

The impact of culturally informed music therapy on visually impaired youth: A Jaffna, Sri Lanka study

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SUMMARY

Music plays a vital role in human culture and development, offering therapeutic benefits that can enhance cognitive and emotional well-being. This is particularly significant for visually impaired individuals who may face unique challenges in these areas. Previous studies have established the benefits of music interventions in improving executive functions in the visually impaired community. We assessed the impact of music therapy interventions on the executive functions and emotional well-being of visually impaired youth residing in a home for the visually impaired in Jaffna, Sri Lanka. Utilizing a quantitative research design, our study systematically assesses working memory, inhibitory control, and cognitive function through standardized assessments while considering the significance of using cultural music for the therapy. To evaluate the role of cultural alignment in music therapy, the study was divided into two arms: one utilizing Tamil Carnatic music and the other utilizing Western classical music. These groups were chosen to compare the effects of culturally relevant music therapy against a more universally recognized form of music therapy. Our findings reveal statistically significant enhancements in working memory, inhibitory control, and emotional well-being within both the Tamil Carnatic and Western classical music therapy groups. Subsequently, an intergroup analysis, which compared the improvements in working memory, inhibitory control, and emotional well-being between the two groups, emphasizes the influence of cultural alignment. Our study underscores the importance of culturally relevant curricula in music therapy for visually impaired individuals, thus emphasizing the importance of cultural sensitivity and the potential benefit of increasing musical presence in the lives of the visually impaired community.

INTRODUCTION

Visual impairment encompasses a spectrum of conditions, ranging from partial sight to complete blindness, with each presenting unique obstacles to daily functioning. Visual impairment poses significant challenges to individuals' lives, particularly in the realm of education and cognitive development (1). The World Health Organization defines "low vision" as visual acuity between 20/60 and 20/400 and "blindness" as visual acuity beyond 20/400 (2). Visual acuity

is reported as a fraction, where the numerator indicates the distance at which a person with normal vision can see an object clearly, and the denominator indicates the distance at which a person with impaired vision must stand to see the same object. For example, a visual acuity of 20/400 means that a person with normal vision can see at 400 feet, a person with impaired vision must be at 20 feet to see.

Executive functioning, a multifaceted cognitive process organized primarily by the prefrontal cortex, plays a pivotal role in cognitive regulation (3). Executive functioning encompasses crucial functions such as working memory, inhibitory control, and cognitive function (3). Working memory is the cognitive system that temporarily holds and manipulates information needed for complex cognitive tasks such as language comprehension, reading, or reasoning. Inhibitory control is the ability to suppress irrelevant or impulsive responses. Cognitive function encompasses broader cognitive processes, including attentional control and cognitive flexibility (4). These cognitive processes contained within executive functioning are essential for guiding complex behaviors, problem-solving, and goal-directed actions. Higher-order executive functions, including planning and self-determined intelligence, require multiple basic executive functions (4).

Visually impaired individuals typically exhibit lower scores on cognitive assessments when compared to those with normal or corrected vision (5). However, the reasons for these lower scores are not well understood. It is unclear whether the assessments depend too heavily on visual stimuli or if individuals with visual impairments are more likely to experience cognitive impairments (5).

Previous research suggested that music training can enhance executive functions, contributing to improvements in working memory, inhibitory control, and cognitive function (6). As students engage in music training, they are exposed to tasks that require them to hold and manipulate information in their working memory, which is essential for various aspects of music education, including reading musical notation, maintaining rhythm, and controlling motor skills. Additionally, inhibitory control plays a crucial role in music performance, as it enables students to suppress impulsive responses and maintain focus on their musical tasks (7).

The role of teachers in facilitating executive function development through music training cannot be understated. Educators who incorporate music into their teaching methods provide students with opportunities to enhance their cognitive skills (8). Moreover, the structured nature of music education, with its emphasis on practice, repetition, and attention to detail, aligns with the principles of other transferable skills in various disciplines, all rooted in executive function

development (9). Teachers who implement music training not only support students' musical development but also contribute to their cognitive growth, which can extend beyond the scope of music into various academic and life domains.

