

The Effectiveness of Therapeutic Exercise on Motor Skills and Attention of Male Students with Autism Spectrum Disorder

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Abstract—Autism spectrum disorders (ASD) involve myriad aberrant perceptual, cognitive, linguistic, and social behaviors. The term spectrum emphasizes that the disabilities associated with ASD fall on a continuum from relatively mild to severe. People with ASD may display stereotyped behaviors such as twirling, spinning objects, flapping the hands, and rocking. The individuals with ASD exhibit communication problems due to repetitive/restricted behaviors. Children with ASD who lack the motivation to learn, who do not enjoy physical challenges, or whose sensory perception results in confusing or unpleasant feedback from movement may not become sufficiently motivated to practice motor activities. As a result, they may show both a delay in developing certain motor skills. Additionally, attention is an important component of learning. As far as children with ASD have problems in joint attention, many education-based programs are needed to consider some aspects of attention and motor activities development for students with ASD. These programs focus on the basic movement skills that are crucial for the future development of the more complex skills needed in games, dance, sports, gymnastics, active play, and recreational physical activities. The purpose of the present research was to determine the effectiveness of therapeutic exercise on motor skills and attention of male students with ASD. This was an experimental study with a control group. The population consisted of 8-10 year-old male students with ASD and 30 subjects were selected randomly from an available center suitable for the children with ASD. They were evaluated by the Basic Motor Ability Test (BMAT) and Persian version of computerized Stroop color-word test and randomly assigned to an experimental and control group (15 students in per group). The experimental group participated in 16 therapeutic exercise sessions and received therapeutic exercise program (twice a week; each lasting for 45 minutes) designed based on the Spark motor program while the control group did not. All subjects were evaluated by BMAT and Stroop color-word test after the last session again. The collected data were analyzed by using multivariate analysis of covariance (MANCOVA). The results of MANCOVA showed that experimental and control groups had a significant difference in motor skills and at least one of the components of attention (correct responses, incorrect responses, no responses, the reaction time of congruent words and reaction time of incongruent words in the Stroop test). The findings showed that the therapeutic exercise had a significant effect on motor skills and all components of attention in students with ASD. We can conclude that the therapeutic exercise led to promote the motor skills and attention of students with ASD, so it is necessary to design or plan such programs for ASD students to prevent their communication or academic problems.

Keywords—Attention, autism spectrum disorder, motor skills, therapeutic exercise.

I. INTRODUCTION

At present, ASD is categorized as neurodevelopmental disorder according to the fifth edition of Diagnostic and Statistical Manual for mental disorders (DSM-V). Spectrum refers to the disabilities that varied from moderate to severe [1]. The symptoms of ASD are categorized according to two important areas: 1) social interaction and communication impairments, 2) repetitive and restricted patterns of behavior, interest, and activities. The impairments start at early childhood, but it is possible that the clinical manifestation is unclear until later years. Generally, these impairments lead to child's communication deficiencies and problems of feeling and language [2]. Children with high functioning autism (HFA) have normal intelligence, but those with low functioning autism (LFA) have lower level of intelligence [3], [4].

In recent years, reported frequencies for ASD across U.S. and non-U.S. countries have approached 1% of the population [1]. In March 2014, the Centers for Disease Control and Prevention (CDC) released their most recent estimate of ASD among children aged 8 years [5]. Their starting finding was that 1 in 68 children met criteria for ASD in 2010, compared with 1 in 88 in 2008 [6]. In Iran it was reported 6.26 in 10,000 children aged 5 years [7]. Some frequencies have approached 1 from 50 male's population (2013) in comparison with 1 in 5000 population (1975) [8].

Often, the behaviors of children with ASD get their parents and therapists into trouble. They show inappropriate, repetitive, risky and stereotyped movements. Some experts have explained that sensory disorders are the cause of these behaviors, then children with ASD have tendency to satisfy their sensory needs through such behaviors [9]. As a whole, ASD leads many problems in various areas such as communication [10], social interaction [11], stereotyped behaviors [12], and motor skills [13].

