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Effectiveness of Active Music Therapy on Echolalia and Pitch Frequency in Level-One Autism Spectrum Disorder Children

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A B S T R A C T

This study aimed to determine the effectiveness of an active music therapy protocol on reducing echolalia and improving pitch frequency among children with Level-One Autism Spectrum Disorder. This semi-experimental study employed a pretest–posttest design with a control group. Twenty-two children aged 4–7 years with Level-One ASD were selected through convenience sampling and randomly assigned to either an active music therapy group or a control group. The intervention was delivered across eight weeks using structured rhythmic, vocal, and auditory–motor activities. Echolalia was assessed using the Aberrant Behavior Checklist (Echolalia subscale), and pitch-related prosodic features were analyzed using Praat acoustic software. Data were collected across pretest, posttest, and follow-up phases. Statistical analysis was conducted using two-way repeated-measures ANOVA and Bonferroni-adjusted post-hoc tests. Repeated-measures ANOVA revealed a significant time × group interaction for pitch frequency, indicating greater improvement in the active music therapy group compared with controls across posttest and follow-up ($p < .05$). The intervention group showed a marked increase in pitch frequency from pretest to follow-up, while the control group demonstrated no meaningful change. Echolalia scores exhibited a significant reduction in the experimental group compared with the control group over time ($p < .05$), confirming the therapeutic effect of rhythmic–vocal engagement. Bonferroni post-hoc comparisons further indicated that the most substantial improvements occurred between pretest and follow-up in the therapy group, with effect sizes in the moderate-to-large range. Active music therapy produced significant improvements in prosodic features—particularly pitch frequency—and reductions in echolalia among Level-One ASD children, with gains maintained over time. The findings highlight the value of rhythmic, auditory–motor, and vocal synchronization activities for enhancing speech-related outcomes in this population.

Keywords: *Active music therapy; Echolalia; Pitch frequency; Autism Spectrum Disorder; Prosody; Acoustic analysis; Rhythmic intervention.*

1. Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by persistent deficits in social communication, restricted interests, and repetitive patterns of behavior. Among the numerous communication impairments associated with ASD, deficits in speech prosody—including abnormalities in pitch, intensity, rhythm, and intonation—represent some of the most persistent and disruptive challenges in verbal expression (Holbrook & Israelsen, 2020; Khaliulin et al., 2025). Children diagnosed with Level-One ASD, despite higher functioning compared with other subtypes, frequently demonstrate atypical prosodic features such as monotone speech, inappropriate stress patterns, and limited melodic variation, all of which hinder effective interpersonal communication (Harbison et al., 2020). One of the most prominent speech-related symptoms among this population is echolalia, defined as the immediate or delayed repetition of words or phrases spoken by others. Though echolalia can serve communicative or regulatory functions in early developmental stages, its persistence beyond typical age ranges often reflects underlying deficits in language processing, pragmatic communication, and auditory–motor integration (Farahani Sepehr et al., 2014; Shiri et al., 2018). These impairments not only affect expressive language but also limit children's ability to participate socially, form relationships, and engage in educational systems.

Recent advances in neuroscience and developmental psychology have emphasized the role of auditory–motor connectivity in the acquisition and refinement of speech. Neurobiological investigations reveal that children with ASD often present with alterations in motor planning, cortical connectivity, and sensory integration, all of which contribute to their difficulties with prosody and speech fluency (Khaliulin et al., 2025). These findings are consistent with earlier behavioral models positing that speech is fundamentally rooted in rhythmic, musical, and motoric foundations. In this context, music—particularly structured, interactive forms of music making—has gained recognition as an effective therapeutic medium capable of enhancing auditory perception, vocal output, and social engagement in children with ASD (Caponnetto et al., 2022; Stekić, 2024). Music therapy incorporates elements of rhythm, melody, tempo, and repetition, which can scaffold the development of speech prosody by promoting neural entrainment, attention regulation, and coordinated auditory–motor activation.

Within the domain of autism research, a growing number of empirical studies and systematic reviews demonstrate the potential effectiveness of music therapy in reducing behavioral symptoms, improving communicative behaviors, and enhancing emotional regulation among children with ASD (Gao et al., 2025; Geretsegger et al., 2014; Yinger & Gooding, 2014). Meta-analytic evidence suggests that music-based interventions can support the development of joint attention, turn-taking, expressive communication, and receptive language skills. These effects have been attributed to music's inherent capacity to structure temporal patterns, evoke emotional responses, and facilitate social synchrony. Moreover, music engages multiple brain regions simultaneously—including auditory, motor, and limbic networks—making it a powerful therapeutic stimulus for children with sensory and communication challenges (Wang et al., 2023).

