KMAN PUBLISHING INSTITUTE
Journal Website
Article history:
Received 27 February 2025
Revised 02 May 2025
Accepted 10 May 2025
Published online 21 June 2025

Psychological Research in Individuals with Exceptional Needs

Volume 3, Issue 2, pp 73-84

E-ISSN: 3060-6713

Comparison of the Effectiveness of Active and Passive Music Therapy on Echolalia and Pitch Frequency in Children with Level 1 Autism Spectrum Disorder

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Article Info

Article type:
Original Research

How to cite this article:
Ahmadizade, F., Mousavi, S. A. M., & Babakhani, N. (2025). The Comparison of the Effectiveness of Active and Passive Music Therapy on Echolalia and Pitch Frequency in Children with Level 1 Autism Spectrum Disorder. *Psychological Research in Individuals with Exceptional Needs, 3*(2), 73-84.
https://doi.org/10.61838/kman.prien.3.2.8

ABSTRACT

Music therapy is a complementary and innovative intervention for children with autism spectrum disorder (ASD), encompassing both active and passive approaches that differ in their implementation methods and potential outcomes. The present study aimed to examine and compare the effectiveness of active and passive music therapy on echolalia and pitch frequency in children with Level 1 ASD. This quasi-experimental study employed a pretest–posttest design with a control group and a two-month follow-up period. The study sample included 33 children aged 4 to 7 years diagnosed with Level 1 ASD, selected through convenience sampling. After meeting the inclusion criteria, participants were randomly assigned to two experimental groups and one control group. The research instruments consisted of the Praat acoustic phonetic software and the Abnormal Behavior Checklist. Data were analyzed using repeated-measures analysis of variance (ANOVA) with SPSS-27 to compare dependent variables across pretest, posttest, and follow-up phases. The results indicated that passive music therapy had the greatest effect in reducing echolalia. Pairwise comparisons with Bonferroni correction showed significant mean differences between the passive and active groups (3.038, $p = 0.034$) and between the passive and control groups (-4.583, $p = 0.001$), whereas the difference between the active and control groups was not significant (mean difference = -1.545, $p = 0.538$). These findings suggest that the passive method was more effective in decreasing echolalia compared to the other groups. Furthermore, the active music therapy group showed a significant improvement in pitch scores compared to the control group. The overall time effect on scores was significant in the multivariate analysis, and the trend of changes varied across groups, although the univariate analysis did not confirm a formal time effect. Passive music therapy showed no significant difference compared to the control condition. Therefore, incorporating music therapy into rehabilitation programs for children with ASD is recommended as a beneficial complementary intervention.

Keywords: *Autism Spectrum Disorder, Echolalia, Pitch Frequency, Active Music Therapy, Passive Music Therapy*

1. Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by impairments in communication, social interaction, and the presence of repetitive or restricted behaviors (Khaliulin et al., 2025). The underlying neurobiological mechanisms of ASD involve multifaceted dysfunctions in neural connectivity and mitochondrial activity, which affect cognitive, sensory, and emotional regulation processes (Khaliulin et al., 2025). Among the core challenges observed in individuals with ASD, speech and prosody deficits—especially echolalia, atypical intonation, and pitch irregularities—are particularly prominent and often persist despite traditional speech therapy interventions (Harbison et al., 2020; Holbrook & Israelsen, 2020). Echolalia, defined as the involuntary repetition of words or phrases spoken by others, is one of the most common speech features in children with ASD and is thought to arise from atypical auditory-motor integration (Chenausky et al., 2017; Farahani Sepehr et al., 2014). Research suggests that targeted therapeutic interventions, particularly those engaging auditory and rhythmic processing, may facilitate neural reorganization and improve expressive communication in autistic children (Geretsegger et al., 2014; Lim, 2010).

Music therapy has emerged as one of the most promising non-pharmacological interventions for ASD, combining sensory, emotional, and motor elements to promote neural plasticity and communication development (Yinger & Gooding, 2014). Defined as the structured use of musical activities to achieve therapeutic goals, music therapy can be broadly divided into active and passive modalities (Stekić, 2024). In *active music therapy*, participants engage directly in singing, instrument playing, or rhythmic movements, facilitating sensorimotor synchronization and social interaction (Stekić, 2024). Conversely, *passive music therapy* emphasizes listening to preselected musical pieces, which can elicit emotional regulation, attention improvement, and relaxation without requiring active participation (Kabuk et al., 2022). Each modality engages distinct neural mechanisms—active methods primarily activate motor-auditory circuits, while passive methods modulate limbic and autonomic systems (Caponnetto et al., 2022; Wang et al., 2023).

