Research Paper: The Effectiveness of Combined Music Therapy and Physical Activity on Motor Coordination in Children With Autism

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ABSTRACT

Objectives: Motor skills play an important role in language, play, academic and adaptive behaviors of individuals. The present study aimed to determine the effectiveness of music therapy along with play therapy in rising motor coordination of children with autism.

Methods: In this quasi-experimental study with pre-test and post-test design, Autism Evaluation Scale and Motor Development Scale were administered to 30 randomly selected male students with autism spectrum disorder aged between 6 and 11 years before and after the intervention. The experimental group attended 15 sessions (each lasted 60 minutes), twice a week and were trained by music therapy along with play therapy program. However, the control group did not receive such programs. One-way analysis of covariance was used for analyzing the data.

Results: There was a significant difference (P<0.001) between the experimental and control groups after applying music therapy along with play therapy.

Discussion: Considering the problems with autism in motor coordination, applying music therapy along with play therapy is necessary for rehabilitating these children. Implications of these results are useful for planning intervention strategies to decrease motor problems in this population.

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Highlights

- A growing body of evidence suggests that motor impairments are frequently present in children with autism.
- Music therapy along with physical activity might benefit children with autism.
- We observed a significant difference between the experimental and control group after applying music therapy along with play therapy.

Plain Language Summary

Children with autism show motor impairments. Music therapy along with physical activity is a significant treatment in improving motor coordination. In this study, 30 children with autism were participated in 15 music therapy sessions. Music therapy are presented in two methods: (a) inactive one; listening to music and (b) active one; playing and rhythmic movements. Based on the results, motor coordination was achieved in the posttest. However, considering the limited studies available, further research is required in this area.

1. Introduction

Autism Spectrum Disorder (ASD) is a large group of heterogeneous disorders that generally include many symptoms. These symptoms are divided into 3 groups as follows: Abnormal social interactions; Abnormal verbal and nonverbal communications; and Repetitive and stereotypical patterns of behavior and interest [1]. However, these symptoms are mostly accompanied by motor abnormalities which can be visible at 6 months of age and postpone the achievement of motor development in important stages of life [2]. Obvious or hidden inability in controlling eye movements, dynamic postural control, manual tasks control [3], and abnormal movements in speed, coordination, stance, and walking, obviously will result in motor coordination disorder in children [4]. Almost 6% of children aged from 5 to 11 years suffer from motor coordination disorders, with a higher prevalence in boys compared to girls [5].

Motor coordination problems negatively impact educational development and everyday life activities in children with ASD [6]. In addition, the children and youth with ASD show limitations in performing gross movements and fine motor coordination, walking disorders, and weaknesses in static and dynamic balance in school years [7]. Studies reported that performers' movements as a spur of the moment display of the expression of "inner motion", the driving force of the music related to interpretation, are shaped by experience and related to emotion, sensation of motion, and communication [8].

Listening to music, playing, and even rhythmic movements accompanied by music improve joints' movement domain and motor skills, increase eye and hand coordination, and reinforce finger control [9]. Musical activities are mostly used for movement and improve the sensorimotor functions of hand, foot, head, and body [10]. Studies indicate that using music and music-based games decrease delay and limitations in non-musical fields in children with ASD [11]. In fact, music and mainly its rhythm lead to the initiation of movements in hands, head, legs, and body, as well as emotional face and tongue expressions.

Listening to music and playing gaming devices empowers the balance of physical movements, body condition, and stimulation of positive feelings through facilitating self-control [10]. In addition, rhythmic actions like clapping and walking during music play considerably facilitate gross motor skills in children with ASD. Studies indicate that a positive result of music therapy is increased motor skills in these children [11]. In addition, combined music and play therapy sessions including play, movement, and singing along the music with the simultaneous usage of play devices further reduces the problems in ASD children, compared to single treatment method [12].

Studies have documented that the common aspect of music along with motor activities is influential on the motor coordination of individuals with ASD [13]. Until 1988, the general idea of available results is based on this fact that physical activities not only improve physical conditions in children with ASD, but also reduce their inconsistent behavioral patterns [14].

It is obvious that precise cognitive and motor abilities and fine motor abilities are largely influenced by the growth and manipulation of motor activities with objects. Greenspan reported that the reduction of motor problems was largely influenced by motor plays [15]. Imitation learning aligned with autistic children's body actions dramatically helps with learning imitative motor skills [16]. In addition, active plays of motor, social, world perception skills facilitate everyday life skills and consistent behavior. It also provides a special chance for children to be physically active [17].

