

# Research Paper: The Effect of Movement Activities in Synchronization With Music on Motor Proficiency of Children With Autism



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## ABSTRACT

**Objectives:** Although social deficits are the main features of autism, children in autism spectrum disorder often too display difficulties with posture, coordination and motor planning. As such, poor motor skills are believed to be associated with greater difficulties in social communication. Some recent studies show that music can improve the sensory processing and motor functions by affecting brain connectivity. The present study aims to examine the effect of movement activities in synchronization with music on motor proficiency of 7 to 14 years old children with low functioning autism.

**Materials & Methods:** A double-blind randomized controlled trial design was used in this study. Twenty two subjects participated in the study and assigned into experimental and control groups randomly. The interventions consisted of movement activities with music for experimental group and without music for control group. Motor proficiency of subjects such as balance performance, bilateral coordination and upper limb coordination were assessed by trained independent evaluator before the treatment and also after 12<sup>th</sup> and 24<sup>th</sup> therapeutic sessions using 3 subtests of Bruininks- Oseretsky Test of Motor Proficiency (BOTMP). The effect of interventions in two groups were compared by repeated measures ANOVA.

**Results:** The results indicated that both interventions improved motor performance in the participants but the effects of interventions on balance performance ( $P < 0.001$ ), bilateral coordination ( $P < 0.05$ ) and upper limb coordination ( $P < 0.001$ ) were significantly different between the two groups.

**Conclusion:** Movement therapy is beneficial for children with autism, but movement activities in synchronization with music can accelerate improvements in motor proficiency of these children.

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## 1. Introduction

**A**lthough it has yet to be established whether motor impairment can be one of the core criteria for diagnosing Autism Spectrum Disorder (ASD), several studies have frequently reported that motor impairment in children with autism do in fact exist [1, 2]. A recent Meta-analysis has shown that major and prevalent variation in motor performance must be counted as ASD core features in motor deficits [3]. Assessment of various area of motor ability have been used to identify these impairments, which include fine manual control, writing, manual dexterity-coordination, ball skills, gait, balance, body coordination, strength and agility, praxis, imitation, postural stability and speed. In each study children with ASD had significantly poorer motor abilities and more frequent subtle neurological signs compared to the control group. Studies have revealed that the rate of motor impairments generally converge on 80-90 percent of the cases [4-9]. Some of such studies confirmed this claim by comparing the scores of Peabody test and Bayley test in children with autism and their typical peers. The result showed significant delay and differences in gross and fine motor skills in ASD children in comparison to the control group [10].

These motor performance dysfunction limits participation of ASD children in daily living skills such as play activities, self-feeding and school related functions [2, 11]. The relation between motor proficiency and social competency is the sure fact, meaning the less motor coordination and agility translates to the less child social participation. Also, deficits in motor proficiency may lead to increase child anxiety and finally cause difficulties in relationship with friends and peers [12, 13]. Sensory integration therapy is the most common therapeutic approach for sensory and motor problems in children with ASD [14].

Today clinicians use some complementary and alternative medical techniques to increase improvement on

their clients. Music therapy as an alternative medicine in conjunction with the effect of joint attention, social interaction and verbal/nonverbal communication, can address motor dysfunction, sensory deficits and behavioral problems in children with autism [15]. The rhythm of music, which is the most structural part of it, can influence some different areas of the brain such as the motor area by making auditory motor integration and coordination [16-18]. Therefore, music can be used as an effective modality in motor rehabilitation. Many studies exist on the efficacy of music on motor improvement, although the effect of music on management of motor problems in ASD was less discussed [12]. Given the need for a thorough randomized trial of music therapy in treatment of motor deficits of individuals with autism, the goal of this study was to investigate whether adding music to the traditional movement therapies can increase motor proficiency in children with ASD, in comparison to using motor exercises alone.

## 2. Materials and Methods

Twenty two children participated in this study. An acceptable sample of the eligible clients was selected from autism charity daily center in Tehran-Iran where the study took place. The inclusion criteria were as the following: age ranges from 7.0 to 14.0 years, confirm the diagnosis of autism by a psychiatrist based on DSMIV-TR, parental consent, low functioning autism based on score of more than 100 on Autism Screening Scale Questionnaire (ASSQ) [19], normal auditory processing as measured by short form of Sensory Profile (SP) [20], and absence of seizure attack in the last two years. All types of treatments and medication during the study period, level of functioning, sensory profile score and age ranges were matched in two groups.