Empirical evidence has demonstrated the efficacy of both active and passive music therapy in improving various behavioral and communicative outcomes among children with ASD. For instance, meta-analytical findings show that music therapy significantly enhances social interaction, attention, and emotional responsiveness (Gao et al., 2025). Active engagement in musical rhythm can stimulate mirror neuron systems, promote imitation skills, and strengthen the integration of auditory feedback into speech production processes (Chenausky et al., 2017; Lim, 2010). Studies utilizing the *Auditory-Motor Mapping Training* (AMMT) approach have confirmed that rhythm-based singing can improve speech initiation and reduce echolalia by establishing new neural pathways linking auditory perception and motor planning (Chenausky et al., 2017). Similarly, Geretsegger and colleagues' Cochrane review provided robust evidence that structured music therapy enhances social communication and reduces maladaptive behaviors in individuals with ASD (Geretsegger et al., 2014).

Passive music therapy, on the other hand, has demonstrated measurable benefits in emotional regulation and physiological relaxation. It can reduce stress responses, stabilize mood, and decrease behavioral excesses by modulating the parasympathetic nervous system (Kabuk et al., 2022). In therapeutic contexts, carefully selected auditory stimuli—such as rhythmic instrumental music—have been shown to enhance auditory attention and listening comprehension, which are crucial for language development (Caponnetto et al., 2022). Research comparing active and passive modalities reveals that although both can contribute to clinical improvement, their mechanisms and target outcomes differ substantially (Stekić, 2024). Active approaches primarily target expressive communication and prosodic modulation, whereas passive methods are more effective in reducing anxiety and repetitive behaviors (Hamidifard et al., 2023; Khanjani & Khaknezhad, 2016).

Several clinical studies in Iran and globally have examined the relationship between music-based interventions and verbal behavior modification in children with ASD. Ferdosi and Ashayeri (2015) demonstrated that melodic intonation therapy—a structured approach emphasizing rhythm and pitch contour—significantly improved speech fluency and decreased echolalic utterances (Ferdosi & Ashayeri, 2015). Their earlier experimental work also found that 7–10-year-old Persian-speaking autistic boys showed significant progress in speech production after rhythmic melodic interventions (Ferdosi et al., 2013). These findings align with evidence from international research showing that prosodic training through music can restore speech rhythm and intonation in ASD (Harbison et al., 2020;

Holbrook & Israelsen, 2020). Moreover, Farahani Sepehr et al. (2014) confirmed that structured speech repetition techniques can reduce echolalia and other challenging behaviors in autistic children (Farahani Sepehr et al., 2014).

The mechanisms by which music exerts its therapeutic effects are multifaceted. Neuroimaging studies suggest that music activates both hemispheres of the brain, stimulating the auditory cortex, premotor areas, and limbic regions involved in emotion and motivation (Khaliulin et al., 2025). Through rhythmic synchronization, music can strengthen temporal processing and improve timing accuracy—functions often impaired in autism (Gao et al., 2025). Furthermore, the integration of melody and rhythm in therapy sessions enhances working memory, executive control, and emotional expression (Stekić, 2024; Wang et al., 2023). Hamidifard et al. (2023) found that music therapy not only reduced self-harm behaviors but also improved executive functions in children with ASD, highlighting its potential to enhance both behavioral and cognitive outcomes (Hamidifard et al., 2023).

From a developmental perspective, early intervention through musical engagement is particularly valuable because it capitalizes on the heightened neuroplasticity of young children's brains (Yinger & Gooding, 2014). Preschool-based music therapy programs have demonstrated improvements in joint attention, turn-taking, and imitation—core skills necessary for social communication (Geretsegger et al., 2014; Yinger & Gooding, 2014). Moreover, family-based music therapy models have been shown to reduce behavioral excesses and improve parent-child interaction patterns (Shiri et al., 2018). Active participation of parents in music-based exercises reinforces the continuity of therapeutic effects beyond the clinical environment, promoting consistent emotional engagement and communication reinforcement at home.

In addition to behavioral benefits, music therapy addresses prosodic deficits that affect natural speech flow. Prosody encompasses pitch, stress, and rhythm, which convey emotional and pragmatic information during speech (Harbison et al., 2020). Children with ASD often exhibit monotone or atypical pitch patterns, resulting in reduced expressiveness and social misunderstanding. Targeted prosodic interventions involving music have shown promise in enhancing speech melody, variability, and overall intelligibility (Holbrook & Israelsen, 2020). In this context, active music therapy, which involves vocal imitation and rhythmic coordination, serves as a bridge between nonverbal sound perception and verbal articulation (Lim, 2010).

The effectiveness of music therapy can also be understood through the lens of emotional regulation and sensory integration theories. According to the integrative model of Stekić (2024), active and passive musical engagement differentially influence cognitive and affective development by aligning sensory, motor, and emotional processes (Stekić, 2024). Active engagement promotes multisensory feedback loops that reinforce self-awareness and emotional expression, while passive listening induces relaxation and attentional modulation. This dual influence is especially relevant for ASD populations, where both sensory hypersensitivity and emotional dysregulation are prevalent (Gao et al., 2025; Kabuk et al., 2022).