Studies demonstrate that social play therapy while improving social behaviors, increases gross motor skills in these children [18]. Many motor skills used in plays stimulate vestibular system, which is responsible for movement recognition and head position changes. This relation is based on muscle strength, balance, and 2-sided coordination. In addition, it causes some changes in tactile system, as the largest sensory system in our body. This system plays an important role in environment recognition. Kourassanis et al. [18] conducted a research entitled "teaching chained social game behaviors to ASD". They concluded that social plays cause some changes in motor behaviors. They found it an effective method of education in children with ASD. Research findings have supported the positive effect of motor activities on reducing motor problems among ASD children and their merge with society [19].

The innovative aspect of this research is its working model which is based on a double system, as follows: Intra-active (referring to the internal activity of subjects); and Inter-active (referring to the relation with others), for psychotherapeutic intervention and evaluation. Frequent methods are specifically applied in educational settings on ASD individuals throughout each session. These methods include primary errorless learning, shaping, positive and negative reinforcement, and physical restraint. Thus, we explore the effect of music therapy along with physical activity on motor coordination behaviors of children with autism.

2. Methods

This was an experimental study, with pre-test-post-test design and a control group. The study consisted of one experimental group and one control group. The study participants included 30 children with autism (boys), aged between 6 and 11 years. The subjects were selected from exceptional schools of Rasht City, Iran, by convenience sampling method. They were randomly assigned into the experimental and control groups. The participants lacked any experiences of participation in combined music therapy with play therapy. The diagnosis of ASD was confirmed before initiating research plan by a psychiatrist and according to the evaluation scale of Baron Cohen et al. [20].

A consent form was obtained from the subjects' parents and instructors. Then, after completing ASD evaluation questionnaire by instructors of these children, those with both ASD and lower grades in motor coordination were selected. Then, 30 children with ASD were divided into 2 groups (experimental and control groups), through direct random sampling method. The experimental group participated in 15 sessions (60-minute sessions), twice a week (except for the last week that 3 sessions were held). The subjects were trained by music therapy along with play therapy program. However, the control group did not receive any treatments.

The inclusion criteria were: A. age range between 6 and 11 years; B. Confirmation of the diagnosis of autism by a psychiatrist based on Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR); C. The lack of other disabilities; and D. Family's consent for participation in the intervention plan. Children with visual and hearing impairments and those with intense behavioral problems, resulting in their non-cooperation were excluded from the research.

Research tools

The Autism Spectrum Quotient: Children's Version (AQ-Child)

This scale, also called 'Cambridge University Behavior and Personality Questionnaire for Children' is devised by Auyeung, Baron Cohen, Wheelwright, and Allison [20]. The AQ-Child includes a number of descriptive statements to evaluate 5 areas related to ASD and the broad autism phenotype (each represented by 10 items), as follows: Social skills; Attention switching; Attention to detail; Communication; and Imagination. Higher scores indicate more 'autistic-like' behaviors, which is answered on a 4-point Likert-type scale.

It includes 50 items, and for each statement there are 4 options completed by child's parent or guardian. The lowest grade of this questionnaire is 0 and the highest grade is 150. Internal consistency reliability of this scale using Cronbach alpha was equal to 97%, internal consistency reliability of each of the subscales were estimated as 93% for the subscale of social skills, 89% for attention switching, 92% for communication, and 88% for imagi-

nation. The test-retest reliability of this scale is 85% [20]. The validity and reliability of this scale for the Iranian population were previously confirmed [21].

Lincoln-Oseretsky's Motor Development Scale

This scale was applied for evaluating motor skills. Oseretsky prepared the first draft of this test in 1923. This test includes 36 items, which is performed on a person-to-person basis. This scale is designed for evaluating the motor ability of children aged from 4 to 12 years. Performing its complete set requires 45 to 60 minutes. The total sum score of 36 items would be the final score of the participant. The Cronbach alpha value of this test is reported to be 0.92, with 0.95 internal consistency reliability [22].

The reliability and validity of this scale is confirmed in the Iranian population [23]. This scale is scaled as follows: for each subtest, there are some special and standard tests that the subject should repeat each of them twice. Then, the examiner records the grades of each repetition and adds them together.

The educational program

In the present research by music therapy, it is meant to do and play different musical instruments with desired rhythm and intensity, rhythmic accompaniment of instruments and co-singing children's songs, and listening to songs of children's music and coordination and making motor rhythmic with it, which follows 'through Orff-Schulwerk approach to elementary music and movement education. Music activities for children were presented in passive (listening to music) and active (playing and rhythmic movements) forms.

Play therapy in the present research, included applying techniques that are directly or indirectly used for the purpose of improving child's balance and coordination. The play therapy was planned and performed based on the disorder. The music therapy program along with the motor activities have been extracted from the musical composition program and the movement of Matthews Moreno et al. [24] and the program of 'the effect of movement activities in synchronization with music' by Atigh et al. [13].

