

Effects of Auditory Integration Training Combined with Music Therapy on Children with Autism Spectrum Disorder

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Abstract. Objective: This study explored the effects of Auditory Integration Training combined with Music Therapy on Autistic Children. Methods: Eighty Autistic Children who received treatment at a Rehabilitation Center for Children with Autism in Guangzhou from January to June 2023 were selected as participants. They were randomly allocated to an Experimental or a Control group, giving 40 in each condition. The Control group received Auditory Integration Training, while the Experimental group received Auditory Integration Training combined with Music Therapy. Sociability, Language, Behavior, and Neuron Development of the two groups of children were compared before and six months after treatment. Results: By comparing the Sociability, Language, Behavior, and Neuron Development scores of two groups of children before and after six months of treatment, the combination of these two treatments has positively impacted the rehabilitation of children with autism. Conclusion: The combination of Auditory Integration Training and Music Therapy has shown promising results in its application for Children with Autism Spectrum Disorder (ASD).

Keywords. Auditory Integration Training, Music Therapy, Children with Autism

1. Introduction

The American Psychiatric Association's "Diagnostic and Statistical Manual of Mental Disorders" (DSM) has defined Autism Spectrum Disorder (ASD), noting its two core symptoms: (1) social communication and social interaction deficits; (2) restricted repetitive patterns of behavior, interests, or activities. In addition to these classic features, the diagnostic criteria for ASD also include sensory abnormalities [1]. Research has shown that patients with disorders related to auditory attention (such as ASD, attention deficit hyperactivity disorder, auditory processing disorder, etc.) have an exaggerated sensitivity to specific frequency ranges of environmental sounds, leading to behavioral and cognitive impairments [2]. Approximately 50% of ASD children have sensory abnormalities in auditory perception.

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Auditory Integration Training (AIT) was first developed in 1982 by Guy Berard. Berard proposed that abnormal sensitivity or insensitivity to specific sound frequencies, irrespective of overall auditory capacity, was connected to various behavior and learning issues [3]. He posited that his auditory integration training (AIT) method could reeducate the hearing process. Berard reported improvement in behavior and learning issues in most cases. AIT was applied to various disorders, including autism, depression, hyperactivity, and learning difficulties. Personal testimonies have linked symptoms of autism, such as repetitive behaviors, limited emotional response, and inappropriate distress, to distorted sensory input. AIT believed to address abnormal sound sensitivity specifically, can potentially improve this problem and alleviate associated disabling symptoms [4].

Music Therapy employs listening, singing, playing musical instruments, and dancing techniques to help children with Autism Spectrum Disorder (ASD) express themselves. Auditory Integration Training and Music Therapy effectively rehabilitate children with ASD. However, using more than one training method often leads to unsatisfactory outcomes. There is limited research on the combined effects of Music Therapy and Auditory Integration Training on rehabilitation in children with ASD. This study examines how these two intervention methods, when used together, can impact rehabilitation in children with ASD, providing valuable insights for rehabilitation training for this population.

2. Related Work

2.1. Auditory Integration Training on Children with Autism

Auditory Integration Training (AIT) is based on the hypothesis that individuals with autism have abnormal auditory processing, leading to difficulties in areas such as language development, communication, and sensory processing. By exposing them to specific frequencies and modulations of sound, AIT aims to retrain their auditory system and improve their ability to process and respond to sounds. AIT can improve various areas, including language and communication skills, social interaction, behavior, attention, and sensory sensitivities [5].

2.2. Music Therapy on Children with Autism

Music therapy is often used for children with autism to improve social interaction, communication, and imitation skills through music. Increasingly, music therapists have incorporated technology into therapy sessions as therapeutic tools [6], [7].

The evaluation of music therapy performance through technology has primarily been done through computer software that analyzes recorded music therapy improvisations [8]. Additionally, databases of information from therapy sessions and programs that provide qualitative descriptions of music therapy events have been utilized [9]. Various interactive music interfaces are available, including rhythm games like Guitar Hero and piano game apps, as well as augmented musical instruments and movement-to-music systems [10].

3. Method

3.1. Participants

Eighty Autistic Children received treatment at a rehabilitation center for children with autism in Guangzhou, China, from January to June 2023 (see Table 1.).

Inclusion Criteria: (1) Ages ranged from 3-9 years old; (2) The children's guardian is aware of the contents of the study and signed the informed consent form voluntarily; (3) IQ score below 70.

Termination criteria: (1) Serious adverse events, complications, and particular physiological changes that make the continuation of the trial inappropriate. (2) Self-discharge during the trial for personal reasons; (3) Loss of visit or accidental injury due to various other reasons; (4) Lack of compliance with treatment and inability to train or receive follow-up visits as required; (5) Receiving other drugs or rehabilitation therapy that may affect the clinical efficacy without following the medical advice [11].

