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Effectiveness of Music Lessons in Enhancing Social Skills and Motor Skills in Children with Autism Spectrum Disorder: A Systematic Literature Review

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Abstract: *Music-based interventions have gained increasing attention as effective approaches for supporting social and motor development in children with autism spectrum disorder (ASD). This synthesis literature review examined the effectiveness of music-based interventions in enhancing social skills, motor skills, and engagement outcomes among children with ASD. Guided by the PRISMA 2020 framework, a systematic identification and screening process was conducted, resulting in the inclusion of nine peer-reviewed journal articles published between 2021 and 2025. A qualitative thematic analysis was employed to integrate findings from participant observations, parental perspectives, therapist reflections, and descriptive intervention data across the selected studies. Three overarching themes emerged: enhancement of social interaction and communication, development of motor skills through embodied musical engagement, and increased engagement, attention, and emotional regulation. The reviewed studies indicated that interventions such as piano instruction, improvisational music therapy, Orff-based approaches, and technology-assisted music programs contributed to improved social responsiveness, motor coordination, and sustained participation in children with ASD. Parental involvement and adaptive intervention delivery further supported positive outcomes. Overall, the findings highlight the value of music-based interventions as engaging, flexible, and developmentally appropriate strategies for supporting multiple developmental domains in children with ASD, and emphasize the need for continued qualitative research to explore long-term impacts and implementation practices.*

Keywords: Autism Spectrum Disorder, music-based intervention, social skills, motor skills, systematic literature review

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by challenges in social communication and interaction, as well as restricted and repetitive patterns of behavior and interests (American Psychiatric Association, 2013). This condition affects approximately 1 in 100 children worldwide, with varying abilities and levels of support needs among individuals (World Health Organization, 2023). According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) published by the American Psychiatric Association, individuals with ASD experience difficulties in social communication and interaction and exhibit repetitive behaviors that impact daily functioning (Lici et al., 2024).

These core features can significantly impact children's ability to engage in social interactions, participate in learning activities, and develop motor skills, necessitating interventions that are both engaging and developmentally appropriate. Music-based interventions, including piano lessons, improvisational sessions, and structured musical programs, have been increasingly recognized as effective approaches for supporting social, motor, and emotional development in children with ASD (Fan et al., 2024; Yang & Zhang, 2025).

Music provides a multisensory and intrinsically motivating medium that facilitates interaction, attention, and communication (Carpente et al., 2022; Yum et al., 2024). Improvisational music therapy has been shown to increase engagement and communicative intent in minimally verbal children through imitation and responsive exchanges (Carpente et al., 2022). Similarly, structured programs such as Orff-based music therapy integrate movement, rhythm, and instrument play to enhance both fine and gross motor skills while simultaneously promoting social interaction (Fan et al., 2024). The flexibility of music allows for the incorporation of parental involvement, technology, and adaptive strategies to meet individual children's needs, thereby extending intervention benefits beyond formal therapy settings (Hernandez-Ruiz, 2023; Wu, 2025).

Parental and caregiver perspectives play a critical role in understanding the impact of music-based interventions. Long-term exposure to music therapy has been reported to improve children's social responsiveness, emotional expression, and daily engagement, as perceived by caregivers (Knapik-Szweda & Thompson, 2025). Group-based interventions, such as arts therapy sessions for preschool children, have also been shown to support peer interaction and cooperative skills, providing a social context for practising communication and turn-taking (Shai & Shuper-Engelhard, 2025). Furthermore, intelligent, technology-assisted music interventions show promise for enhancing social skills by providing adaptive, responsive, and personalised interaction experiences (Wu, 2025).

Empirical evidence from randomized controlled and qualitative studies further supports the effectiveness of music-based interventions in improving engagement, attention, and initiation behaviours (Yum et al., 2024; Yang & Zhang, 2025). The motivating and structured nature of music allows children to participate actively, regulate their emotions, and sustain attention during therapeutic activities, outcomes that are often challenging to achieve through conventional interventions alone. Collectively, these studies indicate that music-based interventions, including piano-focused programs, serve as a versatile and evidence-based approach to addressing multiple developmental domains in children with ASD.