In the context of students with visual impairments, music training offers a uniquely accessible avenue for enhancing executive functions. A prior study has shown that active participation and interest in music from visually impaired individuals can contribute to greater benefits and auditory competency (10). By actively participating in music activities, students can potentially sharpen their working memory, improve inhibitory control, and enhance cognitive function, ultimately leading to better academic performance and social interactions (11). Furthermore, the benefits of music training extend to emotional well-being, with music serving as a powerful tool for self-expression and stress reduction (12). Students with visual impairments may face increased emotional challenges, and music training can offer a therapeutic outlet for managing emotions and fostering positive mental health (12, 13). To our knowledge, previous studies have not been carried out among visually impaired students in Sri Lanka.

Modern music therapy interventions increasingly consider cultural alignment, which refers to the adaptation of these interventions to align with the cultural background and preferences of participants (14). The positive outcome of cultural alignment in music therapy in some studies underscored the importance of considering individual differences and cultural sensitivity (14). Practicing culturally sensitive and personalized music therapy is essential not only from an ethical perspective but also for those who wish to adhere to humanistic principles in their therapeutic practice (15). Additionally, personalized and culturally aligned music therapy interventions have shown promise in creating an empathetic environment and may improve participation and strengthen responses (14). The standard type of music used in music therapy is classical Western music (16). However, in Jaffna, Sri Lanka, where Tamil is spoken by more than 95% of people, Tamil Carnatic music would be more familiar to the general population (17). The key difference between Western classical and Tamil Carnatic music therapy sessions is in the musical content and cultural context. Western classical music therapy centers around harmony, orchestration, and structured compositions, while Tamil Carnatic music therapy centers around ragas, intricate rhythmic patterns, and devotional themes (18). Ragas are a pattern of notes or traditional scales that are used for melodic improvisation in Carnatic music. These differences in content may influence the emotional and psychological impact of the therapy sessions. Western classical music often evokes emotions through its harmonic progressions and dynamics, whereas Tamil Carnatic music relies heavily on the emotive qualities of ragas and intricate rhythmic interplay (19). The cultural and historical context of each musical tradition may also influence how participants perceive and engage with the therapy. We included this second style of music in our study to identify if using culturally sensitive music would enhance outcomes as compared to the standardized administration of Western classical music.

The purpose of our study was to investigate the impacts of culturally informed music therapy on improving the executive functions and emotional well-being of visually impaired youth

in Jaffna, Sri Lanka. In particular, we sought to explore the potential variations in outcomes between culturally aligned music therapy, such as Carnatic Tamil music for Tamil youths, and culturally unfamiliar music, such as Western classical compositions. In this study, we explored three hypotheses: 1) participants who received music therapy interventions, whether Western classical or Carnatic Tamil music-based, would demonstrate improvements in executive function skills compared to their baseline assessments; 2) participants in the group exposed to music interventions aligned with their cultural background would exhibit greater improvements in executive function than those exposed to a culturally unfamiliar style; and 3) music therapy interventions would lead to improved emotional well-being in both groups, as measured by self-report questionnaires, consistent with the notion that music therapy has holistic benefits. Our findings indicate that music therapy interventions significantly improved working memory and emotional well-being in visually impaired youth, with the culturally aligned Tamil Carnatic music showing greater benefits than Western classical music. These results suggest that incorporating culturally relevant music into therapy could enhance its effectiveness and provide a more meaningful and resonant experience for participants. Implementing culturally sensitive music therapy programs in educational and rehabilitation settings could improve cognitive and emotional outcomes for visually impaired youth

RESULTS

To study the impact of music therapy on visually impaired students, we conducted music therapy sessions on 24 people in Jaffna, Sri Lanka for three weeks. In the Western classical music therapy sessions, participants engaged in activities including listening to calming compositions, creating expressive music with instruments, group singing of classical choral pieces, sharing personal memories related to classical music, and guided imagery exercises using a variety of music pieces (20). Conversely, Tamil Carnatic music therapy sessions featured distinct activities, such as practiced raga-based meditation, rhythmic exercises using Solkattu rhythms, singing Tamil Carnatic compositions to enhance vocal and respiratory health, and engaging in activities exploring the emotional qualities of different ragas (21).