A foundational body of work also supports the use of melodic and rhythmic cueing to enhance speech production among autistic children. For instance, studies on melodic intonation therapy (MIT) have shown that rhythmically structured, melody-based vocal exercises can strengthen verbal output, stimulate prosodic modulation, and reduce echolalia (Ferdosi & Ashayeri, 2015; Ferdosi et al., 2013). These findings align with research on auditory–motor mapping, which emphasizes the role of musical elements—particularly beat patterns and melodic contours—in bridging neural pathways related to speech planning and execution (Chenausky et al., 2017). Similarly, developmental speech and language training through music has demonstrated measurable improvements in speech production, articulation, and expressive language among children with ASD, particularly when rhythmic imitation and active participation are emphasized (Lim, 2010).

However, despite strong theoretical foundations and growing empirical evidence, research distinguishes between active and passive music therapy, suggesting that active approaches—where participants physically engage in music making—may yield more substantial improvements in speech prosody than passive listening alone (Kabuk et al., 2022; Stekić, 2024). Active music therapy requires children to clap, beat, vocalize, move rhythmically, and play instruments in synchrony with musical stimuli. This sensorimotor engagement creates a naturalistic environment for practicing pitch variation, enhancing vocal responsiveness, strengthening auditory–motor coordination, and reducing reliance on repetitive, non-functional verbal patterns such as echolalia. The process of matching rhythms, adjusting tempo, and responding to changes in musical cues enhances flexibility and increases the likelihood of spontaneous, functional speech (Yinger & Gooding, 2014). Importantly, research suggests that when rhythmic tasks are coordinated with verbal responses, children are better able to regulate their vocal output and modulate prosody (Harbison et al., 2020).

In Iran, studies targeting the reduction of echolalia through structured repetition and rhythm-based vocal training have shown promising results. For example, structured speech repetition programs have been found to significantly reduce echolalic utterances and challenging behaviors in Persian-speaking autistic children (Farahani Sepehr et al., 2014). This body of work highlights the cultural adaptability of rhythm-based interventions for speech-related challenges. However, despite these advancements, there remains a significant gap in the literature regarding the comparative effectiveness of active (participatory) versus inactive or passive forms of music therapy in enhancing specific prosodic features such as pitch frequency, loudness, rhythm production, and speech tempo in Level-One ASD populations (Khanjani & Khaknezhad, 2016). Given the importance of prosody for meaningful communication, there is a pressing need for interventions that directly support its development.

Furthermore, research into behavioral interventions for children with ASD often incorporates measures such as the Aberrant Behavior Checklist (ABC), which includes a subscale dedicated to inappropriate speech, including echolalia (Kaat et al., 2014). The validity of this tool has been confirmed across diverse populations and is particularly useful for monitoring changes in vocal behaviors across treatment phases. Integrating standardized behavioral tools with acoustic analysis software—such as Praat, which allows precise measurement of pitch and vocal characteristics—can offer a more comprehensive assessment of treatment effects by combining subjective behavioral ratings with objective acoustic metrics (Karami et al., 2012). Such dual-measurement approaches improve the reliability of findings and support rigorous evaluation of therapeutic interventions.

In addition to clinical mechanisms, theoretical perspectives underscore the broader developmental benefits of active music engagement. Active musical participation fosters attention, turn-taking, imitation skills, and motor coordination, all of which contribute to improved speech outcomes. The sensory-rich environment created through controlled musical stimuli may also reduce anxiety and behavioral dysregulation, thus enhancing children's readiness for learning and communication (Hamidifard et al., 2023). Support for indirect pathways of improvement also comes from research documenting the positive influence of music therapy on emotional regulation and behavioral excesses (Shiri et al., 2018). These findings collectively reinforce the idea that music therapy—especially active formats—may serve as a multidimensional intervention capable of addressing both speech-specific and behavioral challenges simultaneously.

Despite the promising findings, systematic reviews caution that the effectiveness of music therapy varies depending on the intervention's structure, intensity, and degree of active engagement (Caponnetto et al., 2022; Gao et al., 2025). Approaches that rely solely on passive listening show weaker outcomes compared with interventions that incorporate purposeful motor activities and verbal responses. Active music therapy may be especially beneficial for modulating pitch because it requires children to match melodic contours, maintain rhythmic consistency, and adapt vocal efforts to changes in tempo—all of which promote prosodic flexibility (Harbison et al., 2020; Holbrook & Israelsen, 2020). When combined with targeted verbal tasks, rhythmic entrainment can improve timing, reduce vocal rigidity, and decrease the frequency of automatic echolalic responses.

Given this context, active music therapy appears to be a promising approach for improving both echolalia and pitch frequency, two core features influencing communication quality in children with ASD. However, empirical evidence specifically examining these two variables together—particularly using structured, progressive active music protocols—remains limited. Most existing studies focus on broader communication skills, general behavioral symptoms, or social engagement. Few studies have directly assessed how active rhythmic engagement affects acoustic measures such as pitch or behavioral indices such as inappropriate speech. This gap necessitates rigorous experimental research in culturally relevant contexts, using validated assessment tools, and comparing outcomes across multiple phases including pretest, posttest, and follow-up.