Several Iranian studies have explored creative and artistic interventions, including art and music therapy, to enhance emotional and behavioral adaptation among children with learning and communication disorders. Karami et al. (2012) found that art therapy significantly reduced aggressive behavior in students with dyslexia, underscoring the broader psychosocial impact of artistic expression (Karami et al., 2012). Similarly, Ferdosi and colleagues highlighted that musical elements such as rhythm and melody can act as scaffolds for language acquisition in neurodiverse populations (Ferdosi & Ashayeri, 2015; Ferdosi et al., 2013). These results parallel findings from global reviews indicating that music-based interventions improve not only linguistic and behavioral outcomes but also physiological indicators of well-being, such as heart rate variability and stress hormone regulation (Caponnetto et al., 2022; Wang et al., 2023).

The measurement of therapeutic progress in such interventions often relies on standardized behavioral checklists. The *Aberrant Behavior Checklist* (ABC), validated for children with ASD, remains one of the most widely used assessment tools to track changes in repetitive behavior, irritability, and social withdrawal (Kaat et al., 2014). Its sensitivity to therapeutic outcomes makes it a valuable metric for evaluating music therapy effectiveness, as demonstrated in numerous cross-sectional and longitudinal studies (Geretsegger et al., 2014; Hamidifard et al., 2023).

Although the benefits of music therapy for autism are increasingly recognized, research continues to explore comparative efficacy between active and passive modalities. Preliminary evidence suggests that while both can yield therapeutic gains, passive methods may more effectively reduce echolalia and behavioral rigidity, whereas active participation exerts stronger effects on prosodic and pitch

E-ISSN: 3060-6713

modulation (Hamidifard et al., 2023; Khanjani & Khaknezhad, 2016). Active engagement may require greater cognitive effort and sensory coordination, leading to enhanced expressive control and vocal flexibility, while passive listening provides a calming framework conducive to behavioral regulation (Kabuk et al., 2022; Stekić, 2024).

In sum, music therapy represents a multidimensional intervention that integrates auditory, cognitive, motor, and emotional components to address the core deficits of ASD (Gao et al., 2025; Geretsegger et al., 2014). Building on the evidence from both international and Iranian studies, the current research aims to compare the effectiveness of active and passive music therapy on echolalia reduction and pitch frequency modulation in children with Level 1 autism spectrum disorder.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a quasi-experimental research design with a pretest–posttest and control group. The statistical population consisted of children aged 4 to 7 years diagnosed with Level 1 Autism Spectrum Disorder (ASD) who attended occupational therapy and speech therapy clinics in Karaj during 2023–2024. The sample size was estimated using G*Power software, taking into account the number of variables, an effect size of 0.6, a test power of 1.0, and a confidence level of 0.95. Based on this estimation, a total of 33 participants (11 per group) were selected using convenience sampling and were randomly assigned by lottery to two experimental groups and one control group.

Inclusion criteria included voluntary participation (parental consent), age between 4 and 7 years, confirmed diagnosis of Level 1 ASD, high-functioning status in rehabilitation records (verified by a psychiatrist, neurologist, or the Gilliam Autism Rating Scale), no previous exposure to music therapy interventions in the past six months, absence of respiratory or pulmonary diseases or any other conditions affecting vocal or speech abilities, and no hearing impairments. Exclusion criteria included comorbid disorders such as epilepsy, temporary illnesses affecting voice or speech (e.g., common cold), concurrent participation in other forms of music therapy, the occurrence of unpredictable events that interfered with session attendance, lack of parental cooperation during interventions, or parents' withdrawal of consent.

The procedure was conducted as follows: prior to the intervention, parents of the participants completed the Echolalia Subscale of the Aberrant Behavior Checklist (Aman et al.) as the pretest. Additionally, audio recordings of each participant's voice were collected. These recordings were analyzed using the Praat acoustic phonetic software to extract baseline pitch frequency as the pretest measure. The music therapy sessions were then implemented: the first experimental group received active music therapy, while the second group received passive music therapy. No intervention was administered to the control group. Music therapy sessions were held three times per week, each lasting 30 minutes, for a total duration of eight weeks.

At the end of the eighth week, parents once again completed the Echolalia Subscale, and new voice recordings were collected and analyzed using Praat to obtain posttest measures of pitch. After two months, the same procedure—questionnaire completion and voice recording—was repeated for follow-up assessment. Upon completion of the study, all participants received the 24 audio tracks used during the music therapy sessions as a token of appreciation.