To examine the potential impact of music interventions on working memory, we used the Digit Span Test, in which participants attempt to recall a series of numbers presented in a recording (22). A higher score on the test indicates a higher level of working memory. We found a statistically significant difference in working memory score (+1.33 points) after Tamil Carnatic music therapy (paired t-test, $p=0.00002$) (**Figure 1**). There was also a statistically significant difference in working memory score (+0.67 points) after Western classical music (paired t-test, $p=0.00002$). Additionally, we found that music intervention was significantly more effective at improving working memory for participants in the Tamil Carnatic Music intervention Group compared to participants in the Western classical Group (+0.66 points, two-sample t-test, $p=0.02$).

In order to identify the potential impact of music interventions on inhibitory control, we used the Go/No-Go Test, gathered by the participant's ability to process information and focus on the brain's ability to make rapid decisions (23). A higher score on the test indicates higher levels of inhibitory control. We found a statistically significant

effect of Tamil Carnatic music intervention on inhibitory control (+7.34 points), as participants' scores improved after music therapy (paired t-test, $p=0.00001$) (Figure 2). There was also a statistically significant difference in inhibitory control scores (+8.16 points) after Western classical music (paired t-test, $p=0.00001$). Furthermore, using a two-sample t-test, we found no statistically significant difference in inhibitory control between participants in the Tamil Carnatic Music intervention Group compared to participants in the Western classical Group.

Finally, to examine any significance of music interventions on cognitive function, we used the Wisconsin Card Sorting Test (WCST) which measures cognitive function by a participant's ability to figure out classification rules to sort cards (24). Students were asked to sort a series of braille and textured cards on different criteria such as shapes, or textures. A high score on the test, achieved by sorting the cards more quickly, indicated higher levels of cognitive function. We saw no significant effect of Tamil Carnatic music intervention on cognitive function, as participants' scores did not improve at a significant level after music therapy (paired t-test, $p=0.5863$) (Figure 3). There was also no statistically significant difference in cognitive function scores after Western classical music ($p=0.5863$). Moreover, using a two-sample t-test, we found that music intervention was not more effective for participants in the Tamil Carnatic music intervention Group compared to participants in the Western classical Group for cognitive function.

Our last hypothesis was that participants exposed to music interventions may exhibit greater improvements in emotional well-being. We designed a series of 6 survey questions using a scale of 1-5 to measure emotional well-being and administered these questions before and after participation in the music therapy. A high score on the test (the average score of the 6 questions) indicates higher levels of emotional well-being. We saw a statistically significant effect of Tamil Carnatic music intervention on Emotional Well-Being (+1.42 points), as participants' scores improved after music therapy (paired t-test, $p=0.00001$) (Figure 4). As for Western classical music, there was also a statistically significant improvement in emotional well-being scores (+0.75 points) (paired t-test, $p=0.00001$). Finally, we found that music intervention was

more effective for participants in the Tamil Carnatic Music intervention Group (+0.67 points) compared to participants in the Western classical Group for emotional well-being as the p-value was statistically significant being less than 0.05 (two-sample t-test, $p=0.0028$).

DISCUSSION

We examined the effects of music therapy interventions on executive functions and emotional well-being in visually impaired youth in Jaffna, Sri Lanka, focusing particularly on the importance of cultural sensitivity in choosing music. The study compared music therapy using Tamil Carnatic and Western classical music and employed standardized assessments to measure working memory, inhibitory control, and cognitive function.

We found significant improvements in working memory for both the Tamil Carnatic and Western classical groups following the music therapy interventions. Notably, the Tamil Carnatic group exhibited a more substantial improvement, suggesting that cultural alignment in music selection may enhance the effectiveness of such interventions. This finding aligns with previous research suggesting that familiar cultural stimuli can enhance cognitive performance (25). More generally, we confirmed the potential benefits of music therapy in enhancing cognitive functions among visually impaired youth. Music therapy has been shown to improve cognitive functions such as memory, attention, and executive functions in various populations, including those with visual impairments. For example, research has demonstrated that musical training can lead to better working memory and attention in children (26). Additionally, culturally relevant music therapy has been found to enhance emotional and cognitive outcomes by resonating more deeply with participants (27). Furthermore, a study found that music therapy could significantly improve cognitive and psychological symptoms in patients with dementia, indicating its broad applicability (28).

