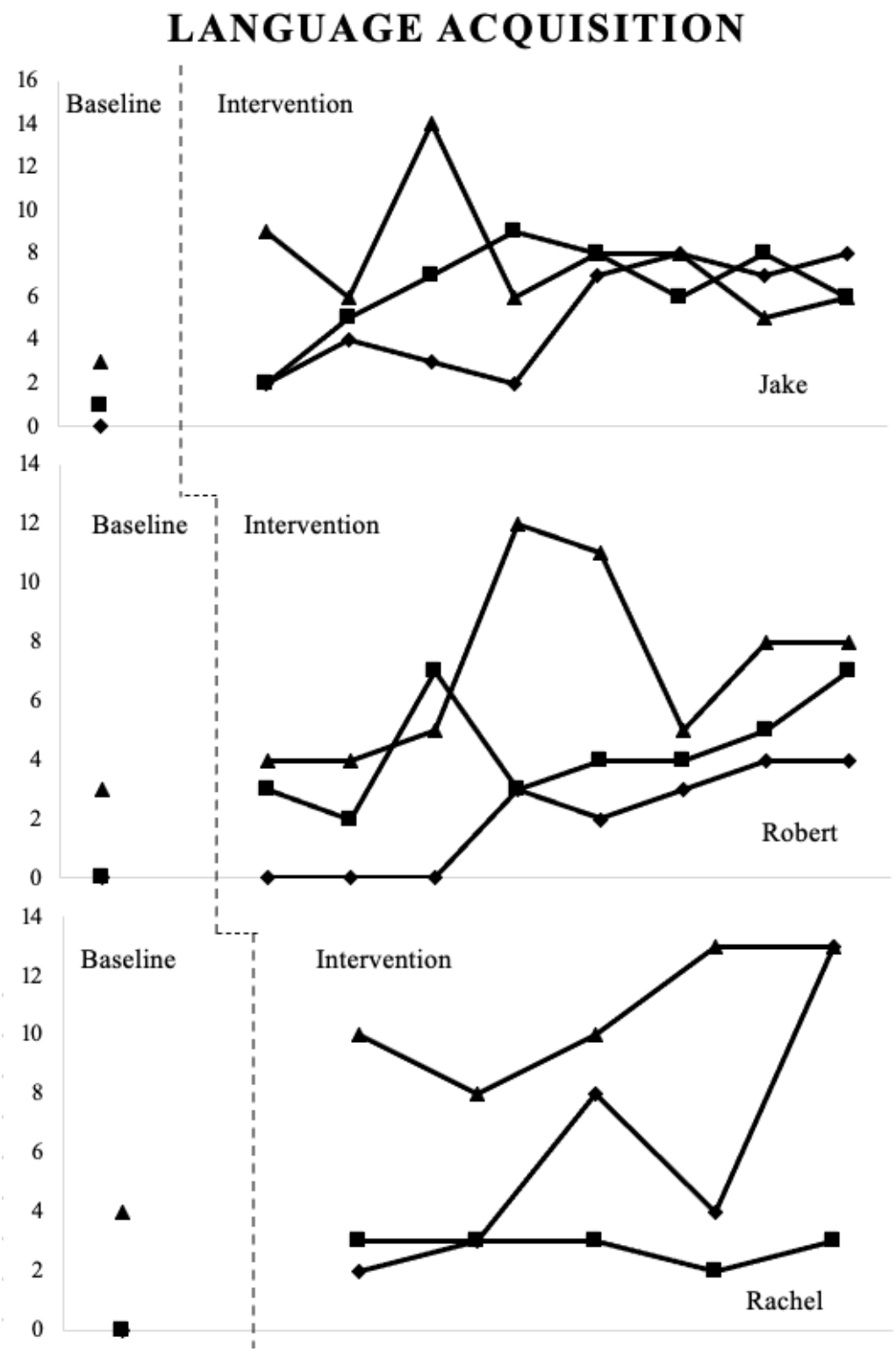
After the baseline assessment was completed, the researcher surveyed the registered behavior technicians (RBTs) who acted as each of the participants' primary behavioral therapists, about general demographics of the children and other pertinent information. The researcher recorded responses regarding the age of each one, the length of time he or she had been receiving ABA services prior to the start of the study, whether the participant had a known affinity for music, whether he or she exhibited a pattern of maladaptive or noncompliant behaviors that should be noted, and whether a prior preference assessment had revealed a preferred item to be used as positive reinforcement, and if so, what was the item.