To guide the sessions, 2 instructors conducted the activities of controlling the subjects. In addition, one instructor (i.e. the researcher) and one expert colleague delivered the intervention program. The instructors were psychologists who participated in the instructional courses of music therapy and play therapy as part of their educational courses. All educational sessions were carried out in a group and in the same class.

The structure of educational sessions of music therapy along with play therapy

The general plan of treatments was as follows: The first session: Using images for making contact, eye contact, singing familiar songs by the music therapist along with music for children with ASD; The second session: Teaching rhythm through body movements, performing active games like golf in small scales and making appointments for the next session; The third session: Regular rotational movements for stimulating vestibular system, and rhythmic games; The fourth session: Balance board game through walking on balance beam, and performing rhythmic motor games accompanied by music; The fifth session: Presenting targeted and planned game designs by including motor elements along with music, and rhythmic and free body movements; The sixth session: Alignment of kid's weakest movements with music rhythm and combining these movements with body beats; The seventh session: Regular rotational movements for stimulating vestibular system along with music play by a music therapist.

The eighth session: Physical skills games and listening to the music; The ninth session: Playing golf in a small scale, throwing a loop to the target, regular rotational movements for stimulating vestibular system, and teaching rhythm through body movements; The tenth session: Playing golf in a small scale, playing with simple devices like wooden blocks, regular rotational movements for stimulating vestibular system, and teaching rhythm through body movements; The 11th session: Walking on the knee, foot and heel, jumping back and forth, and playing music along with a symbol like the photo so that in this way seeing the image associates music; The 12th session: singing children's songs along with music play by a music therapist and performing rhythmic movements simultaneously; The 13th session: using simple exercises along with music play and synchronizing speech with child's movement rhythm; The 14th session: tempo-based training and synchronizing speech with child's movement rhythm; and The 15th session: a brief review of previous sessions and summarizing all of the sessions.

3. Results

The descriptive statistics of pre-test and post-test scores of the experimental and control groups are listed in Table 1 that demonstrates the results of Kolmogorov-Smirnov (K-S)

test for assessing the normal distribution of variables in the study groups. According to Table 1, the Z statistics of Kolmogorov-Smirnov test is not significant for all variables. Therefore, it can be inferred that the distribution is normal in these variables.

To explore the effect of teaching music therapy along with play therapy on the motor coordination of children with ASD, the one-way ANCOVA (analysis of covariance) was used. Results of the homogeneity of regression slopes of pre-test and post-test with respect to motor coordination in the experimental and control groups revealed that regression slope in both groups is identical ($F_{1,26}$=3.95, P>0.05). Levene's test was applied to assess the equality of variances for the dependent variable in the 2 groups. Its results revealed that motor coordination variance is equal in both groups ($F_{1,28}$=1.71, P>0.05).

The F test of the pre-test of motor coordination relation with the post-test of motor coordination (654.55) was achieved as significant (P>0.001). The F test of the pre-test of motor coordination relation with the post-test of motor coordination (1.61) was achieved as not significant. Therefore, there is a linear relationship between motor coordination in the pre-test and post-test. Table 2 lists the 1-way ANCOVA results for the differences between the experimental and control groups in post-test and pre-test.

Considering Table 2, the F value of motor coordination in the post-test is 26.16, which is significant (P>0.001). This indicates a significant difference between the 2 groups with respect to motor coordination. In addition, the effect size of 0.49 indicates that this difference is great and considerable in the society. ANCOVA results indicate that the corrected sum of squares of the experimental group in motor coordination (24.96) is more than that of the control group in this variable (Mean=21.30). The difference between the experimental and control groups in this variable is 3.65, which is significant, considering the F value (P>0.001). As a result, music therapy along with play therapy increases motor coordination in children with ASD.

4. Discussion

The present study aimed to explore the effectiveness of music therapy along with play therapy in increasing the motor coordination of children with ASD. The obtained results suggested that music therapy interventions along with play therapy significantly increased the motor skills of experimental group compared to the controls. The positive effects of music in the motor coordination of children with ASD have been confirmed in previous research studies [13, 25-28], as well.

Findings revealed that, with music practices, the child understands structural components of the beat of music and expresses it through coordinated movements. A rhythmic movement is, in fact, the most prominent part of a coordinated movement [29]. Furthermore, the interrupted and rhythmic nature of musical movements is a kind of movement training and functional balance. Such nature is enjoyable for the individuals. The same temporal struc-

Table 1. Descriptive statistics of pre-test and post-test scores in the experimental and control groups (n=30)

Variable	Situation	Group	Mean±SD	K-S Z	P
Motor Coordination	Pre-test	Experimental	20±8.34	0.74	0.63
		Control	22.13±12.85	0.71	0.68
	Post-test	Experimental	23.86±9.73	0.72	0.66
		Control	22.40±12.65	0.65	0.78

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Table 2. One-way ANCOVA results for the differences between the study groups in motor coordination

Source	TSS	df	MSE	F	Level of Significance	Effect Size
Pre-test	3464.93	1	3464.93	913.66	0.001	0.97
Group membership	99.22	1	99.22	26.16	0.001	0.49
Error	102.39	27	3.79			

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ture in music including rhythmic sounds in a constant pattern facilitates the fine coordination of body movements.