These consistent findings suggest that the positive effects of music therapy on cognition are reproducible and may be generalizable across different patient groups. For example, another study reported that music therapy improved emotional well-being and reduced psychiatric symptoms in patients with Parkinson's disease (29). This highlights the potential of music

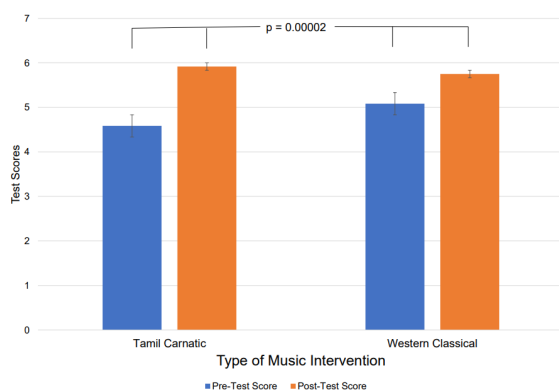


Figure 1: Pre and Post Test Results for Working Memory (Digit Span Test). For Tamil Carnatic music therapy, $n=12$. For Western Classical Music Therapy, $n=12$. Data shown as mean \pm standard error. A paired t-test was used to analyze the differences between pre- and post-test scores within each group, $p = 0.00002$.

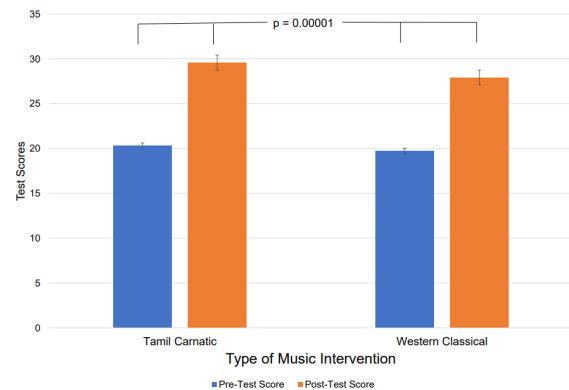


Figure 2: Pre and Post Test Results for Inhibitory Control (Go/No-Go Test Scores out of 40). For Tamil Carnatic music therapy, $n=12$. For Western Classical Music Therapy, $n=12$. Data shown as mean \pm standard error. A paired t-test was used to analyze the differences between pre- and post-test scores within each group, $p = 0.00001$.

therapy not only as a tool for cognitive enhancement but also for improving emotional well-being and overall quality of life in visually impaired individuals. Our study contributes to the growing body of evidence supporting the use of music therapy as an effective and accessible intervention for cognitive and emotional development.

We attempted to control skill level differences between groups in the study, but it is always possible that initial differences in working memory could have influenced the extent of improvement seen in our results. Specifically, individuals who began with different levels of working memory capacity may have derived varying amounts of benefit from the therapy.

We also found improved inhibitory control in both the Tamil Carnatic and Western classical groups. Our results indicate the potential of music therapy interventions to positively impact inhibitory control skills in this population. However, there was no significant difference in improvement between the two music styles, suggesting that both were equally effective in enhancing inhibitory control. Inhibitory control tasks require individuals to suppress prepotent responses, ignore distractions, and inhibit impulsive behaviors. While cultural alignment in music therapy may influence emotional and motivational aspects of inhibitory control, such as attentional focus and arousal levels, it may not directly impact the cognitive processes involved in inhibitory control to the same extent as working memory tasks. Inhibitory control relies more heavily on executive functions such as response inhibition, cognitive flexibility, and response monitoring, which may not be as modulated by cultural factors. This is a current gap in literature and should be further explored.