During nine sessions, over the span of three weeks, subjects were tested once per day, three days per week. Some participants completed fewer trials due to illness or absence. During each trial, the researcher played the designated song with lyrics for the participant once. Each

time, the participant was encouraged to clap and sing along. At the end of the daily trial, after the music commenced, the researcher sang a few lyrics of the song without the music and paused for a moment, verbally prompting the child to finish the lyrics. The researcher then recorded any utterances made by the child during the trial, both while the music was being played and after. The recorded vocalizations were classified under the same three categories as above: full words, verbal approximations, and verbalizations. As in the baseline procedure, both quantitative and qualitative data was recorded for every category during each trial. Each time the participant made a vocalization, the researcher used verbal praise and that participant's specified preferred item as positive reinforcement. If the vocalization was made while the music was playing, the researcher would pause the music, give the client 10 seconds of access to their preferred item or activity, then resume the music. If the vocalization was made after the music had commenced, the participant would still receive 10 seconds of positive reinforcement, and then the researcher would resume the verbal prompting process.

Results

After the three weeks of the study commenced, the researcher reviewed the quantitative data, taking note of the specific fully spoken words, verbal approximations, and verbalizations made by each participant during each trial, as well as the number of utterances in each of the three categories.


LANGUAGE ACQUISITION
Baseline
Intervention
Jake
Baseline
Intervention
Robert
Baseline
Intervention
Rachel