Given the growing interest in music-based interventions, a synthesis of current qualitative evidence is necessary to identify common patterns, highlight effective practices, and inform future research and clinical applications. This review focuses specifically on music and piano-based interventions targeting social and motor skill development in children with ASD, providing a comprehensive examination of intervention strategies, outcomes, and mechanisms of change as reported across nine recent studies (Carpente et al., 2022; Fan et al., 2024; Hernandez-Ruiz, 2023; Jacob et al., 2021; Knapik-Szweda & Thompson, 2025; Shai & Shuper-Engelhard, 2025; Wu, 2025; Yang & Zhang, 2025; Yum et al., 2024).

2. Methodology

This synthesis literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, rigor, and replicability throughout the review process (BMJ, 2021), as depicted in Figure 1.

PRISMA provides a structured framework for systematically identifying, screening, assessing eligibility, and including relevant studies, thereby minimising selection bias and enhancing methodological clarity. Following this framework, the review applied a stepwise process encompassing identification, screening, eligibility, and inclusion phases to select qualitative journal articles published between 2021 and 2025 that focused on music-based interventions for children with autism spectrum disorder. The use of PRISMA 2020 aligns with methodological approaches recommended in recent systematic and synthesis reviews within the field of autism and educational research (Zainal & Zainodin, 2025).