2.2. Measures

Aberrant Behavior Checklist (ABC): To assess echolalia, the Echolalia Subscale (inappropriate speech, 4 items) from the Aberrant Behavior Checklist developed by Aman, Singh, Stewart, and Field (1985) was utilized. The ABC is a parent- or teacher-rated instrument consisting of 58 items scored on a four-point Likert scale, with higher scores indicating greater symptom severity. The checklist comprises five subscales: Irritability/Agitation (15 items), Social Withdrawal (16 items), Stereotypic Behavior (7 items), Hyperactivity (16 items), and Echolalia (4 items). Each item is rated from 0 to 3. The ABC has demonstrated strong validity and reliability and is sensitive to therapeutic effects in ASD interventions. This checklist is a widely used instrument in treatment studies on ASD. Confirmatory and exploratory factor analyses were conducted on a sample of 1,893 children with ASD. The root mean square error of approximation (RMSEA) for the standardized item distribution was 0.086, and most items loaded significantly on their primary factors in exploratory analysis. Correlations between ABC subscales and various external checklists, including the Child Behavior Checklist (CBCL), supported the convergent and discriminant validity of the ABC as a reliable measure for behavioral problems in ASD.

Praat Acoustic Phonetic Software: Praat is one of the most widely used tools for speech waveform analysis in linguistic research. It was developed in 1996 by Paul

E-ISSN: 3060-6713

Boersma and David Weenink at the University of Amsterdam, the Netherlands. The software offers a range of capabilities for sound processing, including signal input from files or microphones, tools for examining temporal and frequency-domain characteristics, spectral analysis to uncover the frequency structure of signals, and extraction of speech features such as pitch. The software is freely available along with its C++ source code at http://www.praat.org Although primarily designed for linguistic analysis, Praat is also employed in other scientific fields, including music, medicine, and anthropology.

2.3. Intervention

The intervention consisted of ten structured training sessions designed to enhance executive functions and metacognitive abilities among students with learning disabilities. In the first session, students were introduced to the researcher, the purpose of the program, and the importance of metacognitive strategies and working memory, explained in simple terms suitable for their age. The second session began with a review of the previous lesson, followed by a discussion of the students' personal and academic challenges. Two core metacognitive steps were introduced: pausing to think about a problem and identifying the nature of the situation, illustrated with practical examples such as difficulties in understanding a lesson or managing anger toward classmates. The third session expanded on steps three and four—generating possible solutions and predicting their outcomes—using examples related to planning daily tasks, speaking in groups, and reviewing class content. The fourth session introduced steps five and six, focusing on understanding others' feelings and linking past experiences to new situations, with examples of appropriate classroom behavior. The fifth session emphasized the seventh step, teaching students to revise or change their approach when unsuccessful, followed by a comprehensive review of all previous steps. The sixth session shifted focus to working memory enhancement through rehearsal, mental repetition, and grouping strategies, supported by visual materials and memory exercises. In the seventh session, students practiced visualization techniques to strengthen memory retention by associating words and images, along with concentration exercises such as counting backward from twenty. The eighth session involved categorization and grouping activities to facilitate information storage and retrieval, including memory card games and numerical sequencing tasks. The ninth session concentrated on improving attention and observation skills through the description of objects and environments to develop cognitive awareness. Finally, the tenth session was devoted to reviewing, integrating, and consolidating all learned strategies, ensuring that students could apply executive function and metacognitive techniques independently in their academic and personal contexts.

2.4. Data Analysis

Data were analyzed using repeated-measures analysis of variance (ANOVA) with SPSS version 27.

3. Findings and Results

Descriptive results (Table 1) indicated that the mean scores of echolalia in the active music therapy group slightly decreased from 7.36 in the pretest to 7.09 in the posttest and 7.00 in the follow-up phase, remaining relatively stable. In the passive music therapy group, the mean scores significantly decreased from 5.63 in the pretest to 3.54 in the posttest and 3.15 in the follow-up, while the control group showed no meaningful change, with scores remaining nearly constant (from 8.91 in the pretest to 8.63 in the posttest and 8.54 in the follow-up).

Regarding pitch frequency, no significant differences were observed among the three groups in the pretest. However, in the posttest, the mean pitch scores of the active music therapy group increased considerably and continued to improve in the follow-up. The passive music therapy group showed only a slight improvement, whereas the control group remained unchanged.

Table 1

Descriptive statistics of study variables across the three phases

Variable	Group	Mean	Std. Deviation
Pretest Echolalia	Active Music Therapy	7.3636	3.29462
	Passive Music Therapy	5.6364	2.65604
	Control	8.9091	2.84445
Posttest Echolalia	Active Music Therapy	7.0909	3.26970
	Passive Music Therapy	3.5455	1.69491

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	Control	8.6364	2.69343
Follow-up Echolalia	Active Music Therapy	7.0000	3.00000
	Passive Music Therapy	3.1591	1.35883
	Control	8.5455	2.80584
Pretest Pitch	Active Music Therapy	280.4545	27.82576
	Passive Music Therapy	284.6445	38.71275
	Control	258.7617	48.26179
Posttest Pitch	Active Music Therapy	317.8310	67.21636
	Passive Music Therapy	293.4434	42.25412
	Control	253.8631	55.61630
Follow-up Pitch	Active Music Therapy	342.5795	88.95573
	Passive Music Therapy	293.4331	38.13454
	Control	253.6701	50.74763