Cognitive function was assessed by the modified WCST in which there were no significant improvements in either music therapy groups or no significant differences between the groups. The music therapy slightly improved WCST performance, but the type of music therapy does not make a difference, and it was not improved at a statistically significant level. The WCST was used as it was the only cognitive function assessment test that could be tailored for the visually impaired community within the scope of our resources (adding braille print and texture to the cards). The original test

uses shapes and colors to which participants would have to sort the cards based off the criteria the facilitator provided. While the original WCST uses shapes and colors, we used textures and/or braille to adapt the test to a visually impaired population. Students needed to find the location of the cards on the table and inspect them individually, which increased the amount of time required to complete the test.

One key takeaway from this research was the importance of cultural sensitivity in music therapy interventions. We found that aligning the choice of music with the cultural background of the participants, such as using Carnatic Tamil music for Tamil youth, enhanced the effectiveness of the therapy. This insight emphasizes the need for culturally tailored approaches in music therapy, ensuring that it resonates with the experiences and preferences of the participants. However, for largely financial reasons, it may be easier to continue using existing curricula which focuses on Western classical music.

The study demonstrated that music therapy may significantly improve cognitive functions, particularly working memory and inhibitory control, in visually impaired youth. These cognitive abilities are fundamental for academic success and everyday life skills (30). The application of music therapy in enhancing these skills can empower visually impaired individuals to navigate the specific challenges they face more effectively. It offers them a valuable tool for not only coping with cognitive difficulties but also thriving academically and socially. Hence, this research highlights the need to improve the accessibility of music therapy for visually impaired youth by creating inclusive music therapy programs and resources specifically designed to cater to the unique needs of this population. This could include the development of accessible musical instruments, music notation in Braille, and audio-based learning materials. Ensuring that music therapy is accessible to all, regardless of their visual abilities, can open new avenues for personal growth and development. Finally, we also investigated the influence of music therapy on emotional well-being and observed notable improvements in both the Tamil Carnatic and Western classical music groups. Participants in the Tamil Carnatic group displayed greater enhancements in emotional well-being compared to those

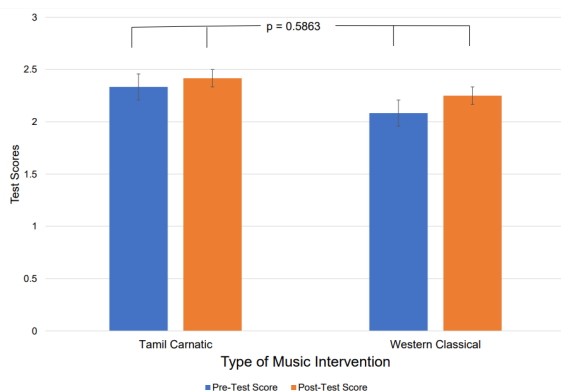


Figure 3: Pre and Post Test Results for Cognitive Function (Modified Wisconsin Card Sorting Test). For Tamil Carnatic music therapy, n=12. For Western Classical Music Therapy, n=12. Data shown as mean ± standard error. A paired t-test was used to analyze the differences between pre- and post-test scores within each group, $p = 0.5863$.

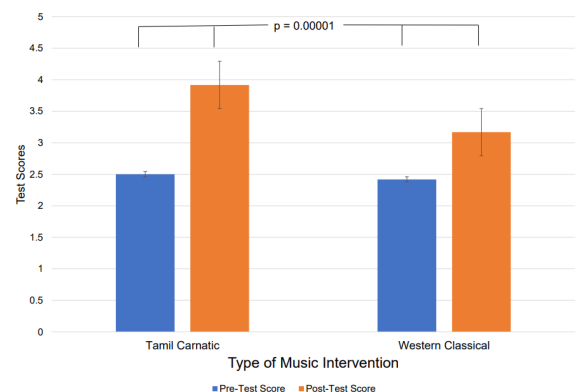


Figure 4: Pre and Post Test Results for Emotional Well-Being & Identity (Assessment Scales 1-5 Ranking). For Tamil Carnatic music therapy, n=12. For Western Classical Music Therapy, n=12. Data shown as mean ± standard error. A paired t-test was used to analyze the differences between pre- and post-test scores within each group, $p = 0.00001$.

in the Western classical group. This suggests that culturally specific music therapy can significantly enhance emotional well-being, likely because participants have a deeper emotional and cultural connection to the music. Greater exposure to the language and familiarity with the music might make it resonate more strongly with them. These findings underscore the significance of cultural considerations in therapeutic practices, as they can greatly enhance the benefits for participants. By customizing music therapy to align with the cultural heritage of the individuals, we can optimize its effectiveness, leading to significant advancements in both cognitive and emotional well-being.