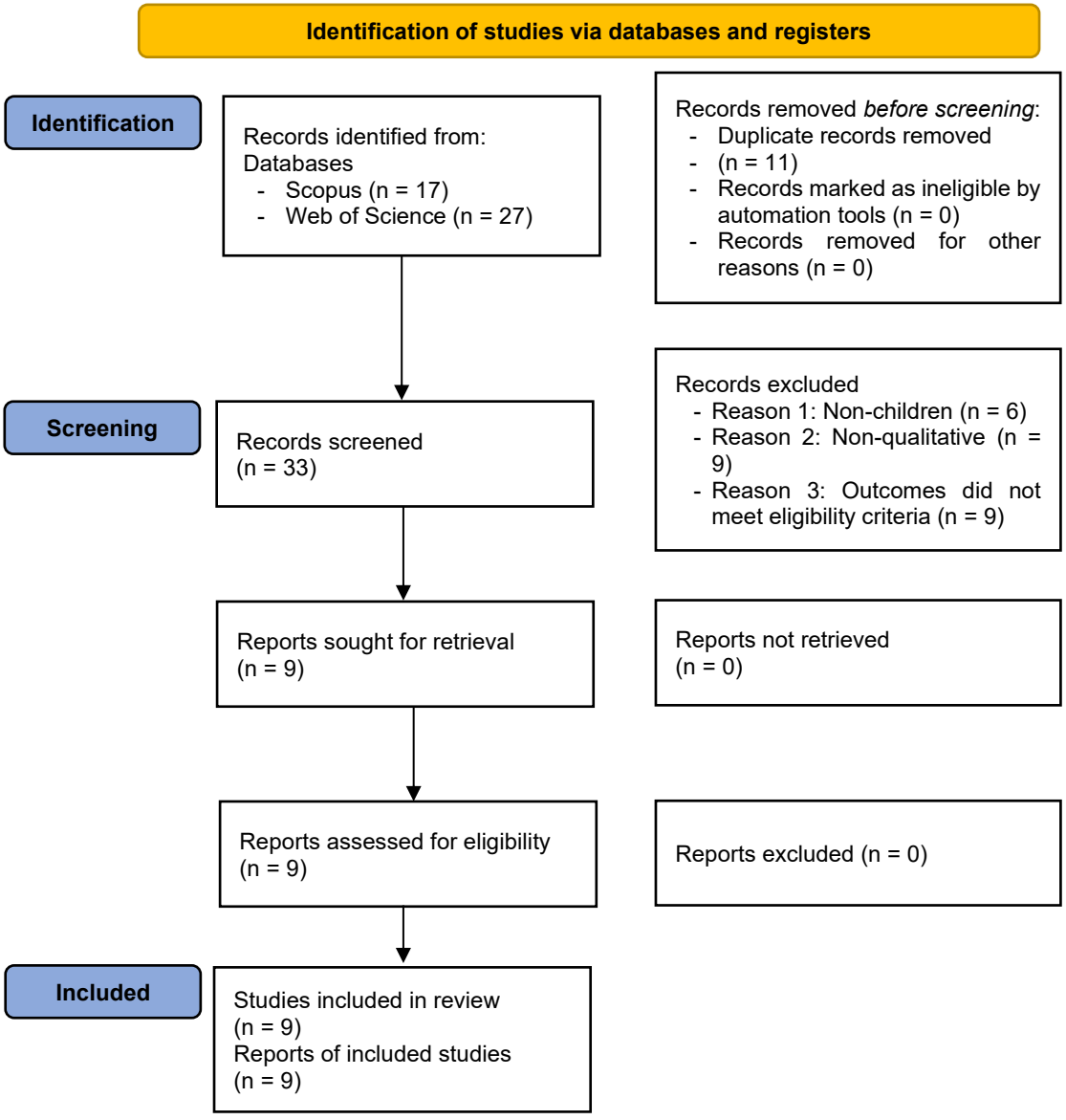

Figure 1: PRISMA Flow Chart

This study employed a synthesis literature review approach incorporating qualitative thematic analysis to examine the effectiveness of piano and music-based interventions in enhancing social skills and motor skills among children with autism spectrum disorder (ASD). A synthesis literature review involves the systematic identification, evaluation, and integration of findings from existing research to generate comprehensive and conceptually rich insights into a focused topic, making it particularly appropriate for qualitative evidence (Zainal & Zainodin, 2025). This approach enables in-depth examination of intervention processes, children's behavioural responses, and perspectives from parents and therapists across multiple studies.

The final selection of nine articles was achieved through a rigorous screening process guided by predefined inclusion criteria that emphasised methodological quality, thematic relevance, and contextual alignment with the study's objectives (Zainal & Zainodin, 2025). Although the initial search yielded a broader pool of studies, only nine met all inclusion requirements by directly addressing the role of piano and music-based interventions in improving social and motor outcomes in children with ASD. Restricting the review to these studies allowed for a focused and coherent synthesis, supporting thematic saturation and deeper qualitative analysis without compromising the specificity of the research focus (Zainal & Zainodin, 2025).

2.1 Identification

Identification refers to the process of systematically searching databases and other sources to locate all potentially relevant records related to the research question (BMJ, 2021). The identification process involves the systematic selection of key search terms to ensure that retrieved articles are directly relevant to autism, music-based interventions, social skills, and motor skills. Comprehensive keyword strings were constructed using Boolean Operators to streamline the search for studies across two databases: Scopus and Web of Science (Table 1). Four keywords were selected: autism, music, social skills and motor skills. To expand the scope while staying relevant to this study, the Boolean Operator "OR" was added to include alternate keywords and synonyms for each keyword.

Scopus and Web of Science are highly cited databases for systematic literature reviews, offering comprehensive access to high-quality, peer-reviewed research spanning various disciplines (Zainal & Zainodin, 2025). The search in these databases was conducted on January 15, 2025, yielding 9 articles.