Any changes in medication, absence of child more than one session in intervention phase and lack of child's cooperation and parents' refusal during the interventions

**Table 1.** Demographic Characteristics of Participant in two groups

	Experiment Group No=11	Control Group No=11	P
Sex (no)%	Boy (9) 81% Girl (2) 19%	Boy (8) 73% Girl (3) 17%	
Age (month) Age Mean (SD)	109.50 (SD=24.25)	107 (SD=18.06)	0.70
SP Mean (SD)	170.73 (SD=10.3)	169.36 (SD=11.43)	0.77
ASSQ Mean (SD)	121.55 (SD=12.23)	122.09 (SD=10.99)	0.91

were the exclusion criteria of this research. The study was approved by Tehran University Ethics Committee of Medical Science. After receiving the permission of participating parents, the medical records of their children were available to researchers which was followed by the Checking of inclusion criteria in the children. After the written parental consent form was collected, all of the selected children (n=31) were assessed by a child psychiatrist to ascertain a correct diagnosis based on DSMIV-TR. Next, an independent evaluator who was blind to group assignment administered the ASSQ and SP for confirmation of level of functioning and sensory issues which were important to the study. The blinded evaluator was a licensed occupational therapist who had sufficient experience working with ASD children.

Eventually, 22 children with low functioning ASD were selected to participate in the study. These children were randomly assigned in two equal groups (experimental and control group) using random number generations (Table 1). Thus eleven children were devoted to the experimental group and eleven to the control group. All participants received the interventions 3 times per week in 45 minutes sessions for 8 weeks. The independent evaluator remained blinded during the study and completed all assessments using the BOTMP. Assessments were implemented 3 times during the period of the study. First assessment, as the pre-test, was given prior to the beginning of treatment session. Second assessment, as the middle test was given after session 12, accurately at the middle of the study. Finally, the last assessment, as the post-test, was performed after the last session (session 24).

Children in the experimental group received musically synchronized movement exercises. All movement activities were retrieved from music therapy methods in previous researches and occupational therapy methods for motor improvement in children. The control group received the same movement exercises without music. Parents of children in control group were promised to receive musically synchronized program for their child after completion of the study. Movement activities included playing marsh, walking on knees, toes and heels, creeping and crawling under different obstacles, jumping forward and backward, playing on trampoline and tilt board, using scooter board plays and balance devices, hopping and more coordinated movement in hands and feet which were designed from easy to complex. All of this exercises in experimental group were performed with musical rhythm. The children were to perform the movement coordinated with the music, playing simple instruments such as maracas, wooden blocks, tambourine and castanets synchronized with rhythm. That meant that at first, one hit per two

beats, then, one hit per one beat and at last, two hit per one beat were done with those instruments [21]. The measures used in this study were: 1) demographic questionnaire, which included information about sex, age and medical history of children; 2) ASSQ for determination of level of function in children with ASD; 3) Short form of SP to assess the sensory processing status of participant; and 4) BOTM for investigating of motor proficiency of children.

The ASSQ questionnaire included 3 areas such as social interaction (14 questions), speech and language level (15 questions), and behavioral issues (15 questions). Scores between 0-49 meant no problem, 50-100 meant mild problem (high functioning autism), 100-150 and more than 150 meant low functioning autism with moderate to severe problems. For this study children with scores 100-150 were chosen for categorizing as low functioning autism [19]. The SP short form is the 38-item parent report of a child's sensory behaviors. This item included 7 domains of tactile processing, olfactory and tasting processing, auditory and visual processing, motion sensitivity, sensory seeking behaviors, auditory hypersensitivity and energy level [20]. For this study children must have not obvious problem in sensory processing in auditory system.