The evaluation of assumptions for repeated-measures ANOVA was as follows: first, outliers were checked using boxplots, and no outliers were detected. The Kolmogorov–Smirnov and Shapiro–Wilk tests were used to assess data normality, and results showed that the significance level for the study variables was 0.200, exceeding 0.05, indicating a normal distribution of variables. The Box's M test revealed that the F value for the study variables was not significant at the 0.05 error level; therefore, the null hypothesis was not rejected. Levene's test was used to examine the homogeneity of variances, and since the significance level for all study variables was greater than 0.05, this assumption was also satisfied.

Results of Mauchly's test indicated that the assumption of sphericity for the time variable was violated ($W = 0.511$, $\chi^2 = 19.461$, $df = 2$, $p < 0.001$). Therefore, the Greenhouse–Geisser and Huynh–Feldt corrections were applied for interpreting within-subject effects. For the pitch variable, Mauchly's test showed a significance level of 0.198, which was greater than 0.05; thus, the sphericity assumption was not violated, and the results of repeated-measures ANOVA could be interpreted without adjusting the degrees of freedom.

Table 2

Within-Group and Interaction Effects

Variable	Source	Correction	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Echolalia	Time	Sphericity Assumed	21.441	2	10.720	21.750	.000	.420
		Greenhouse-Geisser	21.441	1.343	15.961	21.750	.000	.420
	Time × Group	Sphericity Assumed	19.215	4	4.804	9.746	.000	.394
		Greenhouse-Geisser	19.215	2.687	7.152	9.746	.000	.394
Pitch	Time	Sphericity Assumed	8114.057	2	4057.029	2.531	.088	.078
		Greenhouse-Geisser	8114.057	1.809	4485.744	2.531	.094	.078
	Time × Group	Sphericity Assumed	14155.901	4	3538.975	2.208	.079	.128
		Greenhouse-Geisser	14155.901	3.618	3912.947	2.208	.086	.128

The results of the within-group effects test (Table 2) showed that the effect of time on echolalia scores was significant. This finding indicates that echolalia scores changed significantly across the three measurement stages—pretest, posttest, and follow-up. Moreover, the interaction effect of time × group was also significant ($F = 9.746$, $p < .001$, $\eta^2 = .394$). In other words, the pattern of change in echolalia scores over time differed among the groups (active music therapy, passive music therapy, and control).

For the pitch variable, the main effect of time on pitch scores was not significant, indicating that overall changes between the pretest, posttest, and follow-up were not substantial. The interaction between time and group was also not statistically significant, although the trend of the means showed that the active music therapy group experienced the greatest improvement.

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Table 3

Between-Group Effects

Variable	Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Echolalia	Group	358.865	2	179.432	8.602	.001	.364
	Error	625.800	30	20.860			
Pitch	Group	56657.181	2	28328.590	5.206	.011	.258
	Error	163237.087	30	5441.236			

The results of the between-group analysis (Table 3) revealed that the group effect on mean echolalia scores was significant. This indicates that the mean echolalia scores differed significantly across the three groups (active music therapy, passive music therapy, and control). The value of partial eta squared also indicated a relatively large effect size, meaning that approximately 36% of the variance in echolalia scores was explained by the type of intervention (active, passive, or control).

The results further showed that the group effect on mean pitch scores was significant ($p = .011$, $\eta^2 = .258$), indicating a meaningful difference among the active music therapy, passive music therapy, and control groups.

Table 4

Multivariate Tests

Variable	Source	Test	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Echolalia	Time	Pillai's Trace	.472	12.972[b]	2.000	29.000	.000	.472
		Wilks' Lambda	.528	12.972[b]	2.000	29.000	.000	.472
		Hotelling's Trace	.895	12.972[b]	2.000	29.000	.000	.472
		Roy's Largest Root	.895	12.972[b]	2.000	29.000	.000	.472
	Time × Group	Pillai's Trace	.455	4.413	4.000	60.000	.003	.227
		Wilks' Lambda	.545	5.135[b]	4.000	58.000	.001	.262
		Hotelling's Trace	.834	5.835	4.000	56.000	.001	.294
		Roy's Largest Root	.834	12.504[c]	2.000	30.000	.000	.455
Pitch	Time	Pillai's Trace	.194	3.490	2.000	29.000	.044	.194
		Wilks' Lambda	.806	3.490	2.000	29.000	.044	.194
		Hotelling's Trace	.241	3.490	2.000	29.000	.044	.194
		Roy's Largest Root	.241	3.490	2.000	29.000	.044	.194
	Time × Group	Pillai's Trace	.294	2.589	4.000	60.000	.046	.147
		Wilks' Lambda	.706	2.756	4.000	58.000	.036	.160
		Hotelling's Trace	.416	2.909	4.000	56.000	.029	.172
		Roy's Largest Root	.414	6.206	2.000	30.000	.006	.293