While this study provided valuable insights on the benefits of music therapy for visually impaired individuals, we acknowledge that our data reflect only a small sample size taken from a single population. Further research with larger participant groups and cross-cultural investigations could refine our understanding of the effects of different music genres on cognitive functions. This ongoing exploration may lead to more precise and effective interventions, ultimately improving the quality of life for visually impaired youth.

MATERIALS AND METHODS

Participants

The study participants consisted of 24 visually impaired children aged 12-20 (Mean=14.25; SD=1.96; Male = 10, Female = 14) residing at a home for the blind and visually impaired in Jaffna, Sri Lanka. All participants belong to lower-class backgrounds and attend a government school. The sample was selected based on whether the students had visual impairments and the willingness of participants to engage in the study. In this case, every student from the home who was present during the study was selected to participate. Twelve students were assigned to the Tamil Carnatic group, and 12 to the Western classical group. Participants were evaluated for skill level using a pre-program assessment, in which they were asked to rank their previous music experience and complete a short skill test. Groups were designed such that the total scores of the students in each study group were equivalent.

Music therapy activities were used daily, with specific activities lasting 45 minutes to an hour alongside regular lessons. The first two weeks of the workshop focused on executing the workshops and music therapy interventions. Standardized tests were administered at the end of the third week.

Music therapy activities were led by the student researcher of the paper, who has training in music therapy and qualifications equivalent to a bachelor's in music from the Royal Conservatory of Music. Two other local music therapists in Jaffna also helped administer activities, both holding university qualifications in special education and music.

This study received IRB approval. Informed and written consent was obtained from the owner of the home as the student's designated guardians, and assent was obtained from the students ensuring their voluntary participation. Ethical boundaries were established to ensure the anonymity and confidentiality of participants throughout the research process.

Measures

For the research experiment, a series of music therapy activities were designed to be conducted over three weeks, focusing on two distinct musical traditions: Western classical music and Tamil Carnatic music.

In the Western classical music therapy sessions, the first activity involved listening and relaxation, where calming compositions such as Debussy's "Clair de Lune" and Mozart's "Piano Concerto No. 21" were played to induce relaxation and reduce stress. The second activity, expressive music creation, allowed participants to create their own music using instruments like the piano or violin to facilitate emotional expression, guided by a music therapist. Group singing of well-known classical choral pieces like Handel's "Hallelujah Chorus" and Beethoven's "Ode to Joy" promoted a sense of unity and connectedness among participants. Furthermore, participants shared personal memories associated with classical pieces in a "Music and Memory" activity. Finally, guided imagery exercises with pieces like "My Favourite Things," Tchaikovsky's "Swan Lake," as well as Bob Marley and Pink Floyd, were used to guide participants through visualization exercises.

The Tamil Carnatic music therapy sessions began with raga-based meditation, listening to specific ragas such as "Kalyani" and "Sankarabharanam" to promote emotional balance and concentration. Kunnakudi Vaidyanathan, from the Raga Research Centre in Chennai, says playing Raga Sankarabharanam with devotion can calm the mind (31). Solkattu rhythms, a key component of Tamil Carnatic music, were used in rhythmic exercises involving handclaps and vocalizations to improve coordination and cognitive skills. Participants practiced voice and breath control through singing Tamil Carnatic compositions, with guidance on tone production, breath control, and pronunciation, aiming to enhance vocal and respiratory health. Lastly, participants explored the significance of different ragas and their emotional qualities, encouraging self-awareness and reflection in a "Raga Exploration" activity.