Motor skills include special motor components. By growing up, the children will be able to combine the learned skills and do more difficult movements or daily activities. These movements include three major categories: 1) stability abilities, 2) locomotive abilities, and 3) manipulative abilities [14]. Motor skills contribute on the learning and development of other skills (such as academic and social), therefore a child can control his environment more [15]. Due to social and

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behavioral problems, participation of people with ASD in physical activities is low. They usually are at risk for immobility and its negative consequences [6]. Reference [16] showed that in children with ASD, the social interaction has correlated positively with the level of physical activity. Also, some studies have shown that children with ASD have impairment in gross and fine motor skills, motor planning and coordination [17]-[19], poor motor skills and balance in comparison with normally developed children.

A literature review makes it clear that many interventions may be effective for treatment of symptoms of ASD. The interventions include medication, neurofeedback [20] and interventions that are based on motor activities and exercises. It is shown that a course of basic swimming skills has positive effect on the improvement of gross motor skills in 7-11 year-old children with ASD [21]. Another study showed the efficacy of specific physical activities on object control skill in children with HFA [22]. The results indicated that physical activities lead to the decrease of repetitive and stereotyped behaviors [23], increase of communication ability and social interaction in children with ASD [24]. Therefore, we can conclude that exercise-centered interventions lead to reinforce motor skills of children with ASD.

Children with ASD have problems in fine and gross motor skills, movement imitation and motor planning [2], [12]; they show strange and repetitive movements [3]. On the other hand, special motor skills are required for starting joint attention and motor activities are the very important components of learning academic and social skills [3], [14], [25], [26]. Thus they can provide the required motivation for achievement or reinforcement of academic and communication skills [27]. The motivation for trying to do appropriate activities can lead to enjoyment and self-satisfaction. Following these changes, the individual's attention will be drawn to changes in his body. As a result, children will experience greater life satisfaction. This can lead to improve their quality of life [28]. The present study was aimed to determine the effectiveness of therapeutic exercise on motor skills of children with ASD.

II. MATERIALS AND METHODS

The present study was an experimental research with a control group. The study covered a sample of 30 children aged 8-10 years (mean \pm SD 9.41 ± 2.13) with autism disorder representative of 109 autistic children who are educated in centers at Tehran. All subjects were evaluated by Gilliam Autism Rating Scale-2nd edition (GARS-SE) and diagnosed as HFA through psychiatric clinical interview. They were excluded from the study according to: have physical disability, sensory impairments and intellectual disability. The study was formally approved by the ethics committee of the University of Social Welfare and Rehabilitation Sciences in Iran. At first, mothers signed a written consent, then children were allocated randomly to experimental and control groups (15 individuals in each group). To measure children's motor ability, the BMAT-Revised was used [29]. The test includes seven subtests to reflect different abilities, a basketball throw for distance, bead stringing, target throwing, marble transfer, back

and hamstring stretch, a standing long jump, and ball striking. The test-retest reliability for the BMAT was 0.93 [30].

The computerized Persian version of Stroop color-word test was used for assessing attention. The test consisted of three parts. The first part consists of computerized presentation of the names of four colors (blue, red, green, and yellow), that were written in capital letters. Each word was appeared six times in semi-random order, so that the same word never appeared two continuous times throughout the test. Subjects ought to read each word as fast as possible. The first part of the test was intended to obtain a baseline to evaluate the reading ability and determine whether this ability is high enough that not to hinder the interference effect. The second part consists of presenting 24 colored circles (six circles for each color: blue, red, green, and yellow), distributed semi-randomly. Also, the task was similar to the first part and the subject had to name the color of the circle. In the third part, the circles were replaced by written words, relating to the four colors. However, the words were printed in colors that do not relate to the written words (for example, the word 'red' written in green letters). The subjects should ignore the meaning of the written word, naming the color in which the word was written [29]. The correct responses, incorrect responses, no responses, reaction time of congruent words and reaction time of incongruent words in the Stroop test were calculated with computer. It is reported that the Persian version of the Stroop test has good validity and reliability. The reliability of this test, based on the test-retest is varied from 0.80 to 0.91 [31].

After administrating the BMAT and Stroop test, the experimental group participated in 16 intervention sessions (twice a week; 45 minutes per session), while the control group only attended to the mainstream classes. After the last session, all subjects were assessed by BMAT and Stroop test again. The data were analyzed by multiple analysis of covariance (MANCOVA).

The therapeutic exercise program which was used in the present study was designed based on Spark motor program [13]. The content of the therapeutic exercise program is shown in Table I.