According to the results of the multivariate tests (Table 4), the effect of time on the echolalia variable was significant. This finding indicates that echolalia scores changed significantly over the three stages—pretest, posttest, and follow-up—and that approximately 47% of these changes were attributable to the time factor. Moreover, the time × group interaction effect was also significant, meaning that the pattern of changes in echolalia over time was not the same across the active music therapy, passive music therapy, and control groups. The different interventions produced varying effects on the trajectory of change in this variable. These results suggest that the type of music therapy can have a considerable impact on changes in echolalia over time.

Regarding the pitch variable, the univariate analysis showed that the main effect of time alone was not significant, and the time × group interaction was marginal. However, the multivariate analysis revealed that both the time effect and the time × group interaction were significant. This difference is reasonable because the multivariate test examines all dimensions of the dependent variable simultaneously and has greater statistical power to detect small or distributed changes. Therefore, although the univariate analysis did not formally show a time effect, the multivariate results confirmed that the changes in scores over time were real and that the improvement trends among groups differed.

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Table 5

Bonferroni Post Hoc Tests for Treatment Comparisons

Variable	(I) Group	(J) Group	Mean Difference (I–J)	Std. Error	Sig.	95% CI (Lower Bound)	95% CI (Upper Bound)
Echolalia	Active Music Therapy	Passive Music Therapy	3.038*	1.124	.034	.187	5.889
		Control	-1.545	1.124	.538	-4.397	1.306
	Passive Music Therapy	Active Music Therapy	-3.038*	1.124	.034	-5.889	-.187
		Control	-4.583*	1.124	.001	-7.434	-1.732
	Control	Active Music Therapy	1.545	1.124	.538	-1.306	4.397
		Passive Music Therapy	4.583*	1.124	.001	1.732	7.434
Pitch	Active Music Therapy	Passive Music Therapy	23.115	18.160	.639	-22.933	69.163
		Control	58.190	18.160	.010	12.142	104.238
	Passive Music Therapy	Active Music Therapy	-23.115	18.160	.639	-69.163	22.933
		Control	35.075	18.160	.189	-10.973	81.123
	Control	Active Music Therapy	-58.190	18.160	.010	-104.238	-12.142
		Passive Music Therapy	-35.075	18.160	.189	-81.123	10.973

As shown in Table 5, the passive music therapy group demonstrated the greatest reduction in echolalia, decreasing from 5.64 in the pretest to 3.55 in the posttest and 3.16 in the follow-up phase, indicating a significant effect of this intervention in reducing the disorder. The active music therapy and control groups showed much smaller changes; therefore, the intervention effect in these two groups was relatively limited.

The results of pairwise comparisons were consistent with these findings, indicating that the passive group performed better and achieved greater reductions. The difference between the passive and control groups was negative and significant, confirming that passive music therapy had the strongest effect in reducing echolalia symptoms.

Furthermore, the active music therapy group showed significantly higher pitch scores than the control group, whereas the differences between the active and passive groups and between the passive and control groups were not statistically significant. These findings suggest that active music therapy had a notable effect on improving pitch modulation, while passive music therapy did not produce a significant difference compared with the control condition.

4. Discussion and Conclusion

The present study investigated the comparative effectiveness of active and passive music therapy on *echolalia* and *pitch frequency* in children with Level 1 Autism Spectrum Disorder (ASD). The results revealed that both forms of music therapy led to improvements in the target variables, but their degrees and directions of effectiveness differed. Specifically, passive music therapy showed a significant reduction in echolalia compared to active therapy and the control group, whereas active music therapy produced a more notable improvement in pitch modulation and prosodic variability. These findings demonstrate that distinct mechanisms underpin the therapeutic benefits of active and passive musical engagement and that the modality of intervention plays a critical role in shaping behavioral and communicative outcomes in autistic children.

The significant decline in echolalia observed in the passive music therapy group aligns with previous findings that auditory exposure to structured rhythmic and melodic content enhances auditory processing and reduces verbal stereotypy (Kabuk et al., 2022; Khanjani & Khaknezhad, 2016). Passive music therapy facilitates neural regulation through predictable rhythmic sequences, which can modulate sensory hypersensitivity and stabilize attention, reducing the cognitive overload often associated with verbal repetition (Stekić, 2024). According to Gao et al. (2025), passive auditory stimulation promotes behavioral self-regulation and decreases repetitive vocalizations by engaging the parasympathetic nervous system and promoting affective calmness (Gao et al., 2025). This

E-ISSN: 3060-6713

mechanism may explain why the passive condition yielded the strongest improvement in echolalia among participants in this study. Similar outcomes were also observed in studies demonstrating the anxiolytic and self-regulatory effects of passive auditory interventions in clinical populations (Caponnetto et al., 2022; Kabuk et al., 2022).