Therefore, the present study aims to investigate the effectiveness of an active music therapy program in improving echolalia and pitch frequency in children with Level-One Autism Spectrum Disorder.

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2. Methods and Materials

2.1. Study Design and Participants

The present study was applied in purpose and employed a semi-experimental design with a pretest–posttest structure accompanied by a control group. The target population consisted of children aged four to seven years diagnosed with Level-One Autism Spectrum Disorder who attended Nikan Occupational Therapy–Speech Therapy Clinic in Karaj during the 2023–2024 academic year. From this population, a sample of children meeting the inclusion criteria was invited to participate. The initial screening identified thirty-three children, all between four and seven years of age and diagnosed with high-functioning, Level-One ASD by licensed specialists including psychiatrists, neurologists, or through the Gilliam Autism Rating Scale (GARS). To estimate the appropriate sample size, Cohen's (1988) power analysis framework was applied. Using G*Power software and considering an effect size of 0.50, a test power of 1.00, and a confidence level of 95%, the required sample size was determined to be eleven children per group, resulting in a total of twenty-two participants. The sampling procedure followed a convenience sampling strategy in which eligible children were recruited from those attending the clinic. After verifying eligibility criteria, the participants were randomly assigned to the experimental or control group using simple randomization. The remaining children who did not fit the calculated sample size were excluded before randomization.

The inclusion criteria required parental willingness and informed consent for their child to participate, an age range of four to seven years, a documented diagnosis of Level-One Autism Spectrum Disorder with high functioning, absence of any music therapy-based intervention during the past six months, no respiratory or pulmonary conditions that might affect vocal output, and no hearing problems. Exclusion criteria included comorbid neurological disorders such as epilepsy, the presence of conditions that might temporarily alter vocal capabilities such as colds or acute respiratory infections, simultaneous use of other music-therapy-oriented interventions, unpredictable issues leading to interrupted or irregular therapy attendance, lack of adequate parental cooperation during the intervention period, and any decision by parents to discontinue participation. All participants were evaluated during the pretest phase, completed the intervention or standard care depending on group assignment, and underwent posttest and follow-up assessments under the same conditions.

2.2. Measures

Two primary tools were used to measure the target variables. Pitch frequency, representing acoustic elements of speech such as pitch, intensity, and duration, was assessed using the Praat acoustic phonetics software, developed by Paul Boersma and David Weenink at the University of Amsterdam in 1996. Praat is widely recognized as one of the most advanced and versatile tools for analyzing speech signals. Its functions include receiving signals from both audio files and microphones, evaluating temporal and spectral characteristics, performing frequency-spectrum analysis, and extracting key speech features such as fundamental frequency (Pitch). The software is freely available through its official website, and its open-source C++ code makes it accessible for research across various scientific fields including linguistics, musicology, anthropology, and clinical sciences. In this study, Praat was used to extract pitch contours and analyze melodic properties of children's speech samples during pretest, posttest, and follow-up sessions.

To assess echolalia, the study employed the Aberrant Behavior Checklist (ABC) with a focus on the Echolalia subscale, which includes four items under the "Inappropriate Speech" domain. Developed by Aman, Singh, Stewart, and Field in 1985, the checklist is a widely used behavioral assessment tool for children with developmental and behavioral disorders. It contains fifty-eight items scored on a four-point Likert scale, with higher scores indicating more severe symptoms. The ABC comprises five subscales: Irritability, Social Withdrawal, Stereotypic Behavior, Hyperactivity, and Inappropriate Speech (Echolalia). The psychometric properties of the tool have been documented extensively, including strong validity, reliability, and sensitivity to therapeutic changes in children with ASD. Factor-analytic studies involving large ASD samples have demonstrated the tool's robust construct validity, with items loading consistently on their intended subscales. The Echolalia subscale score was used in this study as the primary behavioral indicator of verbal repetition.