BOTMP is one of the best motor assessments in children which has 46 items in 8 subtests, evaluating agility, balance, coordination and strength of children ages 4.5 to 14.5 years. Its Construct validity has been supported and it has good inter-rater reliability (for subtests 89% and for total score 87%) [22, 23]. For the purpose of this study we chose just 3 subtests of BOTMP including balance (subtest 2) contains 8 items of balance skills from standing on one leg to more complex skills like walking on balance beam, bilateral coordination (subtest 3) has 8 items that requires the simultaneous use of upper and lower limbs and sequencing movements, and upper limb coordination (subtest 5) includes 9 items that five of their first are one or two handed ball skills and four other items are fine coordinated and alternative movement of fingers and hands. SPSS was used to perform statistical analyses. Repeated Measures of ANOVA was utilized to examine the effect of interventions on obtained scores of BOTM.  $P < 0.05$  was considered as statistically significant.

### 3. Results

The children's performance on each subtests of measure was compared for the two groups using a repeated measure ANOVA with time (pre, middle, post) as the within group variable and group (experimental vs. control) as the between group variable. Table 2 shows the

outcome means and standard deviations and repeated measures ANOVA results on BOTM subscales.

Analysis of variance indicated that there was a main effect of group,  $F(1, 20)=52.88$ ,  $P<0.001$ ,  $\eta^2=0.72$  on balance function on the BOTMP, such that the experimental group had a higher score of balance than the control group. This main effect was driven by a significant time by group interaction,  $F(1, 20)=46.56$ ,  $P<0.001$ ,  $\eta^2=0$ . Such that experimental group made more gains in balance function than the control group over time. Post hoc comparisons by Bonferroni showed that the experimental group made significantly better balance function at posttest than pretest ( $P<0.001$ ). The experimental group also made significantly more balance function than the control group at middle test ( $P<0.01$ ) and posttest ( $P<0.001$ ). These finding showed that there was a main effect of group,  $F(1, 20)=6.52$ ,  $P<0.019$ ,  $\eta^2=0.24$  on bilateral coordination on the BOTMP, such that the experimental group had a higher score of bilateral coordination than the control group. This main effect was driven by a significant time by group interaction,  $F(1, 20)=20.16$ ,  $P<0.001$ ,  $\eta^2=0.5$ , such that experimental group made more gains in bilateral coordination than the control group over time. Post hoc comparisons by Bonferroni showed that the experimental group made significantly better bilateral coordination at posttest than pretest ( $P<0.001$ ). The experimental group also made significantly more bilateral coordination than the control group at middle test ( $P<0.05$ ) and posttest ( $P<0.01$ ).

Upon finding of this results there was a main effect of group,  $F(1, 20)=46.12$ ,  $P<0.001$ ,  $\eta^2=0.69$  on upper limb coordination on the BOTMP, such that the experimental group had a higher score of upper limb coordination than the control group. This main effect was driven by a significant time by group interaction,  $F(1, 20)=40.9$ ,  $P<0.001$ ,  $\eta^2=0.81$ , Such that experimental group made more gains in upper limb coordination than the control group over time. Post hoc comparisons by Bonferroni showed that the experimental group made significantly

better upper limb coordination at posttest than pretest ( $P<0.001$ ). The experimental group also made significantly more upper limb coordination than the control group at middle test ( $P<0.001$ ) and posttest ( $P<0.001$ ).

#### 4. Discussion

Deriving from the study, improvement in both groups of children with autism after the treatments were observed, but musically synchronized motor exercises in experimental group were leading to further progress in motor proficiency elements, in comparison to motor exercises in control group. In time, the difference was more apparent among the latter group. Although we found evidence for positive effects of traditional motor exercises on improvement of motor efficiencies, however the findings indicated that motor activities with music can bring on more improvement in experimental group [23]. Based on prevalence rate of 85-90 percent of motor problems in ASD children, treatment of motor deficits has always been one of the main therapeutic goals for therapists in fields of treatment methodology [24]. It should be noted that one of the major approaches is sensory integration [14]. Review articles in music therapy and autism revealed that most studies in this field have been case studies or case series with small sample sizes. In addition, most of the extracted results had used pre and post-test assessment on the same experimental group without having any control group [25].