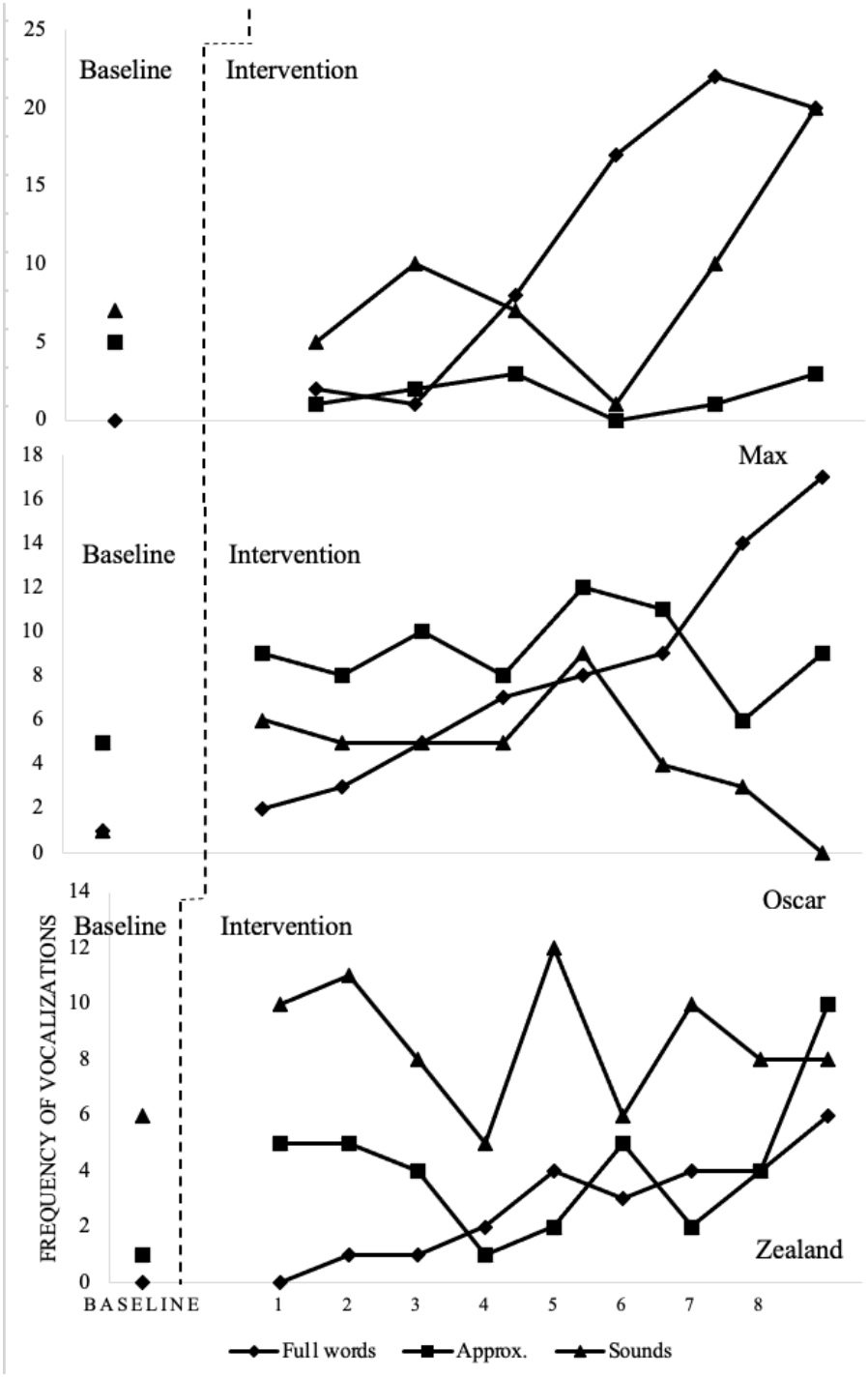


Figure 1

Number of Utterances of Each Verbal Category by Trial

The number of full words spoken by Jake increased from 0 during baseline testing, to 4 during trial two, then decreased to 2 in trial five, and then increased to a maximum of 8 during the eighth trial. The number of verbal approximations emitted by the same participant increased steadily from 1 during the baseline, to a maximum of 9 during the fourth trial, then decreased to 6 during the sixth trial, then increased to 8 during the seventh trial, and decreased to 6 during the eighth trial. The verbalizations fluctuated as they increased from 3 during the baseline to 9 during the first trial, then decreased to 6 during the second trial, then increased to a maximum of 14 in the third trial, then decreased to 6 in the fourth trial, then increased to 8 in the sixth trial, then decreased to 5 in the seventh trial, then increased to 6 in the eighth trial.

The number of full words spoken by Rachel increased from 0 during baseline testing to 8 during the third trial, then decreased to 4 during the fourth trial, and increased to a maximum value of 13 during the fifth trial. The number of verbal approximations emitted by the subject increased from 0 during the baseline to 3 during trial 1, remaining consistent until trial three, then decreasing to 2 during trial four, and increasing to 3 by trial five. The number of verbalizations emitted increased from 4 during her baseline testing to 10 during trial one, then decreased to 8 during trial two, then increased to a maximum of 13 during trials four and five.

The number of full words spoken by Robert remained consistently at 0 from the baseline to trial three, then increased to 3 during the fourth trial, decreased to 2 during the fifth trial, and increased to a maximum of 4 during trials seven and eight. The number of verbal approximations fluctuated, but ultimately increased from 0 during baseline testing, to 3 during trial one, then decreased to 2 during the second trial, then increased to 7 during the third trial, decreased to 3

during the fourth trial, and steadily increased to a maximum value of 7 by the eighth trial. The number of verbalizations increased from 3 during the baseline to a maximum value of 12 during the fourth trial, then decreased to 5 during the sixth trial, and increased to 8 during the seventh and eighth trials.

The number of full words spoken by Max increased from 0 during the baseline trial to 2 during trial one, then decreased to 1 during trial two, then steadily increased to a maximum value of 22 by trial five and decreased to 20 during the sixth trial. The number of verbal approximations decreased from 5 during the benchmark testing to 1 at trial one, then increased to 3 by the third trial, decreased to 0 during the fourth trial, then increasing to 3 by the sixth trial. The number of verbalizations decreased from 7 during baseline testing to 5 during trial one, then increased to 10 during trial two, decreased to 1 during trial four, then steadily increased to a maximum value of 20 by trial six.