Those functions that are performed according to music require correct and fast responses to visual and audio motives. When producing sound by musical instruments, the individual instantly receives constant audio feedbacks from her/his movements. As a result, they can adjust their response speed with the audio motive or their performance quality [30]. Therefore, coordinating body movements with a rhythm can balance motor responses through affecting the nervous system and discharging simulative or inhibitory neurotransmitters depending on the rhythm type. This process gradually results in performance adaptation in body movements.

Listening to music and playing percussion instruments like bells could enhance recovery by increasing self-control in physical movements, performance balance, and physical states [31]. This is due to the activation of the motor cortex and basic complexes and creating a mutual performance on limbic system and sensorimotor integration of basic complexes and cortex-forehead regions [32]. Therefore, rhythmic auditory cueing is an appropriate technique for providing predictable structures and changeability in motor patterns and facilitating motor planning in children with ASD [29].

The positive effects of play and motor activities in increasing the motor coordination of children with ASD have been mentioned in previous research studies [18, 19, 33]. The studies have suggested that when children are engaged in active games, the intensity, duration, and time of movement have a significant influence on their health and motor development [18]. Motor planning is the ability to conceptualize a plan and perform a series of unfamiliar motor tasks. In order to successfully perform motor plans, the child with ASD should be aware of happenings while performing motor tasks.

These skills could be improved by performing plays and different motor activities such as balling, playing with sand, gravel game, finding hidden objects, and different motor activities. Moreover, bilateral motor integration is defined as the coordination of the 2 sides of the body for performing a correct motor task. As a result, games that cause the child to keep an object in each hand and perform bilateral motor tasks like jumping games are helpful in improving this part of motor coordination. In addition, balance skills based on inputs from several sensory modalities like vestibular and proprioceptive system are required for movement and speed and gravitational pull.

Rotating, playing with toys, and walking are examples of the development of balance skills for children with ASD [34]. In addition, the variety of play activities provides higher chances for fine motor skills development in these children. Thus, the repetition of practice games reinforces gross motor actions without pretending or participating in social rules [16]. Combining music with motor activities result in balance and lower alterations in various areas associated with instinct (sleeping, feeding, and individual body activities), higher capacity in imitation and repetition, shaping actions and games, and finally muscle tone growth in children with ASD [24]. This effectiveness could be due to flexibility and child-centeredness of music and play that facilitated the treatment procedure.

This research was limited to educational grades from preschool to the third grade of elementary school. Therefore, in generalizing the results to other educational grades and other sections necessary caution should be taken. In this research due to executive limitations and the administrative obstacles of centers, the researchers were unable to perform a follow-up. Future studies are recommended to consider a larger sample size and a follow-up stage. Children with ASD suffer from different sensory disorders and music evokes various responses in this population. Thus, in additional studies, it is suggested that hypersensitive and hyposensitive children be separated on the basis of the type of assessment prior to implementing the intervention.

5. Conclusion

This study is a primary research on combined music and play therapy for children with ASD. Overall, this research suggests that the participation of children with ASD in music therapy programs along with play therapy will result in reinforcing motor skills through increase in rhythm understanding, and finally performance adaption in body movements. However, because of social isolation, limited eye contact, and stereotypical behaviors, music and play therapy should be performed in a natural environment considering the conditions of these children. Therefore, the level of sound and number of people in the environment, selection of appropriate devices and teaching strategy are among important issues for these children to receive effective treatment.

It is suggested that further studies explore other types of music therapy programs such as improvising, playing more sophisticated instruments, and group playing along with play therapy and its possible effects on other functioning areas of children with ASD in various age ranges.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles were considered in this article. The participants were informed about the purpose of the research and its implementation stages; they were also assured about the confidentiality of their information; Moreover, They were allowed to leave the study whenever they wish, and if desired, the results of the research would be available to them.

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Authors contributions

The authors contributions is as follows: Supervision and conceptualization: Abbas Ali Hossein Khanzadeh; Funding acquisition and visualization: Ahya Hasirchaman; and Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing–original draft preparation, writing–review & editing, visualization and project administration: Fahimeh Imankhah.

Conflict of interest

The authors declared no conflict of interest.

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