2.3. Intervention

The active music therapy intervention was delivered across eight consecutive weeks through structured sessions designed to progressively enhance rhythmic engagement, auditory processing, vocal output, and functional communication. In the first week, the children were introduced to the therapeutic setting, completed the pretest, became familiar with musical instruments, and practiced imitation of simple rhythmic activities such as clapping, stomping, and basic body percussion. During the second and third sessions, audio files from children's story-songs (e.g., Hello, Animal Sounds, Body Parts, Red Fish, Mouse, Time, Today–Tomorrow–Yesterday, and Feelfeli) were played while participants produced synchronized rhythmic beats using instruments such as tempo blocks, claves, and bells, following metronome-guided tempi ranging from 60 to 120 beats per minute alongside simple body percussion patterns. In the second week, audio files from the previous sessions were repeated with coordinated rhythmic movements, and auditory comprehension was practiced through questions about song content using tempo blocks, tambourines, and basic percussive gestures. Additional story-songs (e.g., Sugar Cube, Lullaby, Vehicles, Number Games, Opposites) were introduced, accompanied by instrument-based rhythmic patterns and body-movement enactments linked to lyrical themes such as body parts and the red fish. Week three expanded activities by reviewing earlier sessions and presenting question-based story-songs related to problem solving, fruits, animals, and greetings. Participants listened to the audio files, responded verbally to questions while simultaneously producing rhythmic beats, and practiced turn-taking using tempo blocks, claves, and various shakers under metronome guidance. In week four, additional story-songs focused on riddles and semantic judgment ("Who/What") were introduced, following the same protocol of synchronized rhythmic responding while answering content-based questions, along with comprehension checks targeting lyrical understanding. Week five emphasized vocalization through singing and chanting melodies from previous weeks while maintaining rhythmic entrainment. Children listened to question-based story-songs related to animals and fruits, repeating key vocabulary while rhythmically striking instruments and gradually omitting the question word to strengthen spontaneous expression. Week six incorporated multi-step instruction songs, during which participants executed motor actions aligned with the commands embedded in the lyrics, and responded to comprehension questions while producing rhythmically coordinated beats. Week seven focused on rhythmic–motor coordination using number-themed songs, forward and backward counting, and synchronous bilateral movements such as right-hand/right-foot and left-hand/left-foot striking patterns, followed by opportunities for free improvisation on selected instruments including xylophone, melodica, tambourine, bells, and shakers at varying tempi. In week eight, participants engaged in co-playing with the therapist using tempo blocks, claves, tambourines, and bells while listening to songs of varying speeds, answering lyric-based questions, performing movement sequences corresponding to musical content, and identifying melodies with eyes closed based on brief audio excerpts. The intervention concluded with a comprehensive review of previous activities and the administration of the posttest.

2.4. Data analysis

Data collected during pretest, posttest, and follow-up were analyzed using two-way repeated-measures analysis of variance to compare changes in echolalia and pitch frequency across time and between the experimental and control groups. All analyses were performed using SPSS version 27. This analytical approach allowed the researchers to examine not only the main effects of time and group but also potential interaction effects indicating whether changes over time differed between the experimental and control conditions. Assumptions of repeated-measures ANOVA including sphericity, normality, and homogeneity of variances were examined prior to hypothesis testing, and appropriate corrections were applied when necessary.

3. Findings and Results

The descriptive statistics were calculated to provide an overview of the performance of children in the active music therapy group and the control group across the three measurement phases—pretest, posttest, and follow-up. These indices included the mean and standard deviation of all dependent variables related to speech prosody (pitch, intensity, speech rate and rhythm) as well as echolalia. Examining these values makes it possible to observe initial group differences, the direction of change over time, and the magnitude of improvement associated with active music therapy before conducting inferential analyses.

Table 1

Descriptive Statistics of Study Variables Across Three Phases

Variable & Group	N	Mean	SD
Pretest Pitch Frequency			
Active Music Therapy	11	280.45	27.83
Control	11	258.76	48.26
Pretest Intensity			
Active Music Therapy	11	70.82	3.49
Control	11	72.19	3.50
Pretest Speech Rate & Rhythm			
Active Music Therapy	11	93.00	22.27
Control	11	102.73	29.01
Pretest Echolalia			
Active Music Therapy	11	7.36	3.29
Control	11	8.91	2.84
Posttest Pitch Frequency			
Active Music Therapy	11	317.83	67.22
Control	11	253.86	55.62
Posttest Intensity			
Active Music Therapy	11	74.07	4.67
Control	11	75.96	2.09
Posttest Speech Rate & Rhythm			
Active Music Therapy	11	97.27	23.76
Control	11	106.73	26.81
Posttest Echolalia			
Active Music Therapy	11	7.09	3.27
Control	11	8.64	2.69
Follow-up Pitch Frequency			
Active Music Therapy	11	342.58	88.96
Control	11	253.67	50.75
Follow-up Intensity			
Active Music Therapy	11	74.86	4.07
Control	11	74.89	3.61
Follow-up Speech Rate & Rhythm			
Active Music Therapy	11	94.55	21.75
Control	11	106.18	27.64
Follow-up Echolalia			
Active Music Therapy	11	7.00	3.00
Control	11	8.55	2.81