Exclusive Criteria: (1) children with ear wax problems, inner ear damage, ear infections or hearing loss; (2) With organic brain disease, mental abnormality; (3) With epilepsy, hereditary diseases, etc.

Eighty Autistic Children were randomly allocated to either an experimental or a control group, giving 40 in each condition. The general information of the two groups was comparable, with no statistically significant difference ($P > 0.05$). The Medical Ethics Committee of this rehabilitation center approved this study.

Table 1. Comparison of general data between two groups ($\bar{x} \pm s$).

Group		Control group	Experimental group	χ^2 / t	P
Number		40	40		
Gender Number(%)	Male	28(70.00%)	25(62.50%)	0.503	0.478
	Female	12(30.00%)	15(37.50%)		
Year ($\bar{x} \pm s$)		5.54 \pm 2.48	5.63 \pm 2.52	-0.161	0.873
Duration ($\bar{x} \pm s$)		2.43 \pm 0.34	2.46 \pm 0.35	-0.389	0.698
IQ ($\bar{x} \pm s$)		56.13 \pm 8.71	55.78 \pm 8.65	0.180	0.857

3.2. Study design

3.2.1. Control group

The GK-7000 Children's Auditory Integration Training Instrument was used to provide auditory training to Autistic Children (see Figure 1.), and the specific training contents were as follows: (1) Oral training: After demonstrating different pinyin pronunciations, children are guided to imitate the training regarding listening, speaking, and reading, (2) Inducing vocalization in children: The therapist patiently guides the children to use the device to produce sound. When the children vocalize, the animated figure on the device's screen automatically responds with sound and actions. The training continues until the

children accurately vocalize towards the device, (3) Vocalization training: After inducing vocalization in children, they are guided to prolong the duration of their vocalization. This training helps extend the time spent with the children and trains their vocal cords and breathing, (4) Perceptual coordination training: By adjusting the vocalization pitch, the amplitude of the animated movements is modified. Simultaneously, the children are guided to imitate the actions displayed on the screen and engage in imitation training [12], (5) Memory training: Previously trained sounds are recorded and screen-captured. Training is conducted without sound once the children are familiar with the device's patterns. The children are then asked to verbalize the meaning of different actions displayed on the screen. This helps to train their comprehension skills and memory abilities.

Training is conducted three times per week, with each session lasting 30 minutes. The training duration spans six months, and the therapeutic effectiveness on children with autism is evaluated through scale surveys.



Figure 1. An Autistic Child trained with the GK-7000.

3.2.2. *Experimental group*

The experimental group adds Music Therapy to the Auditory Integration Training, the same as the control group (see Figure 2.) .

The contents of the Music Therapy were as follows: (1) Improvisational Performance: The therapist spontaneously plays children's songs according to their condition to activate their joyful emotions, inspire, and encourage the child to sing or hum along with the melody [2]. During the improvisational performance, the therapist observes the child's emotions, identifies their points of interest, and documents them for the next session to play more of the child's favorite song types and enhance their therapeutic engagement, (2) Instrument Selection: Under the therapist's guidance, the child explores different instruments through activities such as touching and tapping and selects their favorite instrument based on instructions while also learning to recognize and express the names of the instruments. For those with good language skills, this activity can also foster their ability to express their desires and preferences, (3) Instrumental Performance: Based on the child's condition, the therapist plays pre-recorded or improvised music, guiding the child to play instruments or move to the rhythm of the music. The therapist encourages the child to hum along with the melody

during the rhythmic activities. As the child's ability improves after several sessions, they are encouraged to participate in small activities to demonstrate their skills and engage in social interactions with other children of similar age to enhance their social communication skills.



Figure 2. An Autistic Child received Music Therapy with a therapist.

3.3. *Measurement*

3.3.1. *Sociability*

We used Autism Treatment Evaluation Checklist (ATEC) to assess the Sociability of Autistic Children before and after six months of treatment. ATEC is a scale inversely proportional to the improvement of the subject (the lower the score, the better the condition), and is divided into four subscales that cover all areas affected by autism: (1) Speech/Language/Communication (14 items), (2) Sociability (20 items), (3) Sensory/Cognitive Awareness (18 items) and (4) Health/Physical/Behavior (25 items). The total score ranges from 0 to 179, with higher scores indicating poorer Sociability. It is a brief and easily applicable formulary that can be used to assess efficacy of any kind of interventions [13].

3.3.2. *Language*

We used Psycho-educational Profile third edition (PEP-3) to assess the Language ability of Autistic Children before and after six months of treatment; higher scores indicate better language ability. The PEP-3 was divided into two main sections: Performance and Caregiver Report. The Performance section consisted of 172 items, divided into ten subtests. In this study, we mainly focus on Children's development level, so we chose to examine the first three subtests of the scale, that is, the cognitive verbal, the expressive language, and the receptive language [14].