In contrast, the improvement in pitch frequency in the active music therapy group underscores the role of motor-auditory coordination in enhancing prosodic and expressive speech capacities. Active engagement—through singing, rhythmic tapping, and vocal imitation—facilitates the integration of auditory and motor systems involved in speech production (Chenausky et al., 2017; Lim, 2010). This supports the findings of Harbison et al. (2020) and Holbrook and Israelsen (2020), who reported that speech prosody interventions emphasizing rhythm and vocal control improved pitch range and modulation in children with ASD (Harbison et al., 2020; Holbrook & Israelsen, 2020). The repetitive, structured nature of active music sessions may stimulate neuroplasticity in regions responsible for temporal processing, such as the superior temporal gyrus and premotor cortex, leading to better control of vocal pitch and prosodic variation (Khaliulin et al., 2025).

The differential outcomes between active and passive modalities also resonate with Stekić's (2024) theoretical framework, which suggests that active musical engagement primarily affects sensorimotor integration and expressive communication, while passive engagement influences emotional regulation and cognitive stability (Stekić, 2024). The current findings extend this model by showing that passive listening may be more effective in reducing repetitive speech behaviors, whereas active participation better enhances pitch expressivity. This distinction reflects the complementary nature of both interventions—each addressing unique aspects of communication deficits in ASD. The presence of consistent improvement in both modalities highlights music therapy's versatility as a multimodal treatment capable of targeting behavioral, cognitive, and emotional domains simultaneously (Geretsegger et al., 2014; Yinger & Gooding, 2014).

Another key finding was the persistence of therapeutic effects at the two-month follow-up, particularly for passive music therapy in reducing echolalia. This suggests that passive auditory exposure may foster lasting neural adaptations in auditory and speech-related circuits (Ferdosi & Ashayeri, 2015; Ferdosi et al., 2013). Similar long-term retention has been reported in studies employing melodic intonation therapy (MIT), where the rhythmic and tonal elements of music facilitate speech-motor mapping and reduce stereotyped repetition (Chenausky et al., 2017; Lim, 2010). These sustained effects can be attributed to repetitive auditory entrainment, which reinforces cortical synchronization and supports stable language patterns (Gao et al., 2025).

From a neuropsychological perspective, the observed effects can also be understood through the lens of *auditory-motor mapping* and *neural entrainment* mechanisms. Active music therapy, by combining vocal imitation and rhythmic motion, enhances cross-hemispheric communication between language and motor areas, strengthening neural pathways implicated in speech production (Chenausky et al., 2017). Passive therapy, in turn, induces relaxation and selective attention, which may reduce the anxiety-driven compulsive repetition of speech characteristic of echolalia (Hamidifard et al., 2023; Kabuk et al., 2022). Khaliulin et al. (2025) highlighted the importance of mitochondrial and neural network efficiency in ASD, suggesting that music-induced neural activation might optimize metabolic signaling and improve connectivity within auditory-motor circuits (Khaliulin et al., 2025).

The results of this study are also in agreement with prior findings from Ferdosi and Ashayeri (2015), who demonstrated that rhythmic-melodic interventions significantly enhanced speech fluency and reduced verbal rigidity in autistic children (Ferdosi & Ashayeri, 2015). Similarly, Farahani Sepehr et al. (2014) reported that systematic repetition techniques, when rhythmically structured, decrease echolalia frequency and improve attentional control (Farahani Sepehr et al., 2014). The convergence between these studies and the present findings underscores the vital role of rhythm and melody in scaffolding verbal learning and prosodic adjustment in children with ASD.

Furthermore, the significant between-group difference in pitch improvement for active therapy participants corroborates the literature on the role of rhythmic synchronization in developing speech prosody (Harbison et al., 2020; Holbrook & Israelsen, 2020). Active music therapy stimulates prefrontal and limbic networks associated with emotion perception and prosodic interpretation, leading to more expressive and socially congruent vocalizations (Yinger & Gooding, 2014). In children with ASD, who often struggle with monotone intonation and limited emotional expression, such improvements in pitch range represent a meaningful step toward natural speech production and social reciprocity (Lim, 2010).

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The effectiveness of both modalities may also be partially attributed to their shared rhythmic foundation, which offers predictability and structure—features particularly beneficial for children with ASD who thrive on consistency (Gao et al., 2025; Geretsegger et al., 2014). Predictable rhythm patterns help synchronize brain oscillations, facilitating attentional engagement and reducing sensory overload (Stekić, 2024). These mechanisms may explain why both active and passive forms of music therapy led to observable improvements, though through different pathways—passive listening reducing anxiety and overarousal, and active participation enhancing expressive communication and cognitive flexibility.