Music therapy as an alternative and complementary medicine has recently seen an extended use in autism research for improving social-communicational and emotional- behavioral skills. Yet, few studies on the effect of musical interventions on motor function of these children have been carried out so far. It should be mentioned though that evidence does exist on the effect of music and motor combination training for the treatment of some movement parameters of neurological disorders such as Parkinson's disease, cerebral palsy, stroke [26-28]. Therefore, in this article we hypothesized that

**Table 2.** Finding for mean (SD) scores of BOTM subscales of participants and repeated measures ANOVA results

Subscale	Experimental Group Mean(SD)			Control Group Mean(SD)			ANOVA Results	
	Pretest	Middle	Posttest	Pretest	Middle	Posttest	F Group	F Group×Time
Balance	1(0.00)	2.45(1.86)	16.81(3.54)	1(0.00)	1.18(0.40)	5.36(3.69)	52.88**	46.56**
Bilateral coordination	4.27(3.71)	7.72(4.00)	13.45(4.32)	2.909(3.47)	4.54(3.58)	6.18(3.86)	6.52*	20.18**
Upper limb coordination	1.45(0.68)	4.18(3.06)	16.36(3.07)	1.09(0.70)	1.36(0.92)	4.36(3.32)	46.12**	40.90**

\*:  $P<0.001$ ; \*\*:  $P<0.05$

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accompanying of music with movement activities can lead to more improvement in motor function like balance performance, bilateral and upper limb coordination. Rhythm as the most structured factor in each piece of music can influence neural plasticity in the brain. Since, motor system is very sensitive to auditory system physiologically, music can activate different areas of the brain such as pre motor and motor area and cerebellum, thus causing positive effects on motor outputs [16, 29, 30].

Luft et al. (2004) [31] indicated that after 6 weeks rhythmic auditory motor treatments and bilateral hand movements, considerable changes were occurring in pre central gyrus, complementary motor area and cerebellum of their participants. These findings proved that engaging in short time rhythmic motor activities can result in brain plasticity and structural and functional changes in the brain [31]. In support of those findings, Taut et al. (2010) announced that rhythmic auditory stimulation can increase movement speed, motor coordination and length of steps in persons with neurological disorders. They noted that rhythmic auditory stimuli can correct general pattern of motions as well as affecting motor timing much faster than other gradual trainings [16, 25].

Thus, we can emphasize that rhythmic auditory stimuli is an effective tool in motor rehabilitation [32, 33]. Rhythm affects human brain by coordinating movement with auditory rhythm in person suffering from neurological impairments. It can also activate motor neurons in reticula spinal tracts [34], and can regulate spatial organization and motor sequencing. Therefore, synchronization of movement with music pulls visual, auditory, somatosensory and motor areas of the brain together in a coordinated manner and activate the perception- action cycle [35-37]. Considerable evidence on structural and functional abnormalities in cerebellum [38, 39], proves that music can be used as a feedback on motor control where rhythmic auditory stimuli as a feed forward factor can predict motor outputs of a person. Therefore, children with ASD will no longer need to rely on proprioceptive data to increase their motor quality and the smoothing of their movement after the interventions [40].

Movement activities with music can affect cerebellum function of children with autism and promote their balance performance and coordination. Data also exists that a person with cerebellar damage executes movements with a lesser coordination and smoothness, resulting in a lower quality of movements in comparison to optimal level. Although children with ASD have the ability to move their body. Some basic disabilities may lead to incoordination and deficits in motor planning which even-

tually affects their motor skills negatively. Considering the fact that the regular and rhythmic behavior in cerebellar dysfunction remains normal [25] with the higher interest and musical perception in ASD children in comparison to normal peers [41-43], we can suggest that motor activities synchronized with music can be an affective therapeutic strategy in ASD motor rehabilitation. In our previous records the cognitive skills of people with schizophrenia improved by music interventions [44-46]. Therefore, it seems the effect of music on cognitive abilities in children with ASD with their common characteristics should be examined. There were several limitations to this study that should be acknowledged. Having a low sample size because of the lack of previous RCT studies to estimate an accurate sample size, and difficulties accessing homogenous participants.

## 5. Conclusion

In sum, our findings suggest that synchronization of music with traditional sensory motor activities lead to increase improvement in balance performance, bilateral and upper limb coordination in ASD children. More researches with more sample size and investigating the effect of music on other elements of motor function is needed.

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## Conflict of Interest

The authors declared no conflicts of interest.

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