3.3.3. *Behavior*

Children were assessed using the Autism Behavior Checklist (ABC) scale before and after the intervention. This scale has five dimensions: Social Interaction, Motor Skills,

Sensory Perception, Language, and Self-care. The total score ranges from 0 to 158, with higher scores indicating more severe symptoms [15].

3.3.4. Neuron development

We used Gesell Developmental Schedules (GDS) to assess the Neuron development of Autistic Children before and after six months of treatment. It has 144 items and covers five development areas: adaptive, gross motor, fine motor, language, and personal social behavior. The results are expressed as a developmental quotient, calculated as developmental age divided by chronological age multiplied by 100%. A quotient of ≥ 86 is considered normal, 75-85 suggests possible neurological impairment, and ≤ 74 indicates neurological impairment [16].

3.4. Data Processing

We represented typically distributed continuous variables as $(\bar{x} \pm s)$ and used t-tests for comparisons. For categorical variables, we presented them as percentages (%) and used χ^2 tests for intergroup comparisons. We considered a significance level of $P < 0.05$ as indicating statistically significant differences.

4. Results

4.1. Comparison of two groups of Autistic Children before and after treatment: Sociability

Before treatment, the two groups of children had no significant difference in Sociability scores ($P > 0.05$). After six months of treatment, the Sociability scores in both groups of children decreased compared to before treatment ($P < 0.05$), and the experimental group had lower scores than the control group ($P < 0.05$) (see Figure 3.).

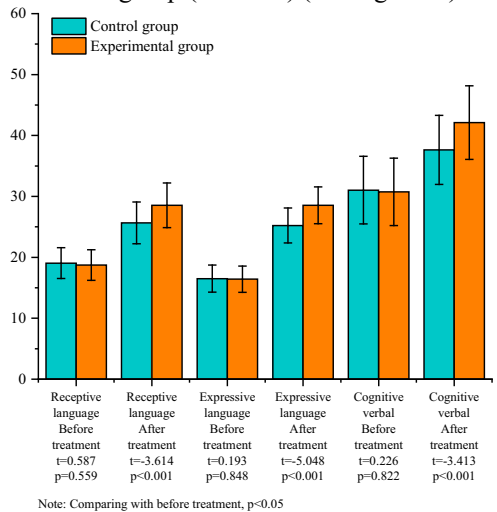


Figure 3. Comparison of two groups of Autistic Children before and after treatment: Sociability.

4.2. Comparison of two groups of Autistic Children before and after treatment: Language

Before treatment, the two groups of children had no significant difference in Language ability scores ($P > 0.05$). After six months of treatment, the scores for cognitive verbal, expressive language, and receptive language significantly improved in both groups of children ($P < 0.05$), and the experimental group showed a more significant improvement compared to the control group ($P < 0.05$) (see Figure 4.).

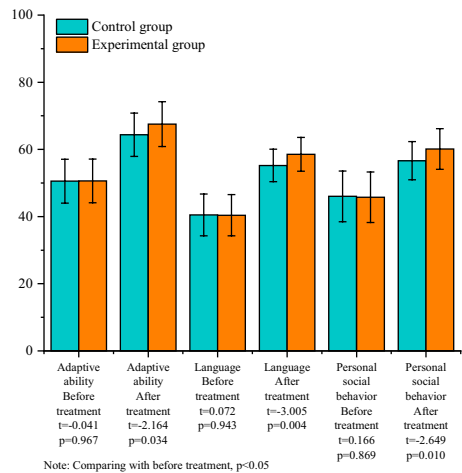


Figure 4. Comparison of two groups of Autistic Children before and after treatment: Language.

4.3. Comparison of two groups of Autistic Children before and after treatment: Behavior

Before treatment, the two groups of children had no significant difference in Behavior scores ($P > 0.05$). After six months of treatment, the scores for Behavior in both groups of children decreased compared to before treatment ($P < 0.05$), and the experimental group had lower scores than the control group ($P < 0.05$) (see Figure 5.).

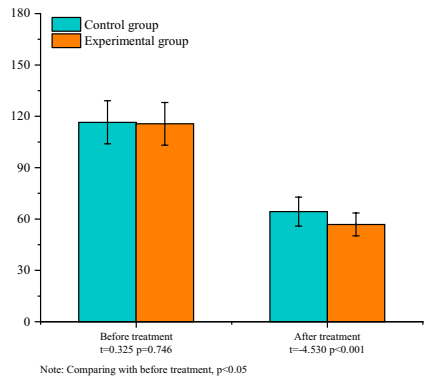


Figure 5. Comparison of two groups of Autistic Children before and after treatment: Behavior.