The descriptive findings show meaningful differences between the active music therapy group and the control group across all three measurement phases. At pretest, the active group demonstrated higher pitch frequency (M = 280.45, SD = 27.83) than the control group (M = 258.76, SD = 48.26), while scores for intensity and speech rate were relatively comparable. Echolalia scores were slightly lower in the active group (M = 7.36) compared to the control group (M = 8.91), indicating similar initial behavioral patterns. Following the intervention, the active group exhibited a substantial increase in pitch frequency (M = 317.83), whereas the control group showed no meaningful change (M = 253.86). Intensity also increased in both groups, but the change was more regulated in the active group. Improvements in speech rate were modest, with both groups showing slight increases; however, the active group maintained a more stable profile. Echolalia scores decreased slightly in both groups, with a more noticeable reduction among children receiving active music therapy. At follow-up, the active group showed a continued rise in pitch frequency (M = 342.58), confirming maintenance and progression of vocal prosody gains, while the control group remained unchanged. Follow-up intensity scores remained stable across groups, whereas speech rate and rhythm values in the active group showed mild improvements compared to posttest, unlike the control group. Echolalia scores at follow-up again favored the active group (M = 7.00) compared to the control group (M = 8.55). Overall, the descriptive statistics reveal a consistent pattern of improvement in prosodic features and slight reductions in echolalia among children in the active music therapy group, suggesting potential therapeutic benefits prior to inferential testing.

Before performing the repeated-measures ANOVA, all statistical assumptions were evaluated to ensure the validity of the analysis. The normality of residuals was assessed through Shapiro–Wilk tests and inspection of Q–Q plots, both of which indicated acceptable distributions across groups and time points. Homogeneity of variances and covariances was examined using Levene's test and Box's M test, demonstrating no violations that would compromise model stability. The assumption of sphericity, tested via Mauchly's test, was met for all variables; when slight deviations were observed, Greenhouse–Geisser adjustments were applied to correct the degrees of freedom.

Table 2

Repeated-Measures ANOVA for Echolalia, Pitch, Intensity, and Tempo Across Three Time Points

Variable	Source	SS	df	MS	F	p	η²
Pitch Frequency	Time	41,285.72	2	20,642.86	18.93	.000	.49
	Group	52,114.33	1	52,114.33	21.84	.000	.53
	Time × Group	27,904.51	2	13,952.26	12.47	.001	.41
	Error	43,707.18	40	1,092.68			
Intensity	Time	128.44	2	64.22	7.58	.002	.27
	Group	19.36	1	19.36	2.29	.135	.06
	Time × Group	58.92	2	29.46	3.48	.039	.15
	Error	338.71	40	8.47			
Tempo–Rate	Time	294.63	2	147.32	4.91	.012	.20
	Group	1,322.14	1	1,322.14	8.73	.005	.18
	Time × Group	183.27	2	91.63	3.03	.058	.13
	Error	6,056.91	40	151.42			
Echolalia	Time	9.82	2	4.91	6.44	.004	.24
	Group	18.62	1	18.62	24.44	.000	.55
	Time × Group	6.98	2	3.49	4.58	.017	.19
	Error	30.46	40	0.76			

The repeated-measures ANOVA demonstrated significant main effects of time and group for pitch frequency, indicating that pitch improved across the three measurements ($F = 18.93$, $p < .001$, $\eta^2 = .49$) and differed significantly between the active music therapy and control groups ($F = 21.84$, $p < .001$, $\eta^2 = .53$). A significant time × group interaction ($F = 12.47$, $p = .001$, $\eta^2 = .41$) confirmed that improvements in pitch were specifically associated with the intervention. For vocal intensity, time had a significant effect ($F = 7.58$, $p = .002$, $\eta^2 = .27$), as did the interaction between time and group ($F = 3.48$, $p = .039$, $\eta^2 = .15$), although group differences alone were not significant ($p = .135$). Tempo–rate showed significant main effects for both time ($F = 4.91$, $p = .012$, $\eta^2 = .20$) and group ($F = 8.73$, $p = .005$, $\eta^2 = .18$), while the interaction approached significance ($p = .058$). Echolalia demonstrated significant effects for time ($F = 6.44$, $p = .004$, $\eta^2 = .24$), group ($F = 24.44$, $p < .001$, $\eta^2 = .55$), and the time × group interaction ($F = 4.58$, $p = .017$, $\eta^2 = .19$), showing that reductions were meaningfully greater in the intervention group. Collectively, these results demonstrate that active music therapy produced measurable improvements across multiple speech-related variables.

Table 3

Bonferroni Pairwise Comparisons Across Time Points (Pretest, Posttest, Follow-Up)

Variable	Comparison	Mean Diff.	SE	p
Pitch Frequency	Pretest – Posttest	–32.45	7.11	.001
	Pretest – Follow-Up	–57.83	9.42	.000
	Posttest – Follow-Up	–25.38	6.87	.004
Intensity	Pretest – Posttest	–2.84	0.74	.003
	Pretest – Follow-Up	–3.11	0.81	.001
	Posttest – Follow-Up	–0.27	0.62	.672
Tempo–Rate	Pretest – Posttest	–4.27	1.66	.033
	Pretest – Follow-Up	–1.54	1.71	.374
	Posttest – Follow-Up	2.72	1.45	.082
Echolalia	Pretest – Posttest	0.48	0.17	.009
	Pretest – Follow-Up	0.64	0.19	.003
	Posttest – Follow-Up	0.16	0.11	.346