III. RESULTS

The mean and standard deviation of age in the experimental and control group were 9.35 ± 2.05 and 9.47 ± 2.22 , respectively. The results of independent t-test showed that there was no significant difference between the experimental and control groups according to age ($t = 1.93$ & $p = 0.09$). Table II shows the descriptive statistic of motor skills and attention span for the experimental and control groups in pretest and posttest situations.

As reflected in Table II, the mean score of motor skills in the experimental and control groups increased in posttest situation compared to pretest. Also, the results showed that the mean scores of attention span components (correct responses, incorrect responses, no responses, reaction time of congruent words and reaction time of incongruent words in the Stroop test) in experimental and control groups increased in posttest situation in comparison with pretest. We used MANCOVA to

compare the mean score of motor skills in the experimental and control groups.

TABLE I
THE CONTENT OF THERAPEUTIC EXERCISE PROGRAM SESSIONS

Session	Aim	Content
1	Familiar with the child	Doing soft exercises (in a group or individually)
2	Gross motor coordination	Doing activities (such as: sit down & stand up)
3	To strengthen gross muscles	Activities like: dragging and pushing the wheeled objects straight forward and backward
4	To strengthen body balance	Walking on a straight line, hopping in a circle, putting crossed colored circles and jumping in them
5	To strengthen static and dynamic balance	Standing on tiptoe, jumping up and down with two feet and one foot
6	To strengthen motor skills and attention	Hopping and standing up with one foot in various intervals, throwing the ball in definite direction, passing the ball through the trainer feet
7	To strengthen hand and body muscles	Concurrent movements of hand and body in different directions, walking on hands while a trainer holding the child's legs
8	To increase attention, eye-hand coordination	Doing activities such as: throwing a coin to a bowl or till
9	Reinforcing tactile and body awareness	Playing with clay and paste, hiding objects in sand, turning over the sand
10	Coordinating fine and complex skills	Playing such as: turning the ball and passing it among obstacles, arranging a puzzle, building logos
11	To strengthen body balance	Walking and running in different postures and jumping over obstacles
12	Coordinating of complex motor skills	Doing effective activities on the muscles of thighs, toes, and arms, such as making a circle and aerobic movements
13	Orientation; active motor coordination	Holding competence between two children for grasping the ball, without let the ball fall
14	Reinforcing attention; dynamic balance	Putting a glass of water in palm while standing and moving, carrying a tray contains several glasses of water without pouring them
15	Increasing eye-hand coordination	Using equipment such as a bubble maker, throwing up a balloon and striking it with hand
16	Reinforcing orientation, selective attention	Striking the ball with baton, tracing specific colored lights in a dark room, tracing hanging colored balls and striking them systematically

At first, it is required to test the assumption of MANCOVA for determining the effectiveness of the therapeutic exercise on motor skills and attention span of male students with autism disorder. The Kolmogorov-Smirnoff (k-s) showed that all variables were normal ($p > 0.05$). The assumption of equality of variances was confirmed by Leven test ($F = 0.85$ & $p = 0.41$). The results of MANCOVA are reported in Table III.

TABLE III
RESULTS OF MANCOVA FOR COMPARING MOTOR SKILLS AND ATTENTION SPAN OF EXPERIMENTAL AND CONTROL GROUPS

Variable	Source of change	SS	df	MS	F	Sig	η^2
Motor skills	Motor skills	64.24	1	64.24	5.85	0.001	0.53
Attention span	Correct responses	117.21	1	117.21	33.08	0.001	0.59
	Incorrect responses	23.84	1	23.84	37.60	0.001	0.60
	No responses	17.44	1	17.44	11.00	0.001	0.57
	Reaction time of congruent	1132.27	1	1132.27	26.57	0.001	0.63
	Reaction time of incongruent	180.07	1	180.07	29.04	0.001	0.49

It probably seems that as children with ASD have impairments in different development areas such as behaviors