The number of full words spoken by Oscar steadily increased from 1 during baseline testing to 9 by trial six, then again to a maximum value of 17 by the eighth trial. The number of verbal approximations fluctuated, increasing from 5 during baseline testing to 9 during trial one, decreasing to 8 during trial two, then increasing to 10 during trial three, then decreasing to 8 during trial four, then increasing to 12 during trial five, then decreasing to 6 during trial seven, and increasing to 9 during trial eight. The number of verbalizations increased from 1 during baseline testing to 6 during trial one, then decreased slightly to 5 from trials two to four, then increased to 9 by trial five, then decreased steadily to 0 by the eighth trial.

The number of full words spoken by Zealand increased from 0 during the baseline testing to 4 by the fifth trial, then decreased to 3 during trial six, then increased to 6 during the ninth

trial. The number of verbal approximations increased from 1 during the baseline to 5 during trial one. It then decreased to 1 in trial four and then increased to 5 in trial six, then decreased to 2 in trial seven, and increased to 10 in trial nine. The number of verbalizations fluctuated, increasing from 6 during the baseline to 11 during the second trial, then decreasing to 5 during the fourth trial, then increasing to 12 during the fifth trial, decreasing to 6 during the sixth trial, increasing to 10 during the seventh trial, and decreasing to 8 during the eighth and ninth trials.

Discussion

After the three weeks of the study commenced, the researcher found that exposure to music with lyrics increased the verbal communication of children with nonverbal autism spectrum disorder, supporting her hypothesis. The findings of the study suggest that there is a relationship between music and language acquisition in children with nonverbal autism spectrum disorder. The number of full words spoken once exposed to the selected song, increased in all six participants from baseline testing to the final trial. Jake increased his number of full words spoken from 0 to 8, Rachel increased hers from 0 to 13, Robert increased his from 0 to 4, Max increased his from 0 to 22, Oscar increased his from 1 to 17, and Zealand increased his from 0 to 6. Although some participants made more verbal progress than others, all increased the number of full words spoken once exposed to music as a language acquisition device, which implies that there is a positive correlation between the two.

The results of the study also found that the number of verbal approximations spoken increased from baseline testing to the final trial, in five of six participants. Jake's verbal approximations increased from 1 to 6, Rachel's increased from 0 to 3, Robert's increased from 0 to 7, Oscar's increased from 5 to 9, and Zealand's increased from 1 to 10. The only decrease in

verbal approximations was in the case of Max, whose score decreased from 5 to 3. The results showed that he had the highest number of full words spoken of any of the participants, and it is likely that the forementioned decrease was due to the increase in full words.

The study also found that by the final trial, four of the six participants produced higher amounts of full words than verbal approximations. This is likely because as the children began to produce more full words, there was less of a need to produce verbal approximations. It is also clear, based on the fluctuation of numbers across all categories of words for most participants, that language acquisition is not a linear process. This could be due to the compliance, or lack thereof, of the subjects during a given trial.

Despite the drastic developmental differences between two-year-olds and seven-year-olds, verbal communication increased in all participants regardless of age, suggesting that this therapy was equally effective when applied to children in the early childhood stage, as it was when applied to those in the childhood stage. This increase in vocalization across participants also suggests that the length of time the children had been receiving ABA services had no significant impact on the words spoken, as the participant who had been receiving services for only six weeks made verbal gains in the same manner as he who had been receiving services for four years. This was the case for all six participants, thus limiting length of prior treatment as an extraneous variable. Likewise, all participants, regardless of whether they had experience pairing with the researcher prior to the start of the study, improved in their verbal communication, implying that this therapy impacted all subjects equally regardless of their relationship with the researcher.

Various preferred items were used throughout the study as positive reinforcement for the participants. These included food toys, dinosaur toys, bubbles, and *Madagascar* music, respectively. Despite the differences in reinforcers used for each subject, all six of the participants increased their verbal communication, suggesting that music was an effective therapeutic tool regardless of the reinforcement with which it was accompanied. Likewise, although only two of the six participants were reported to have a prior known affinity for music, all six of them responded to the intervention of music therapy and improved upon their verbal communication. This suggests that participants did not need to possess a noteworthy liking of music for this therapy to be effective. Based on the results of the study, maladaptive and noncompliant behaviors did not have a significant impact on the outcome of vocalizations. Ultimately, the findings of the study suggest that music is an effective language acquisition device for children with nonverbal autism spectrum disorder despite differences in age, length of ABA treatment, relationship with the researcher, type of reinforcer used, whether there was a known affinity for music, and the participants pattern of maladaptive behavior.