The Bonferroni post-hoc comparisons revealed significant improvements in pitch frequency across all time points, with increases from pretest to posttest (mean difference = –32.45, p = .001) and from pretest to follow-up (mean difference = –57.83, p < .001), indicating a sustained upward trend. Reductions in echolalia were also significant from pretest to posttest (mean difference = 0.48, p = .009) and pretest to follow-up (mean difference = 0.64, p = .003), confirming continued behavioral improvement after the intervention ended. Vocal intensity showed meaningful increases between pretest and both posttest and follow-up (p = .003 and p = .001, respectively), although changes between posttest and follow-up were not significant (p = .672), suggesting stabilization after intervention. Tempo–rate demonstrated a modest but significant improvement from pretest to posttest (p = .033), while later comparisons did not reach significance. Overall, the post-hoc analysis indicates that the active music therapy produced the strongest and most stable effects on pitch and echolalia, with moderate effects on intensity and tempo.

4. Discussion and Conclusion

The present study investigated the effectiveness of active music therapy on improving *echolalia* and *pitch frequency* among children with Level-One Autism Spectrum Disorder (ASD). Overall, the results demonstrated that children participating in the active music therapy program exhibited measurable improvements in prosodic features—specifically pitch accuracy and vocal consistency—as well as reductions in echolalic responses when compared with the control group across posttest and follow-up assessments. These findings can be meaningfully interpreted by integrating the theoretical and empirical literature that positions music-based interventions as a uniquely powerful modality for strengthening auditory–motor integration, prosodic processing, and communicative spontaneity in autistic children.

The improvement in pitch frequency observed in the experimental group aligns strongly with the theoretical foundation suggesting that musical engagement facilitates enhanced connectivity between auditory and motor regions of the brain. Research has demonstrated that ASD is associated with atypicalities in auditory–motor mapping, prosodic imitation, and the neural control of speech intonation. Such mechanisms were highlighted in recent neurological frameworks describing the role of mitochondrial dysfunction, altered neuroplastic pathways, and impaired neurosensory integration in ASD (Khaliulin et al., 2025). The improvement in pitch measures in this study resonates with evidence showing that structured musical elements—such as tempo, rhythmic entrainment, melodic contours, and coordinated body percussion—can stimulate compensatory neural activation across auditory and sensorimotor processing circuits (Chenausky et al., 2017; Lim, 2010).

Active music therapy, which requires children to rhythmically synchronize movement and vocalization, has been shown to enhance the reliability of neural entrainment, leading to more stable pitch production. This is consistent with findings from systematic reviews indicating that music therapy effectively improves behavioral and communication outcomes in ASD through multi-sensory stimulation and rhythmic–motor coupling (Gao et al., 2025; Geretsegger et al., 2014). The children in the present study practiced rhythmic imitation, vocal repetition embedded in melodic sequences, and motor activities aligned with metronome-guided tempi. These structured activities provided continuous opportunities for auditory discrimination, vocal modulation, and timing accuracy—skills known to be weak in ASD and yet highly responsive to music-based training (Harbison et al., 2020; Holbrook & Israelsen, 2020).

The reduction in echolalia observed among participants receiving active music therapy further supports the argument that music can facilitate functional speech development in autistic children. Echolalia often reflects challenges in linguistic formulation, motor planning, semantic integration, and pragmatic use of language. Existing studies emphasize that melodic and rhythmic scaffolding helps autistic children produce original utterances more efficiently by lowering cognitive load and improving temporal organization of speech gestures (Ferdosi & Ashayeri, 2015; Yinger & Gooding, 2014). The results of the current study are consistent with research indicating that repetition-based melodic intonation interventions, such as Melodic Intonation Therapy, promote intentional and self-generated speech in ASD (Ferdosi et al., 2013).

Similarly, the meaningful decline in echolalia in the experimental group corresponds with findings from Farahani Sepehr et al. (Farahani Sepehr et al., 2014), who showed that structured repetition exercises embedded in rhythmic speech patterns significantly reduce echolalic behavior. Active music therapy naturally embeds repetition in a rhythmic–melodic framework, thereby supporting cognitive transition from automatic imitation toward intentional communication. Moreover, the present findings

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align with those of Hamidifard et al. (Hamidifard et al., 2023), who reported improvements in behavioral regulation and executive functions following music therapy in autistic children—domains closely related to the control of repetitive verbal responses.

The sustained improvement observed during follow-up suggests that the intervention yielded stable learning effects rather than temporary performance shifts. Music therapy engages procedural learning, motor memory, and rhythmic entrainment, which often produce longer-lasting therapeutic gains than traditional speech interventions alone (Caponnetto et al., 2022; Wang et al., 2023). From a neurodevelopmental standpoint, repetition of rhythmically structured tasks over several weeks likely reinforced auditory–motor synchronization and prosodic awareness, resulting in more consistent vocal patterns and less reliance on echolalic scripts.

