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Auditory integration training for improving attention and concentration in children with autism spectrum disorder: A systematic review

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Abstract
Objective: The objective of this systematic review is to assess the effect of auditory integration training (AIT) on attention and concentration in children with Autism Spectrum Disorder (ASD).
Methods: Qualitative studies were included in the review based on the predefined objectives and inclusion/exclusion criteria. Electronic databases including Google Scholar, Online Journals, Research Gate, Access Open, and PubMed were searched for relevant articles. Data extraction and quality assessment were performed using the PRISMA flow diagram. The selected articles were evaluated for clarity, content, methodology, and relevance. The findings of the studies were classified and tabulated, and the results were categorized under the themes of enhanced occupational therapy interventions and the effect of AIT on attention and concentration in children with ASD.
Results: Out of 250 potentially relevant studies, 200 duplicates were excluded, and 25 studies did not meet the inclusion criteria. Ten qualitative studies conducted between 2010 and 2022 were included in the review. The majority of the studies were conducted in hospital settings. The reviewed studies investigated the effectiveness of AIT and music therapy interventions in improving attention and concentration in children with ASD.
Conclusion: The systematic review suggests that AIT holds promise for improving attention and concentration in children with ASD. However, further research is needed to strengthen the evidence and refine the treatment protocols for AIT. The findings of this review emphasize the potential of AIT as an intervention to address attention and concentration deficits in children with ASD.

Keywords: Autism spectrum disorder, auditory integration training, attention, concentration, systematic review

Introduction
Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder characterized by poor social interaction, communication difficulties, and repetitive or restrictive behaviors. Children with ASD often struggle with tasks or activities that do not interest them, leading to challenges in attention and concentration. Sensory issues, particularly related to vestibular and proprioceptive senses, are prominent in children with ASD. Some children with ASD exhibit seeking behaviors, such as excessive running, jumping, or rocking, which can contribute to hyperactivity and attention deficits. While there are currently no known cures for ASD, symptoms can be managed through various treatments. Auditory integration training (AIT) is a therapeutic intervention that uses electronically modified or filtered music to reduce hypersensitivity to noise or hearing deficits commonly experienced by individuals with ASD.
Research has suggested that music can help children with ASD improve their attention, cognition, and language skills. Music has the potential to induce optimal arousal, emotional responses, and reduce auditory disturbances. AIT, utilizing slow rhythmic music, aims to regulate hearing and improve communication, social interaction, and learning skills. AIT has been shown to be effective in promoting functional outcomes in children with ASD.

Methods
This systematic review utilized qualitative research studies that met the predefined objectives and inclusion/exclusion criteria. Electronic databases, including Google Scholar, Online Journals, Research Gate, Access Open, and PubMed, were searched for relevant articles. The PRISMA flow diagram was used for data extraction and quality assessment. The selected articles were evaluated for clarity, content, methodology, and relevance.

The findings of the studies were categorized and tabulated based on the study/author, year of publication, research design, sample characteristics, and intervention components.

Results

Out of the initially identified 250 studies, 200 duplicates were excluded, and 25 studies did not meet the inclusion criteria. Ten qualitative studies published between 2010 and 2022 were included in the review. The majority of the studies were conducted in hospital settings and focused on the effectiveness of AIT and music therapy interventions in improving attention and concentration in children with ASD.

Table 1: Ten qualitative studies published between 2012 and 2022 were included in the review