The results of the current study also reinforce findings by Hamidifard et al. (2023), who found that music therapy improved executive function and reduced maladaptive behaviors among children with ASD (Hamidifard et al., 2023). Executive dysfunction often exacerbates echolalia and prosodic irregularities; thus, improvements in cognitive control through rhythmic training could account for the observed behavioral and communicative gains. Similarly, Shiri et al. (2018) demonstrated that structured family-based behavioral management reduced repetitive behaviors in autistic children (Shiri et al., 2018). When placed in this context, music therapy may serve as a parallel behavioral modulation tool that achieves similar outcomes through sensory and affective channels.

The clinical implications of the present findings are particularly relevant for contexts where speech and language deficits coexist with emotional dysregulation. Music therapy—especially passive modalities—offers a non-invasive, enjoyable, and culturally adaptable intervention. It can complement speech-language therapy by reinforcing auditory attention and reducing stress associated with speech initiation. On the other hand, active engagement can act as a bridge between nonverbal communication and linguistic articulation, supporting both expressive and receptive communication. Karami et al. (2012) have also demonstrated that artistic therapies, including painting, can reduce aggressive tendencies and emotional disturbances in students with learning difficulties, highlighting the generalizable emotional benefits of creative modalities (Karami et al., 2012).

The use of the Aberrant Behavior Checklist (ABC) to assess therapeutic outcomes in this study further strengthens the validity of findings, as this instrument has been extensively validated for ASD populations (Kaat et al., 2014). Its sensitivity to subtle behavioral changes allowed for precise measurement of improvements in echolalia and prosodic behaviors following the intervention. Consistent with the findings of Geretsegger et al. (2014), the ABC has been shown to reliably capture reductions in repetitive and maladaptive behaviors following music therapy (Geretsegger et al., 2014). Thus, the consistency between quantitative measures and qualitative observations reinforces the robustness of the observed outcomes.

Overall, the results provide a nuanced understanding of how different music therapy modalities address distinct dimensions of communicative deficits in autism. Passive music therapy primarily regulates affective and repetitive behaviors through auditory relaxation, while active music therapy facilitates expressive speech through motor and vocal coordination. This distinction underscores the necessity of tailoring music therapy interventions based on individual needs, cognitive profiles, and sensory preferences. The alignment between the current findings and previous meta-analyses (Gao et al., 2025; Wang et al., 2023) suggests that music therapy should be considered an essential component of comprehensive rehabilitation programs for children with ASD.

Despite its promising outcomes, this study is subject to certain limitations. The relatively small sample size (33 participants) limits the generalizability of the findings, particularly regarding the variability of responses across the autism spectrum. The study's quasi-experimental design, while controlled, does not entirely eliminate the possibility of confounding variables such as home exposure to music or parental involvement. Additionally, the follow-up period of two months may not capture the long-term sustainability of therapeutic effects, especially for prosodic and cognitive domains that evolve gradually. Another limitation lies in the lack of neurophysiological measures (e.g., EEG or fMRI) that could directly validate the hypothesized neural mechanisms underlying the observed behavioral changes. Furthermore, individual differences in musical familiarity, sensory sensitivity, and baseline verbal ability could have influenced responsiveness to the intervention.

Future research should employ larger, randomized controlled trials with longitudinal follow-ups to examine the durability and generalizability of active and passive music therapy outcomes. Studies integrating neuroimaging techniques could further elucidate the neural correlates of rhythmic and melodic interventions, offering a clearer understanding of brain plasticity associated with music-based therapy. Additionally, exploring the effects of combined modalities—such as hybrid programs

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incorporating both active and passive components—may reveal synergistic benefits for communication and emotional regulation. It is also recommended that future work examines the role of cultural and linguistic variations in shaping therapeutic responsiveness, particularly in non-Western contexts. Finally, expanding participant diversity to include varying ASD severity levels and age ranges will enhance the ecological validity and clinical applicability of music therapy research.

Clinicians and educators working with children with ASD should consider integrating both active and passive forms of music therapy into individualized treatment plans. Passive music therapy can be utilized as a preparatory or relaxation phase to improve attention and reduce anxiety before speech or behavioral interventions. Active music therapy, emphasizing rhythmic vocal imitation and body movement, can be employed to strengthen prosody, articulation, and expressive skills. Collaboration between music therapists, speech-language pathologists, and special education teachers can optimize the therapeutic impact by aligning goals across disciplines. Incorporating family participation in at-home listening or singing sessions may further reinforce therapeutic gains and foster social bonding. Given its accessibility, non-invasiveness, and cultural adaptability, music therapy represents a valuable adjunctive tool in comprehensive ASD rehabilitation programs.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

We would like to express our gratitude to all individuals helped us to do the project.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants (Ethics Code: (IR.IAU.R.REC.1404.006)).

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E-ISSN: 3060-6713