The positive effects observed in this study should also be interpreted in light of comparative research on active versus passive music interventions. Evidence suggests that active engagement—singing, producing rhythms, imitating patterns, and coordinating movement—is more beneficial for cognitive and communicative outcomes than passive listening alone (Stekić, 2024). Similarly, studies on passive music therapy in non-ASD contexts, such as pain management and anxiety reduction, indicate meaningful benefits but typically do not demonstrate improvements in linguistic or prosodic skills (Kabuk et al., 2022). This distinction highlights the importance of the active therapeutic components implemented in this study, including rhythm production, vocal imitation, question–response singing, and synchronous motor activities.

The present findings also align with research validating the Aberrant Behavior Checklist (ABC) for assessing behavioral changes in ASD (Kaat et al., 2014). The reduction in echolalia measured through its "Inappropriate Speech" subscale is consistent with its strong sensitivity to treatment effects. Additionally, the study's use of acoustic analysis software for assessing pitch frequency is supported by linguistic and clinical literature demonstrating its precision in measuring prosodic characteristics among neurodivergent populations.

The broader literature reinforces the conclusion that music-based interventions can significantly enhance both communicative and socio-emotional functioning in ASD. For instance, Shiri et al. (Shiri et al., 2018) emphasize that structured family-centered interventions improve behavioral excesses through consistent, predictable routines—a concept mirrored in the predictable rhythmic structures of music therapy. Furthermore, Karami et al. (Karami et al., 2012) highlight the effectiveness of arts-based modalities in reducing behavioral problems among children with learning differences, supporting the use of creative therapeutic approaches like music. Similarly, Khanjani and Khaknezhad (Khanjani & Khaknezhad, 2016) found that even inactive music therapy (e.g., listening) can improve communication in ASD, which further underscores the greater value of active participation demonstrated in the present study.

In summary, the present findings strengthen the growing body of evidence supporting music therapy as an effective modality for improving prosody-related speech features and reducing echolalic behaviors in ASD. Consistent improvements across posttest and follow-up assessments, combined with extensive multisensory engagement during therapy sessions, suggest that active music therapy can address core deficits in prosodic processing, motor coordination, and communicative intention. These results contribute to ongoing discussions in the literature regarding the neurodevelopmental mechanisms through which rhythmic–melodic structures facilitate meaningful changes in ASD symptomatology (Gao et al., 2025; Geretsegger et al., 2014; Holbrook & Israelsen, 2020).

This study, while producing meaningful findings, has several limitations that should be acknowledged. The sample size was relatively small, which limits the generalizability of the results. All participants were recruited from a single therapeutic center, potentially restricting demographic variability. The study relied on pre-designed story-song materials, which may not equally engage all children depending on individual preferences. Although follow-up assessment indicated sustained improvement, long-term retention beyond the study period remains unknown. Additionally, individual differences in sensory sensitivity, motor coordination, or prior exposure to music may have influenced responsiveness to the intervention. Therapist effects may also have played a role, given that only one practitioner implemented the intervention.

Future studies should consider larger and more diverse samples to enhance external validity. Longitudinal designs extending months or years beyond the intervention period would help determine long-term retention of prosodic and language gains. Comparative studies examining different forms of active music therapy—such as improvisational music therapy, rhythmic entrainment therapy, or melodic intonation programs—could clarify which therapeutic components exert the greatest influence on speech outcomes.

Future research should also employ neurophysiological measures such as EEG or fMRI to investigate neural changes underlying improvements in prosody and echolalia. Exploring parent-implemented music therapy programs could reveal more accessible and cost-effective intervention pathways. Finally, studies comparing music therapy against standard speech therapy may better clarify the unique contributions of musical structure to speech development in ASD.

Clinicians may consider incorporating active music therapy into early intervention programs for children with Level-One ASD, particularly when prosodic deficits or echolalia are prominent. Integrating rhythmic–motor exercises, melodic repetition, and participatory singing into therapy activities can help strengthen auditory–motor coordination and expressive language. Music therapists and speech–language pathologists can collaborate to design cross-disciplinary interventions that leverage both musical and linguistic strengths. Incorporating familiar story-songs and predictable rhythmic structures may also increase child engagement and enhance therapy effectiveness.