Assessments

The Digit Span Test was used for Working Memory. Participants listened to an auditory recording of numbers presented at a rate of one number per second. They were instructed to repeat the numbers in the same order they heard them until they could no longer remember. The test was discontinued when a participant made two consecutive errors. Scoring was based on the longest correct sequence of numbers correctly repeated. For example, if a participant correctly recalled sequences up to "5-7-2," their score for this test would be three.

The Go/No-Go Task was used for Inhibitory Control. Participants completed a total of 20 trials, with 10 "Go" trials and 10 "No-Go" trials presented randomly within the task. When a participant correctly responded to a "Go" signal (high pitch beep), they received a point. If a participant responded incorrectly to a "No-Go" signal (low pitch beep), they lost a point. Scoring was based on the net number of correct "Go" responses minus any incorrect "No-Go" responses. For example, if a participant correctly responded to 8 "Go" signals but incorrectly responded to 2 "No-Go" signals, their score for this task would be 6.

The Wisconsin Card Sorting Test (WCST) was modified to

be used for cognitive function. Participants completed a total of 6 trials in the modified WCST. The modified WCST involved using braille text on certain cards and textures on others such as felt and leather instead of shapes and colors for sorting. Auditory cues signaled rule changes, and participants adapted to new sorting criteria. Participants received a point for each correct adaptation and accurate sorting within the trials. The score in this test was based on the number of correct adaptations and accurate sorting across the 6 trials. For example, if a participant correctly adapted to new rules and sorted cards accurately in 4 out of 6 trials, their score for this task would be 4.

The emotional well-being assessment consisted of pre-surveys and post-surveys designed to measure changes in emotional well-being across the study. To ensure unbiased data collection, participants were not asked about their music preferences or the specific music program they would be assigned to during the pre-survey. Participants responded to a set of questions (rating from 1-5) in the pre-survey and post-survey aimed at assessing their emotional well-being at the beginning of the study. A list of these questions can be found in the appendix.

Data Analysis

Quantitative data was analyzed using independent t-test and paired samples t-test, to examine the impact of music therapy interventions on executive function and emotional well-being, using a significance threshold of $p < 0.05$.

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APPENDIX

Emotional Well-Being Questionnaire Distributed to Student Participants

Before the Music Therapy Workshop:

- General Emotional Well-being:
 - On a scale of 1 to 5, with 1 being very low and 5 being very high, how would you rate your overall emotional well-being in the past week?
- Specific Emotional States:
 - Please rate your current levels of stress, anxiety, and depression on a scale from 1 to 5, with 1 indicating low levels and 5 indicating high levels.
- Coping Mechanisms:
 - On a scale from 1 to 5, how effective do you find your current coping mechanisms for managing stress or difficult emotions?
- Expectations from the Workshop:
 - Rank from 1 to 5 how much you expect the music therapy workshop to positively impact your emotional well-being, with 1 being not at all and 5 being significantly.
- Quality of Life:
 - Rate your satisfaction with your current quality of life, considering emotional aspects, on a scale from 1 to 5, with 1 being very dissatisfied and 5 being very satisfied.

After the Music Therapy Workshop:

- Perceived Impact of the Workshop:
 - To what extent do you feel the music therapy workshop positively impacted your emotional well-being? Rank from 1 to 5, with 1 being not at all and 5 being significantly.
- Changes in Emotional States:
 - Please rate the changes in your levels of stress, anxiety, and depression after participating in the workshop on a scale from 1 to 5, with 1 indicating no change and 5 indicating significant improvement.
- Effectiveness of Music Techniques:
 - On a scale of 1 to 5, how would you rate the effectiveness of the music techniques you've learned during the workshop in managing stress or difficult emotions?
- Reflection on Musical Experience:
 - Rank from 1 to 5 how significant and insightful your musical experiences or breakthroughs were during the music therapy workshop, with 1 being not at all and 5 being very significant.
- Overall Improvement:
 - To what extent do you believe the workshop has contributed to an improvement in your overall well-being? Rank from 1 to 5, with 1 being no improvement and 5 being significant improvement.