Table 1: The Search String and Findings

Search String	Databases	Search Limitations	Findings
TITLE-ABS-KEY ("autism spectrum disorder" OR ASD OR autism) AND (piano OR "music intervention" OR "music therapy" OR "music-based intervention") AND ("social skills" OR "motor skills" OR "fine motor")	Scopus	Journal articles 2021-2025	17
TS= ("autism spectrum disorder" OR ASD OR autism) AND (piano OR "music intervention" OR "music therapy" OR "music-based intervention") AND ("social skills" OR "motor skills" OR "fine motor")	Web of Science	Journal articles 2021-2025	27

2.2 Screening

Screening involves reviewing the titles and abstracts of identified records to exclude studies that are clearly irrelevant or do not meet the initial inclusion criteria (BMJ, 2021). This paper

initially reviewed 44 articles based on predefined inclusion and exclusion criteria. The inclusion criteria required studies to be journal articles, published in English, and to have been published between 2021 and 2025. The time frame was set to ensure that only the most recent research was considered. Additionally, no restrictions were placed on the country of publication, allowing for a diverse and global perspective. After title and abstract screening, 24 articles were automatically excluded due to irrelevance to the review objectives.

During the screening phase, titles and abstracts were screened to remove duplicates and clearly irrelevant studies. Screening focused on studies that involved children with ASD, employed music-based interventions, and reported outcomes related to social skills and motor skills.

Therefore, 11 duplicate articles were removed. This resulted in 9 articles advancing to the eligibility phase, where further evaluation was conducted. The rigorous selection process ensured that only high-quality, relevant studies were included in the final systematic review, strengthening the credibility and reliability of the findings.

Table 2: Criteria Set in The Filtering Phase

Criteria	Qualifications
Publication year	2021–2025
Language	English
Type of literature	Journal (Study article)
Index	Scopus & Web of Science
Country	All

2.3 Eligibility

Eligibility is the phase in which full-text articles are assessed in detail to determine whether they meet all predefined inclusion and exclusion criteria, with reasons for exclusion documented (BMJ, 2021). In the third phase, the authors manually assessed the screened articles to ensure that all 9 articles met the study criteria**.** Ultimately, only 9 articles could be accessed and were selected. All the selected articles use qualitative methodologies to ensure a rigorous and consistent review process.

2.4 Included

Included refers to the final set of studies that satisfy all eligibility requirements and are selected for qualitative synthesis or analysis in the review (BMJ, 2021). In this qualitative synthesis, the final nine studies were included. These studies covered a range of interventions, including improvisational music therapy (Carpente et al., 2022), Orff-based music therapy (Fan et al., 2024), arts therapy (Shai & Shuper-Engelhard, 2025), technology-enhanced interventions (Wu, 2025), and parent-coaching models (Hernandez-Ruiz, 2023; Knapik-Szweda & Thompson, 2025).

PRISMA 2020 was used to visually document this process, showing the number of records identified, screened, excluded, and included. The use of PRISMA ensures methodological rigor, clarity, and reproducibility in the literature review process (Zainal & Zainodin, 2025).

2.5 Data Analysis

Data extraction was conducted systematically for all included studies, capturing information such as authors, year, study location, participant characteristics, type of music-based intervention, research design, and methodological approach. A thematic analysis was

conducted following the six-phase approach proposed by Braun and Clarke (2006), which provides a systematic method for identifying, analysing, and reporting patterns in qualitative data (Zainal & Zainodin, 2025).

The first step involved familiarisation with the data, during which the full texts of the included studies were read multiple times to gain a comprehensive understanding of the research context and methodologies. Next, initial codes were generated by highlighting key concepts, methodological details, and relevant qualitative information, using an inductive approach to allow patterns to emerge naturally from the data. The third step involved searching for themes by grouping related codes into potential broader categories that reflected patterns across studies.

The fourth step consisted of reviewing the potential themes against the extracted data to ensure accuracy, coherence, and relevance, while redundant or overlapping codes were merged. Next, themes were defined and named, with clear definitions and identification of sub-themes where appropriate to capture methodological or conceptual patterns. Finally, in step six, the thematic structure was documented in a narrative format, detailing the analytic process to ensure transparency, rigor, and reproducibility, consistent with PRISMA guidelines for systematic reviews. The themes and sub-themes were clearly named, resulting in four main themes and eleven sub-themes (Braun & Clarke, 2006).