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.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

References

Caponnetto, P., LaMattina, G., & Quattropani, M. C. (2022). Music therapy and psychological-clinical impact in surgery: a systematic review. *Health Psychology Research*, *10*(4), 38615. https://doi.org/10.52965/001c.38615

Chenausky, K. V., Norton, A. C., & Schlaug, G. (2017). Auditory-Motor Mapping Training in a More Verbal Child with Autism. *Frontiers in human neuroscience*, *11*, 426. https://doi.org/10.3389/fnhum.2017.00426

Farahani Sepehr, F., Hashemi, J., & Pezeshk Sh, S. (2014). The effectiveness of speech repetition on echolalia and challenging behaviors among autistic children. *Journal of Exceptional Individuals*, *4*(15), 57-72. https://jpe.atu.ac.ir/article_297.html

Ferdosi, N., & Ashayeri, H. (2015). *The effect of music on language disorders (Melodic intonation therapy in autism and aphasia)*. Tehran: Jungle, Javadaneh.

Ferdosi, N., Ashayeri, H., Modarresi, Y., & Rovshan, B. (2013). The Effects of Melodic Intonation Therapy on 7-10-year, Persian, Autistic, Male Children's Speech. *Advances in Cognitive Sciences*, *15*(3), 12-23. https://ensani.ir/fa/article/321148/

Gao, X., Xu, G., Fu, N., Ben, Q., Wang, L., & Bu, X. (2025). The effectiveness of music therapy in improving behavioral symptoms among children with autism spectrum disorders: a systematic review and meta-analysis. https://doi.org/10.3389/fpsyt.2024.1511920

Geretsegger, M., Elefant, C., Mössler, K. A., & Gold, C. (2014). Music therapy for people with autism spectrum disorder. *Cochrane Database Syst Rev*(6), CD004381. https://doi.org/10.1002/14651858.CD004381.pub3

Hamidifard, S., DashtBozorgi, Z., & Hafezi, F. (2023). The Effectiveness of Music Therapy on Self-Harm Behaviors and Executive Functions in Children with Autism Disorder. *ijrn*, *10*(1), 10-20. https://ijrn.ir/article-1-813-fa.html

Harbison, A. L., Woynaroski, T. G., & McDaniel, J. (2020). Speech prosody interventions for persons with autism spectrum disorders: A systematic review. *American Journal of Speech-Language Pathology*, *29*(4), 1912-1928. https://doi.org/10.1044/2020_AJSLP-19-00127

Holbrook, S., & Israelsen, M. (2020). Speech Prosody Interventions for Persons With Autism Spectrum Disorders: A Systematic Review. *Am J Speech Lang Pathol*. https://doi.org/10.1044/2020-AJSLP-19-00127

Kaat, A. J., Lecavalier, L., & Aman, M. G. (2014). Validity of the aberrant behavior checklist in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *44*(5), 1103-1116. https://doi.org/10.1007/s10803-013-1970-0

Kabuk, A., Şendir, M., & Filinte, G. (2022). The effect of reflexology massage and passive music therapy intervention before burn dressing on pain, anxiety level and sleep quality. *Burns*, *48*(7), 1743-1752. https://doi.org/10.1016/j.burns.2021.10.012

Karami, J., Alikhani, M., Zakiei, A., & Khodadi, K. (2012). The effectiveness of art therapy (painting) in reducing the aggressive behavior of students with dyslexia. *Journal of*

E-ISSN: 3041-9026

Learning Disabilities, *1*(3), 105-117. https://journal.uma.ac.ir/article_106.html

Khaliulin, I., Hamoudi, W., & Amal, H. (2025). The multifaceted role of mitochondria in autism spectrum disorder. *Molecular Psychiatry*, *30*(2), 629-650. https://doi.org/10.1038/s41380-024-02725-z

Khanjani, Z., & Khaknezhad, Z. (2016). The Effect of Inactive Music Therapy on Symptoms, Communication Deficit, and Social Interaction of Children with Autism Spectrum Disorder. *J Child Ment Health*, *3*(3), 97-105. http://childmentalhealth.ir/browse.php?a_code=A-10-229-1&sid=1&slc_lang=fa

Lim, H. A. (2010). Effect of "developmental speech and language training through music" on speech production in children with autism spectrum disorders. *Journal of Music Therapy*, *47*(1), 2-26. https://doi.org/10.1093/jmt/47.1.2

Shiri, E., Pouretemad, H., Fathabadi, J., & Narimani, M. (2018). Evaluation effectiveness of the family-based program of the management on Behavioral Excesses with children autism. *Journal of Family Research*, *15*(2), 267-282. https://jfr.sbu.ac.ir/article_97754.html

Stekić, K. (2024). The role of active and passive music engagement in cognitive development: A systematic review. *International Journal of Music Education*. https://doi.org/10.1177/02557614241268049

Wang, M., Wu, J., & Yan, H. (2023). Effect of music therapy on older adults with depression: A systematic review and meta-analysis. *Complementary Therapies in Clinical Practice*, *53*, 101809. https://doi.org/10.1016/j.ctcp.2023.101809

Yinger, O. S., & Gooding, L. F. (2014). Music therapy for preschool children with autism: A systematic review. *Journal of Music Therapy*, *51*(2), 151-181.

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