This study attempted to bridge the gap of the communication deficit in children with nonverbal autism, using music with lyrics. The results of the study suggest that after being exposed to music with lyrics, children with nonverbal autism are more likely to develop verbal communication skills. Knowledge of this could significantly impact the way neurodivergent children are taught to speak. Music therapy could be easily administered in the majority of settings—at school, a behavioral therapy center, or at home—and could be available and accessible to people of various social, cultural, and economic demographics.

Limitations

It is important to note that the increase in utterances over time, for some participants, may have been influenced by the child's developing levels of comfortability with the researcher as time progressed. In most cases, pairing naturally occurred between the researcher and the subject over the three-week period, which could have impacted the subject's willingness to be more verbally expressive over time. Because the baseline consisted of the participant's first exposure to the selected song with lyrics and the intervention involved consistent exposure to this piece of music, there was only one baseline assessment conducted as more would have constituted treatment. This could be limiting as having only one baseline did not account for a client potentially not performing to his or her best ability and thus may not have given the most accurate depiction of a subject's baseline verbal abilities.

It is impossible to completely eliminate extraneous variables, as the researcher was unaware of the current treatment plans for the clients at the autism center. This meant that there was no way to ensure that outside of the study, all participants were receiving the same amount of speech therapy or attention toward their communication goals. Any inconsistencies in this area could have contributed to incomparable results. Because the same children's song was consistently used for every trial and with all participants, there is a possibility that each child's personal affinity for the selected song impacted his or her desire to engage with the task and sing along. It is also important to acknowledge that the overall compliance of a subject on a given day, directly influenced his or her verbal participation. Also, the research was conducted at a behavioral therapy clinic, limiting the generalizability of its results.

Future Research

The results of this study suggest that music is an effective language acquisition device for children between the ages of 2 and 12 years, who have been diagnosed with nonverbal autism spectrum disorder. It would be beneficial to increase the length of the study. Due to limited time and space, the experiment lasted for a total of four weeks, and subjects participated in a maximum of nine trials during this period, excluding baseline testing. Because language acquisition is a time-consuming process, increasing the number of trials would likely increase the linguistic development of participants. There were also several test subjects who missed one or more trials due to illness or unforeseen absences, which makes the generalization of the data across participants difficult. In the future, it is important to ensure that all participants engage in the same number of trials. It might also produce more participant engagement to conduct a preference assessment prior to the beginning of the study, so that the song selected can be one that has the most shared interest of the subjects. This might help to limit the extraneous variable of participant bias in terms of a potential affinity of one client or another to a certain song.

Acknowledgements

This work is dedicated to Dr. Elizabeth Sites, whose vision inspired the research process and who whole-heartedly supported the writing of this thesis from Heaven. The researcher is grateful to ABA Results Behavioral Therapy for providing the location to conduct the research, as well as to the participating families and their children.

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Appendix

Jake

Table 1

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B		a-bah a-bah (round and round)	nom, wah, whoo
1	up, I	obeh (open), it (swish)	ep, op, ss, buh, dit, uh, ip, ih, dih
2	beep, up, baby, I	ep (bus), obeh (open), it (swish), huh (shh), bup (bus)	up, ep, ebeh, dat, dah, em
3	open, up, I	obeh (open), hit (swish), bababa (beep), up (bus), eep (and), dow- (down), huh (shh)	ep, up, imeh, ihbee, dadadadah, nanana, dot, bapa, doodoo, aye, bee, eep, eebee, at
4	up, wah	ep (bus), ebeh (open), it (swish), dat (blink), behbeh (beep), doo (vroom), huh (shh), addy (daddy), buh (bus)	yaya, epepep, dadada, uh, eep, ee
5	open, ABA, up, me, all, daddy, I	oh (go), hit (swish), at (cat), epep (beep), huh (shh), uhpb (love), ooh (you), bap (clap)	mmm, epep, pee, dat, dot, hah, ehbeh, ehbee
6	baby, up, all, wah, daddy, I, yeah, yay	ehbeh (open), it (swish), oh (go), dit (blink), ehbeh (beep), huh (shh)	ep, ehbeh, up, beh, eh, ooh, et, upeh
7	open, all, up, yeah, wah, daddy, I	ep (bus), ye (the), oh (go), dat (blink), upup (beep), huh (shh), up (love), a-bah a-bah (round and round)	ep, up, ee, ah, yee
8	up, open, hot, cat, wah, I, daddy, yay	up (bus), et (on), it (swish), ep (beep), huh (shh), ubeh (mommy)	epen, et, ot, ep, yoy, yee