4.4. Comparison of two groups of Autistic Children before and after treatment: Neuron development

Before treatment, the two groups of children had no significant difference in Neuron development scores ($P > 0.05$). After six months of treatment, the scores for adaptive ability, language, and personal social behavior significantly increased in both groups of children ($P < 0.05$), and the experimental group showed a more significant improvement compared to the control group ($P < 0.05$) (see Figure 6).

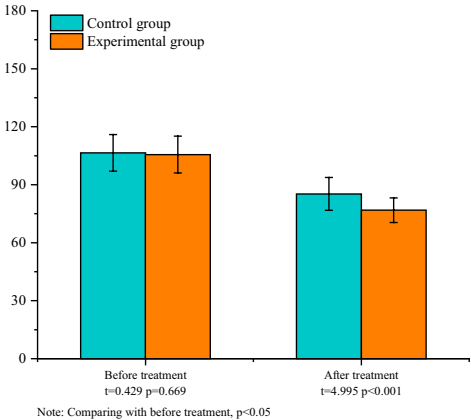


Figure 6. Comparison of two groups of Autistic Children before and after treatment: Neuron development.

5. Discussion

5.1. Effects of Combined Therapy on Autistic Children: Sociability

Auditory Integration Training helps children with autism gradually adjust to and accept different sounds, improving their ability to cope with their auditory environment. It also reduces sound sensitivity and improves social skills. Music therapy, on the other hand, stimulates emotional expression and social interaction in children with autism. Engaging with music helps them express emotions and improves attention, concentration, and musical perception [17]. In conclusion, auditory integration training and music therapy enhance sound acceptance, balance the auditory system, improve adaptability, reduce sensitivity, and enhance social skills in children with autism.

5.2. Effects of Combined Therapy on Autistic Children: Language

The auditory integration training rehabilitation method is a therapy for children with autism that stimulates their auditory system through exposure to different sounds. This stimulation helps maintain a balance in their brain's hormones and activates brain functions, improving memory. Combined with music therapy, this method also helps children with autism process and understand audio information more effectively. Children can enhance their language expression abilities by gradually improving their

perception of sound. This comprehensive treatment method aims to activate the cerebral cortex and stimulate neural development. By providing diverse sound stimulation and music experiences, this therapy promotes overall brain function development in children with autism, which is crucial for their overall development [10].

5.3. Effects of Combined Therapy on Autistic Children: Behavior

The balanced development of perception and cognition, including vision, hearing, touch, and proprioception, is crucial for developing children with autism. Auditory integration training combined with music therapy can improve the attention and focus of children with autism, reducing their abnormal behaviors. Music therapy, through various training methods, enhances the learning and interactive abilities and cognitive skills of children with autism, promoting their behavioral development [18]. These training methods help children with autism adapt to diverse environments [19].

5.4. Effects of Combined Therapy on Autistic Children: Neuron development

The essence of auditory integration training combined with music therapy is to stimulate different sensory organs in children and elicit corresponding responses, activating the brain's motor cortex with neural stimulation [20]. This allows the content of the integration training to be transmitted to the brain, enabling children to establish neural behaviors. The auditory integration training rehabilitation method has specific stimulating effects on the auditory system of children with autism, helping maintain hormonal balance in the brain and enhancing children's memory. Combined with music therapy, it can improve incoherence in sound processing, enhance children's perceptual and language expression abilities, and activate the cerebral cortex, thereby stimulating neural development.

6. Conclusion

Currently, there is no specific medication for treating children with autism, and conventional rehabilitation therapy has limited effectiveness. In China, Auditory Integration Training is widely used to treat children with autism. Although this therapy has some effectiveness, relying solely on one treatment technique is challenging to achieve satisfactory results. For the treatment of children with autism, it is necessary to broadly draw on and utilize advanced techniques and concepts from relevant disciplines for comprehensive treatment.

Combining Music Therapy based on Auditory Integration Training can increase direct sensory stimulation and experiential sensation, helping to strengthen the child's integration of sensory information and improve the brain's control over the body. This can achieve the goal of contributing to the rehabilitation of children with autism. By comparing the Sociability, Language, Behavior, and Neuron development scores of two groups of children before and after treatment, it is evident that their combined use has a positive impact.

This study has limitations, including a small sample size, a short follow-up period, and a lack of a follow-up assessment. Future research could address these limitations by conducting larger-scale studies, longer-term follow-up assessments, and exploring the potential mechanisms underlying the positive effects of Auditory Integration Training

and Music Therapy. By doing so, we can continue to improve our understanding of how to best support the rehabilitation of children with Autism Spectrum Disorder.

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