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Motor Skill Training Effects on Coordination and Reaction Time in 6 - 16 Years Old Children with ASD and DS

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Abstract

ASD is becoming one of the most common pediatric cases in the world and several research studies report an increased ASD prevalence. DS is a genetic disorder caused when abnormal cell division results in an extra full or partial copy of chromosome 21. Main objective of this study was to investigate motor skill training effects on coordination and reaction time in 6 - 16 years old children with ASD and DS. 21 children with ASD 20 children with DS became part of this study. 3 tests were used to evaluate the motor skills: 1. Grooved Pegboard Test (mod 7446). 2. Box and Blocks Test. 3. Ruler Drop Test. A 12 weeks exercise training program 3 times/week, including; cardiovascular exercise, short and fast jogging, flexibility exercises and gross motor control exercises. Each group was assigned to an exercise station (total 5 stations), with a total of 20 min. Repeated measures Motor skill training had a positive effect on eye-hand-subject coordination and reaction time in the subjects participated in this study showing that this type of exercise, if possible, can and should be included in the overall rehabilitation therapy for this category.

Keywords: ASD; DS; motor skills; coordination and reaction time.

1. Introduction

DS is a genetic disorder caused when abnormal cell division results in an extra full or partial copy of chromosome 21. This extra genetic material causes the developmental changes and physical features of DS.

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The population with DS presents certain barriers that limit the practice of physical activity and favour sedentarism, these barriers pose a great risk in a population that has been associated with high prevalence of obesity and overweight, risk of cardiovascular disease, osteoporosis, among others [1,2]. Also a large body of literature has documented delays in basic motor skills, such as walking, reaching and grasping, in children with Down syndrome [3,4]. It remains unclear whether 'enriched environments', in the form of motor-based intervention programs, impact on long-term developmental motor outcomes in Down syndrome [5,6]. Much of this developmental delay continues to be attributed to isolated factors such as low muscle tone [7]. Muscle tone evaluated under passive conditions may have little relationship with the strategies used by the nervous system under more dynamic conditions such as during standing [8]. In fact, Latash [9] has suggested that over time, individuals with Down syndrome learn to develop adaptive motor strategies that optimize safety and stability. He suggests that early intervention should focus on exploration of a range of motor solutions to avoid the development of fixed patterns of motor behavior. Perceptual processes interact with motor processes during action production, action correction, and action comprehension [10,11]. Recent studies support the hypothesis that regular physical activity is associated with improved reaction time in youth with intellectual disabilities [12]. Physical activity could act by enhancing the production of neurotrophins aimed at controlling survival, growth, and differentiation of neurons, synaptogenesis, and angiogenesis, with consequent improvement in areas of cognitive performance, such as speed of processing, planning and control strategies, and working memory [13,14]. On the other side a positive correlation has been found between the quality of affective parent–child interaction and the exploratory and symbolic skills of children with Down syndrome [15-17]. ASD relate to impairments in social communication and interaction, evidence suggests that children with ASD also have a variety of motor impairments that cannot be explained by neurocognitive deficits alone [18]. Motor skill deficits commonly observed in children with ASD include, fine and gross motor delays; [18-20] gait abnormalities such as differences in joint angles and ground reaction forces [21]; postural instability due to possible difficulties using sensory information [22]; and coordination difficulties with motor planning and execution [23]. Gross motor delays in infancy have been associated with later ASD diagnosis [27,28], as well as deficits in early social communication [29], implying that neural systems supporting gross motor development could contribute to social impairment in ASD, which generally manifests in toddlerhood. There is an extensive delay in the developmental skills in children with Down syndrome compared to typically developing children [30]. The delay is due to structural differences in the brain, like reduction in the volume of grey and white matter of the cerebellum, frontal lobes, parietal lobes, corpus callosum, and hippocampus, along with a delay in central and peripheral neural myelination [31-33]. Because of these structural changes, various neuromuscular and musculoskeletal deviations occur in children and adolescents with Down syndrome [32]. Along with the quantitative delay, children with Down syndrome display qualitative differences, such as slowness and clumsiness compared to typically developing children [34,35]. There is little information for these subject categories regarding a well-organized and well-structured exercise intervention program aiming at the improvement of motor skills.

2. Objectives

Main objective of this study was to identify the effects of motor skill training on coordination and reaction time in 6 - 16 years old children with ASD and Down Syndrome (DS).