Rachel

Table 2

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B			doo, w-, aah, wee
1	bus, no	rah (round), reh (swish), eesh (shh)	oh, ahh, reh, eeh, soo, eyeee, dah, wah, weer, woowoo
2	no, okay, whoa	rou- (round), bak (blink), voo (vroom)	woo, ah, re-, ooh, eh, ma, lee, wuh
3	no, cat, meow, up, down, wah, say, bus	ope- (open), shuh (shut), ck (blink)	hee, eh, ooh, hahaha, eeh, eek, oh, whoo, ee, lehleh
4	no, go, okay, hohoho	way (wait), mamama (mama)	hee, ah, heh, yee, la, ooh, lele, beh, wooh, mahh, eh, mm, shh
5	no, oh, do, duck, mommy, truck, up, and, down, wah, shh, you, all	ah (I), loh (love), rou- (round)	ooh, mmm, woo, shah, d-, wat, ha, mamama, sehseh, shooshoosh, ahh, duh, shah

Robert

Table 3

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B			ooh, eh, oh
1		ink (blink), uhh (shh), mm (round)	eeh, eh, ooh, ahh
2		eeh (wah), hee (shh)	oh, eh, eeh, uh
3		ope- (open), see see (beep), buh (bus), uh (up), hsss (shh), ahh (all), buhbuh (bubbles)	mmm, yee, eeh, oh, uh
4	up, hey, all	oh-boh (open), bope (beep), hh (shh)	mmm, w-, eeh, wowowo, hh, yss, b-, oh, eh, omeh, whoa, hehe
5	all, I	hih (swish), eeh (beep), buh (bus), uh (up)	ck-, guhguh, oh, eh, geegee, ah, b-, ooh, lala, eeh, ohohoh
6	hey, all, I	oh-oh (open), ih (blink), boo (vroom), uh- (up)	uh, ah, oh, b-, eh
7	up, I, all, hey	ohbe- (open), hih (blink), ee (beep), hih (shh), ah (I)	ooh, uh, oh, ah, mm, b-, ee, huh
8	shh, I, up, hey	Ou- (round), o- (open), ih- (swish), ee- (beep), buh- (bus), uh- (up), -ah (wah)	oh, ee, b-, ah, om, mm, oooh, hooo

Max

Table 4

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B		mah (mommy), ah (on), bah (bus), gah (goes), bah (baby)	ahlalalalagah, twahtwahtwah, ahdahdohtee, dododopee, mahmahehnah, bebebe-, ehmememe
1	big, and	ben (open)	bah, ha, pah, ss, dahee
2	dog	ink (blink), ah (wah)	was, ah, be, a, ma, nas, de, ahtas, tada, adeek
3	circle, blink, five, four, three, two, one, yay	din (and) suh (shut), sis (switch)	fee, dee, see, mmm, hmm, so, wee
4	daddy, music, bus, up, sad, I, don't, know, bouncing, up, down, done, eating, dinosaur, eat, down, apple		ahh
5	round, say, bus, pig, oink, daddy, open, go, bye, swish, up, down, baby, do, not, I, am, big, speak, monkey, all, done	ink (blink)	bah, beh, duh, d-, ah, eh, ooh, seh, kay, ee
6	round, and, open, doors, bus, all, through, the, town, baby, pig, cat, soup, I, want, daddy, me, say, all, done	dut (shut), mwahkey (monkey), el-eh-ah (elephant)	wa, duh, tow, ah, bass, mass, tih, jee, juh, wee, ee, peep, oop, elle, ess, pshh, chh, chee, I-ee-bee, sho-doe