2.6 Location of Studies

The data analysis showed that among the nine selected articles, three studies were conducted in China, and one each in Hong Kong, Mexico, Canada, Israel, Poland and South Africa (Table 3). This distribution highlights the geographical scope of the reviewed research.

Table 3: Country by Study Location

Country	Number of Studies (n)	Author(s)
China	3	Fan et al. (2024); Yang & Zhang (2025); Wu (2025)
Hong Kong	1	Yum et al. (2024)
Mexico	1	Hernandez-Ruiz (2023; 2025)
Canada	1	Carpente et al. (2022)
Israel	1	Shai & Shuper-Engelhard (2025)
Poland	1	Knapik-Szweda & Thompson (2025)
South Africa	1	Jacob et al. (2021)

2.7 Year of Publication

The distribution of studies by year of publication (Table 4) shows that four articles were published in 2025, two in 2024, and one article each in 2023, 2022, and 2021, indicating a growing research focus on the topic in recent years.

Table 4: Number of Articles by Publication Year

Year	Number of Studies (n)	Author(s)
2025	4	Knapik-Szweda & Thompson (2025); Shai & Shuper-Engelhard (2025); Yang & Zhang (2025); Wu (2025)
2024	2	Fan et al. (2024); Yum et al. (2024)
2023	1	Hernandez-Ruiz (2023)
2022	1	Carpente et al. (2022)
2021	1	Jacob et al. (2021)

3. Findings

A thematic analysis was conducted across the nine included studies to identify common patterns in the qualitative findings. Analysis of participant interviews, parental perspectives, therapist reflections, and descriptive observational data resulted in four overarching themes. These themes reflect shared patterns in how music-based interventions support developmental outcomes among autistic children across diverse contexts and intervention approaches. Despite variations in study design, participant characteristics, and modes of delivery, consistent thematic convergence was observed across the included literature.

The four main themes identified were: (1) enhancement of social interaction and communication, (2) development of motor skills through embodied musical engagement, and (3) increased engagement, attention, and emotional regulation, and (4) intervention delivery and methodology. The detailed categorisation of themes and sub-themes is presented in Table 5, forming the basis for a comprehensive psychosocial analysis, which is further synthesized and supported by evidence from the included studies in the following sections.

Table 5: Articles by Themes Studied

Year		**2025**				**2024**		**2023**	**2022**	**2021**
Authors		Knapik-Szweda & Thompson	Shai & Shuper-Engelhard	Wu	Yang & Zhang	Fan et al.	Yum et al.	Hernandez-Ruiz	Carpente et al.	Jacob et al.
Main Theme	**Sub-Theme**									
Enhancement of Social Interaction and Communication	Turn-taking and joint attention	/	/		/	/				/
	Imitation and modelling		/							/
	Parent or therapist scaffolding	/	/						/	
Development of Motor Skills Through Embodied Musical Engagement	Fine motor development						/	/		
	Gross motor / rhythmic coordination				/	/				
Increased Engagement, Attention, and Emotional Regulation	Attention and initiation	/						/		

	Emotional responsiveness	/	/	/						
	Motivation and participation	/				/			/	
Intervention Delivery and Methodology	Use of technology or intelligent systems				/		/			
	Group vs individual interventions		/	/						
	Parent coaching or involvement	/	/						/	

3.1 Enhancement of Social Interaction and Communication

Across the reviewed studies, music-based interventions consistently supported improvements in social interaction and communication skills among autistic children. Several studies highlighted the role of music as a shared social medium that facilitates turn-taking, joint attention, and reciprocal interaction. Improvisational music therapy, in particular, was shown to increase engagement and communicative intent in minimally verbal children through imitation and responsive musical exchanges (Carpente et al., 2022). These musical interactions created opportunities for children to initiate responses and sustain social engagement without relying on verbal language.

Parent- and therapist-mediated scaffolding further strengthened social communication outcomes. Hernandez-Ruiz (2023) demonstrated that virtual parent coaching enabled caregivers to use music-based strategies at home, promoting social responsiveness and interaction beyond clinical settings. Similarly, long-term music therapy from a family-centred perspective revealed that mothers perceived improvements in their children's communicative behaviours, including eye contact, emotional expression, and social connection (Knapik-Szweda & Thompson, 2025).