TABLE II
DESCRIPTIVE INDICES OF VARIABLES IN PRETEST AND POSTTEST SITUATIONS

Variable	situation	Experimental group		Control group	
		Mean	SD	Mean	SD
Motor skills	Pretest	35.87	2.82	35.66	2.91
	Posttest	42.61	2.14	36.40	2.47
Correct response	Pretest	29.51	1.87	28.65	1.75
	Posttest	35.52	1.94	27.56	1.64
Incorrect responses	Pretest	42.63	2.01	43.59	2.25
	Posttest	39.48	1.18	43.66	1.54
No responses	Pretest	22.15	2.54	23.10	1.67
	Posttest	19.60	1.66	22.18	2.58
Reaction time of congruent	Pretest	1297.36	5.62	1218.65	6.99
	Posttest	1239.47	16.27	1222.60	12.11
Reaction time of incongruence	Pretest	1342.43	3.88	1244.22	12.11
	Posttest	1328.25	4.24	1241.77	3.63

As indicated in Table III, there is a significant difference ($p < 0.001$) between the experimental and the control groups according to motor skills and attention span. Also, according to eta quotient (η^2), 53%, 59%, 60%, 57%, 63%, and 49% of variation in motor skills, correct responses, incorrect responses, no responses, reaction time of congruent words and reaction time of incongruent words of the experimental group can be explained by attending to the therapeutic exercise sessions. This study showed that the motor skills and attention span of children with ASD were promoted after participating in intervention sessions and received the therapeutic exercises.

IV. DISCUSSION

According to the findings, the therapeutic exercise intervention has positively influenced the motor skills of male students with ASD. This coincides with some other studies [16]-[19]. Reference [21] showed that basic motor skills training leads to improve motor abilities of 7-11 year-old children with autism. Another study confirmed that physical activities are effective on improvement of object control skills in HFA children [22]. Prupas and Reid concluded that the physical activities lead to decreasing of stereotyped behaviors in children with ASD [23]. It is also in agreement with the results of another study that showed the effect of physical exercises on promotion of communication and social interaction of children with ASD [24].

and motor skills, in comparison to normally developing children, they experience more challenges. They do not know the right way of doing motor activities and it is the reason for their deficiencies in effective communication and adaptation to the environment [2]. Concerning that the therapeutic exercise program includes special movement components as stability, locomotive and manipulative abilities, it is possible that these abilities have helped the child to learn and do the more complex movements or daily activities according to his development status [14]. On one hand, many training programs, which are formed based on physical movement, can help individuals with autism to communicate and to have social interaction [32]. On the other hand, motor skills play an important role on learning and developing other abilities such as academic and social skills. Then, they can provide the opportunity for child to have more control on his life [15]. As far as the therapeutic exercise program in the study has focused on gross and fine motor skills coordination, improving body balance and stability, improving static and dynamic balance and orientation, as a consequence they strengthen body and hand muscles and it is expected that the program has a positive influence on motor skills of children with autism.

If such suitable training program will be provided, the motor skills of children with autism disorder improve to a higher level. The practitioners of the therapeutic exercise have emphasized on the necessity of ongoing training, repeat and exercise of the learned skills till getting mastery [33]. Therefore, if there is a probability to design and formulate a given program that would consider the details of the therapeutic exercise, it will undoubtedly lead to significant changes in motor skills of children with ASD [34] and it will promote their quality of life and satisfaction [28].

The effectiveness of the therapeutic exercise program on motor skills of children with autism was limited to rather small sample size, and lack of follow-up. It is recommended that the therapeutic exercise program be applied as an educational and rehabilitation intervention in schools in order to prevent movement disabilities and promote motor skills of children with ASD. Also, the application of the program on the other ages beyond the present study will guarantee the effectiveness of the therapeutic exercise on motor skills. Furthermore, such movement-centered programs can be applied as a complementary method for reducing related motor problems of children with ASD in academic and therapeutic settings. Furthermore, motor skills are complex and multidimensional phenomenon with several components (strengthen large muscles, balancing, fine and complex motor skills coordination, reinforce orientation, active motor coordination, eye-hand movements, improve tactile sense and body awareness), thus the programs are necessary to pay attention to these factors. Such programs will promote the mentioned-above factors and improve the motor skills of children with ASD.

V.CONCLUSION

Regarding to the results, it can be concluded that the therapeutic exercise program has positive influence on motor

skills of children with ASD. Considering that acquiring motor skills lead to communication and social interaction, to apply the therapeutic exercise for children with ASD can lead to positive consequences. Therefore, it seems that the planning and designing the specific training and rehabilitation programs which are movement-centered, will lead to reduce the communication problems of children with ASD.

ETHICAL CONSIDERATION

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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