Oscar

Table 5

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B	wah	rou-d (round), tow- (town), bae-buh (baby), mah (mommy), buh (bus)	shth (shh)
1	baby, I	rou- (round), chuh (shut), buh-suh (bus), behbeh (beep), vuh-vuh (vroom), duh (down), sch (shh), bebe (mommy), dyedye (daddy)	buh, suh, buh-kuh, uh-buh, eh, duh
2	bus, wah, I	rou- (round), wuh (wheel), buh-s (bus), beh-beh (open), shh-shh (swish), wuh-kuh (blink), baby (beep), ch (shh)	vuh, beh, wuh, wuh, kay
3	wah, bus, shh, daddy, I	rou-d (round), ope- (open), buh-s (bus), sish (swish), sh-uh-t (shut), buh-kay (blink), behbeh (beep), dow- (down), beh (up), baby (mommy)	beh, row, vuh, fuh, wuh
4	door, the, all, wah, shh, daddy, I	rou-d (round), buh-s (bus), oh-peh (open), wuh-puh (wiper), buh-kay (blink), behbeh (beep), vuh (vroom), uh-beh (up)	wa, ee, ss, w, sh
5	bus, all, open, the, up, baby, daddy, I	wuh (wheels), rou-d (round), duh (door), buh-l-kay (blink), behpeh (beep), buh-tuh (motor), tow- (town), dow- (down), beh-bee (mommy), vuh (love), day (tree), wuh-duh (road)	mm, gg, shish, kah, b-b-, fuh, shh, wuh, gah
6	open, all, bus, cat, up, baby, wah, shh, daddy	wuh (wheel), sh-uh-tay (shut), tah-n (town), s-sh (swish), buh-kay (blink), st-buh (stop), baby (beep), duh-buh (down), behbeh	wuh, eh, oh, vuh

		(mommy), tay (tree), wuh-duh (round)	
7	pig, round, open, all, the, bus, red, baby, up, wah, shh, daddy, go, happy	buh-keh (monkey), buh-eh-woe (bear), behbeh (beep), boo (blue), gaeeh (green), bahbee (mommy)	eh, bah, buh
8	round, and, open, bus, all, the, go, up, baby, wah, shh, piggy, monkey, cat, daddy, I, red	wuh-leh (wheel), shh (swish), ikah (blink), behbeh (beep), vuhvuh (vroom), baby (mommy), vuh (love), wuh (you), buw (bear)	

Zealand

Table 6

Utterances Spoken by Category

Trial	Full Words	Verbal Approximations	Verbalizations
B		voo (vroom)	eeh, oh, guhguhgah, lalala, yahyahyah, yeeyeeyeeyee
1		sh (swish), dink (blink), uh (up), gah (down), lalala (wah wah wah)	eeh, oh, ah, ahlah, ahehaluluh, eehehh, gogahahgah, keekuh, ahluhehsehseh, lalala,
2	all	oh-oh (open), shish (swish), gik (blink), ahss (bus), buh (bus)	eh, lehh, ga, ayy, oh, gee, geegah, uh, gaga, ihh, ee
3	all	ah (all), ohh (open), deek (blink), doo (vroom)	eeh, oh, ah, eh, ooh, geee, gegegahgah, gagaga
4	yay, up	geek (blink)	eeh, yee, aye, ooh, ck
5	go, yeah, yay, why	uhh (bus), uh (up)	ck-, guhguh, oh, eh eh, geegee, ah, b-b-, ooh, lala, eeh, ohohoh, ooh
6	yeah, go, yay	eee (swish), eee eee (beep beep), ay-ee (baby), duh (bus), a- (and)	eeeh, gah, ah ah, gagaga, geee, eh
7	yay, yeah, go, shh	ah (all), guh (go)	hah, uh, ke, gee, eh, eee, yee, gegege, ah, lo
8	off, all, you, yeah	ah (swish), ooh (vroom), uh (up), ah (wah)	ooh, akah, ah, gegegee, yeee, yayy, oh, eeee
9	all, wah, shh, I, love, you	ah (swish), voo (vroom), yayee (baby), eh (the), ee (beep), ah ah (open), oh oh (open), ik ik (blink), wuh wuh (vroom), uh (up)	ah, eh, ee, oof, ih, gegeee, wuh, I