Technology-enhanced interventions also contributed to social development. Intelligent music therapy systems using deep learning algorithms were found to promote social skill acquisition by adapting musical responses to children's behaviours, thereby reinforcing interactive exchanges (Wu, 2025). Collectively, these findings indicate that music functions as an effective communicative bridge, supporting both verbal and non-verbal social interaction across diverse intervention formats.

3.2 Development of Motor Skills Through Embodied Musical Engagement

Music-based interventions were also found to support the development of motor skills through embodied and rhythmic engagement. Several studies emphasised how movement-based musical activities encouraged coordination, timing, and motor planning. Orff-based music therapy, which integrates movement, rhythm, and instrument play, demonstrated positive effects on both fine and gross motor development among children with autism spectrum disorder (Fan et al., 2024).

Embodied musical engagement allowed children to synchronise physical actions with auditory cues, enhancing rhythmic coordination and body awareness. Yang and Zhang (2025) reported that structured melodic activities facilitated motor imitation and coordinated movement during group-based interventions. These findings align with the idea that music provides a multisensory framework that supports motor learning through repetition and rhythmic structure.

Additionally, attention to visual and pictorial supports alongside music further enhanced motor outcomes. Jacob et al. (2021) found that combining music therapy with pictorial illustrations improved attention span and task-related motor engagement among children with mild intellectual disability. Overall, the evidence suggests that music-based movement activities offer a developmentally appropriate and motivating pathway for strengthening motor skills.

3.3 Increased Engagement, Attention, and Emotional Regulation

Increased engagement and sustained attention were among the most consistently reported outcomes across the reviewed studies. Music therapy interventions were shown to enhance children's ability to initiate participation, maintain focus, and remain emotionally regulated during sessions. Randomized controlled evidence indicated that music therapy significantly improved engagement and initiation behaviours among autistic children with mild intellectual disabilities (Yum et al., 2024).

Emotional regulation emerged as a closely related outcome, with music providing a structured yet flexible environment for emotional expression. Arts-based group interventions supported emotional responsiveness and self-regulation by allowing children to express emotions through sound, movement, and creative interaction (Shai & Shuper-Engelhard, 2025). Similarly, caregivers reported that long-term exposure to music therapy contributed to improved emotional stability and reduced frustration in daily routines (Knapik-Szweda & Thompson, 2025).

The motivating nature of music was frequently identified as a key mechanism underlying these outcomes. Improvisational and child-led musical approaches fostered intrinsic motivation, encouraging active participation and sustained attention (Carpente et al., 2022). Together, these findings suggest that music-based interventions are particularly effective in supporting engagement-related domains that are often challenging for autistic children.

3.4 Intervention Delivery and Methodology

The reviewed studies employed a range of intervention delivery models, including individual therapy, group-based sessions, parent-mediated approaches, and technology-assisted systems. Group interventions were found to promote peer interaction and shared musical experiences, while individual sessions allowed for tailored responsiveness to each child's needs (Shai & Shuper-Engelhard, 2025).

Parent involvement emerged as a significant component in extending the impact of interventions beyond formal therapy sessions. Virtual coaching and caregiver training empowered parents to implement music-based strategies within naturalistic environments, enhancing consistency and generalisation of skills (Hernandez-Ruiz, 2023). Additionally, advances in technology-enabled music therapy demonstrated potential for personalised intervention through adaptive and intelligent systems (Wu, 2025).

Overall, the diversity of intervention delivery methods reflects the flexibility of music-based approaches and their adaptability to different contexts, resources, and participant profiles.