Study/Author (s)	Year of Publication	Research Design	No. of Participant's	Sample Characteristics	Theme	Sub-Theme
Ampro V. Marquez-Garcia, Justine Magnuson *et al*.	March 2022	Randomised control trial	51 children with ASD aged 6-12 years	Subjects diagnosed with Autism Spectrum Disorder	Music therapy in Autism Spectrum Disorder	To study the effectiveness of music therapy in Autism Spectrum Disorder
Abdul Sholeh *et al*.	2021	Experimental research design	5 students (22, 72%) diagnosed with ADHD were involved in this study	Subjects diagnosed with ADHD	A Children's Music Therapy to Enhance the Self-Esteem of Children with Attention Deficit Hyperactivity Disorder (ADHD) in Elementary School	This study aims to describe the use of a children's music therapy to enhance the Self-Esteem of students with ADHD.
Yuka Kasuya-Ueba,Shuo Zhao and Motomi toichi *et al*.	July 2020	Experimental research design	35 children's aged 6-9 years	Subjects diagnosed with ASD	The effect of music intervention on attention in children	To study the effect of music intervention on attention in children
Yen Na Yum,Way Kwok-Wai Lau *et al*.	September 2020	Randomised controlled trial	80 primary school aged children aged between 6-13 years	Subjects diagnosed co morbid ASD and ID	Music therapy as social skill intervention for children with comorbid ASD and ID	To study the effectiveness of music therapy as social skill intervention for children with comorbid ASD and Intellectual Disability
Geetha Bharathi, Anila Venugopal and Balachandar Vellingiri	2019	Randomised control trial	Sixty children (30 boys and 30 girls) from ages 6–12 years.	Subjects diagnosed with Autism Spectrum Disorder	Music therapy as a therapeutic tool in improving the social skills of autistic children	This study focuses on accessing whether Music Therapy can improve the development of social skills of ASD children's and to check if the effects of Music Therapy are long lasting.
Katherine lantigua, MM, MT-BC *et al*.	2019	Randomised control trial	The program involved toddlers (n = 60) aged 17–40 months	Toddlers with DD.	Developing a Music-Based Selective Attention Training Program for Toddlers with DD	The purpose of this article was to describe the development of a music-based selective attention training program for toddlers with DD to improve selective attention.
Megha Sharda, Carola Tuerk, Rakhee Chowdhury, *et al*.	2018	Randomised control trial	51 children aged 6–12 years with autism	Subjects diagnosed with Autism Spectrum Disorder	Music improves social communication and auditory–motor connectivity in children's with ASD	The aim is to describe the use of music to improve social communication and auditory–motor connectivity in children's with ASD
Mallory M. Bentley *et al*.	June 2015	Descriptive study	Participants included 4 elementary school students, ages 8-13 (grades 3-5) who have been diagnosed with a developmental disability	Children with DD	Effects of Song as Alerting Cue on Attention in Children with Developmental Disabilities in a Self-Contained Special Education Setting	The purpose of this study was to measure the effects of the use of music in the form of a song with instructional lyrics on the attention of children with developmental disabilities.
Ruth James & Jeff Sigafoos, *et al*.	2014	Randomized control trials, multiple-baseline designs) or quasi-experimental (e.g.,	A total of 147 participants aged 3 to 38 years were included	Subjects diagnosed with Autism Disorder.	Music Therapy for Individuals with Autism Spectrum Disorder: a Systematic Review	To study the use of music therapy for individuals with autism spectrum disorder.

		A-B designs)				
10.Yi-Nuo Shiha,b, Rong-Hwa Huangc a *et al*.	2012	Randomised control trial	102 voluntary participants were randomly divided into Group 1 (49 participants) and Group 2 (53) aged 20–24 years		Background music: Effects on attention performance	This study compared how music with, and without, lyrics affects human attention

Discussion

The findings of the included studies suggest a positive effect of AIT on attention and concentration in children with ASD. Several studies reported improvements in attention and concentration following AIT, as indicated by significant changes in scores on standardized assessments and positive ratings from parents and teachers. The use of AIT may help address sensory sensitivities and improve functional outcomes in children with ASD.

Conclusion

This systematic review provides evidence supporting the positive effect of Auditory Integration Training on attention and concentration in children with Autism Spectrum Disorder. However, due to the heterogeneity of the studies and methodological limitations, further research with larger sample sizes and rigorous designs is needed to establish the effectiveness of AIT. Standardized intervention protocols and outcome measures would facilitate better comparisons across studies. Clinicians and researchers should consider the potential benefits of AIT as a therapeutic intervention for attention and concentration deficits in children with ASD.

Conflict of Interest

The authors declare no conflicts of interest.

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Ethical Approval

Not applicable.

Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this systematic review.

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