4. Discussion

This thematic synthesis demonstrates that music-based interventions offer meaningful support for the social and motor development of children with ASD. The findings align with existing theoretical perspectives suggesting that music promotes neurodevelopment through multisensory integration, rhythmic entrainment, and emotional engagement. Importantly, the qualitative evidence highlights not only outcome improvements but also the processes through which change occurs, such as shared musical experiences, imitation, and embodied participation. The overall results of the analysis and findings are summarised in Table 6.

Table 6: Overview of Outcomes of Music-Based Interventions in Autism

Theme / Outcome Domain	Key Findings	Mechanism of Impact	Supporting Studies
Social Interaction & Communication	Music interventions improved turn-taking, joint attention, social responsiveness, and communicative intent, especially for minimally verbal children. Parent-mediated and technology-enhanced approaches extended gains beyond therapy sessions.	Music functions as a shared social medium that enables imitation, reciprocal exchange, and interaction without relying solely on speech. Caregiver scaffolding and adaptive musical responses reinforce communication.	Carpente et al. (2022); Hernandez-Ruiz (2023); Knapik-Szweda & Thompson (2025); Wu (2025)
Motor Skill Development	Movement-based music activities improved coordination, rhythmic timing, motor imitation, and both fine and gross motor skills. Visual supports further strengthened task engagement.	Rhythm and auditory cues guide body movement, while repetition and multisensory input support motor learning and body awareness.	Fan et al. (2024); Yang & Zhang (2025); Jacob et al. (2021)
Engagement, Attention & Emotional Regulation	Music therapy increased participation, sustained attention, initiation behaviours, emotional stability, and reduced frustration. Group arts approaches supported emotional expression and self-regulation.	Music's motivating and structured nature supports intrinsic engagement while offering safe channels for emotional expression through sound and movement.	Yum et al. (2024); Shai & Shuper-Engelhard (2025); Knapik-Szweda & Thompson (2025); Carpente et al. (2022)
Intervention Delivery & Methodology	Effective delivery models included individual therapy, group sessions, parent-mediated coaching, and AI-assisted systems. Parent involvement improved generalisation of skills, while technology enabled personalised intervention.	Flexibility of music allows adaptation to context, resources, and child needs. Family participation and adaptive systems enhance continuity and personalisation.	Hernandez-Ruiz (2023); Shai & Shuper-Engelhard (2025); Wu (2025)

Social interaction emerged as the most prominent outcome, with music serving as a bridge for communication, particularly for children with limited verbal abilities. The emphasis on non-verbal interaction, imitation, and turn-taking supports the view that music interventions are especially suited for addressing core social challenges in ASD. Motor improvements were closely linked to rhythmic and movement-based musical activities, reinforcing the role of music in supporting sensorimotor integration.

Furthermore, parental involvement and contextual factors played an important role in enhancing intervention effectiveness. Studies incorporating parent coaching and long-term engagement suggested that generalisation of skills beyond therapy sessions was more likely when families were actively involved (Hernandez-Ruiz, 2023; Knapik-Szweda & Thompson, 2025). Emerging technology-enhanced approaches also showed potential in individualising interventions and increasing engagement, although further qualitative exploration is needed.

Despite these promising findings, the reviewed studies varied in methodological depth and reporting, and most involved small sample sizes. This highlights the need for more rigorously designed qualitative and mixed-methods studies to deepen understanding of how and why music interventions work for children with ASD.

5. Conclusion

This synthesis literature review demonstrates that music-based interventions offer multifaceted benefits for autistic children, particularly in enhancing social interaction and communication, supporting motor development through embodied engagement, and increasing attention, engagement, and emotional regulation. Across diverse methodologies and contexts, music consistently functioned as a motivating and accessible medium for developmental support.

The findings highlight the importance of flexible intervention delivery, including parent involvement and technology-enhanced approaches, to maximise the reach and sustainability of music-based practices. Overall, the reviewed evidence supports the continued integration of music-based interventions within educational, therapeutic, and inclusive frameworks, while underscoring the need for further research to refine best practices and long-term outcomes.

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Conflict of Interest Statement
The author declares that there are no conflicts of interest regarding the publication of this study.

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