3. Materials and Methods

41 children of the "Luigj Gurakuqi" Special School and the "Jonathan Center" in Tirana, Albania, were included in this study. Assessment of the level of motor skills in the two groups was performed by three tests. Specifically: 1. Grooved Pegboard Test (mod 7446), a test that measures eye coordination and motor speed. The test has been internationally certified since 1977. Neuropsychological Test Manual developed by Dr. Ronald Trites, [24] Royal Ottawa Hospital, Ottawa, Ontario, Canada. Grooved Pegboard is a manipulative test that assesses a subject's level of agility. This test requires complex visual and motor coordination. This device has 25 holes where in the sequence of them the exerciser must put the pins in the right position. 2. Box and Blocks Test [25], is a functional test used for the rehabilitation and of upper limbs mobility and agility. In this test, the subject for 1 min must try each hand, shifting the cubes to the other side of the box. The instructor keeps track of what his dominant hand is. 3. Ruler Drop Test) [26]. It's a simple reaction time test using only a ruler and a little calculation. This test uses the known properties of gravity to determine how long it takes for a person to respond to the fall of the object and he reacts before the viewfinder falls to the ground. The instructor holds the ruler high on the 50cm mark while the exerciser keeps his hand open to wait with command at the 0cm mark. Prior each test all subjects had the possibility to perform some familiarization trials. All subjects after completing each test had a rest period until the start of the next test. All tests have been performed for 3 times and marked the best result. The instructors also have motivated the subjects during the tests. All subjects participating in this study were also following their usual rehabilitation program during the 12 weeks intervention program. Also, all parents have given their signed informed-consent, for their children to take part in this study.

3.1. Exercise intervention program

A 12 weeks exercise intervention program with 3 training sessions/week conducted by the staff of Sports University of Tirana along with the help of institutions teachers. In the end of the exercise intervention period, the same tests were performed again to see the results.

3.2. Training sessions components

A total training session duration was 60 min including: Warm-up; 10 min warm-up (cardiovascular exercises, short and fast runs, flexibility exercises and gross motor control exercises). Main part; (40 min), each group was assigned to practice in exercise "stations" (5 stations), mostly involving body weight exercises, sports and gaming activities, including; football, basketball, volleyball, badminton and ping-pong. In this part, participants were also engaged in exercises focusing in the improvement of motor skills and motor abilities. These exercises were mainly executed with ping-pong and tennis balls and different manipulations with TheraBand's, gymnastic sticks, sponge balls, circles and gymnastic bottles. Skills for performing co-ordinating movements with different tool including the necessity to use arms strength and, to execute different tasks with gymnastic stick focusing the development of hand-to-eye and objects reflex development. Cool-down; (10 min), including, active and passive stretching exercises.

3.3. Statistical Analysis

Statistical Analyses was conducted using IBM SPSS Statistics 24. Pre and post scores for the dependent variables were analyzed using descriptive and inferential methods. The analysis of the data gathered before and after intervention were carried out by comparing means of depended variables of the two measurements (comparing results of Grooved Pegboard Test (mod 7446); Box and Blocks Test; and Ruler Drop Test). The analysis of pre and post measurements were performed by comparing means of dependent variables. T-tests were used to identify and statistically evaluate a possible statistically significant change that can be attributed to the intervention. ANOVA analysis with 2 repeated measurements was used to identify and statistically evaluate a possible statistically significant difference of the dependent variables.

4. Results

Descriptive Statistics and frequency distributions were calculated for the dependent variables (Test scores) and these results are presented in the following sections. Pre- and Post- intervention scores for Box & Block Test for 60 sec are presented in Table 1. These results demonstrated an improvement of mean scores for Box & Block Test after the training period for each category (Left & Right hand, Girls & Boys). Pre- and Post- intervention scores for Ruler drop test are presented in Table 2. These results demonstrated an improvement of mean scores for Ruler Drop Test after the training period for each category (Girls & Boys). Pre - and Post- intervention scores for Grooved Pegboard Test (min: sec) are presented in Table 3. Results demonstrated an improvement of mean scores for Grooved Pegboard Test after the training period for each category (Girls & Boys). Ruler drop test determining how long it takes for a person to respond to the fall of the object and he reacts before the ruler falls to the ground was further analyzed using inferential methods. Descriptive Statistics (Pre & Post Intervention) results for ruler drop test are presented in Table 4. Paired Samples T-Test (Pre & Post Intervention) results for ruler drop test are presented in Table 5. Second tests measurements pointed out improvements of the performance (both boys and girls, both ASD and DS groups).

Table 1: Box & Block Test for 60 sec.:Pre- and Post- intervention scores (Total, ASD & DS, 17 girls & 24 boys)

	Test, before intervention (Box & Block Test)	Test, after intervention (Box & Block Test)
Girls, left hand	21.67	22.76
Girls, right hand	23.03	24.86
Boys, left hand	22.89	25.73
Boys, right hand	24.55	25.67
Total	23.03	24.75

Table 2: Ruler drop test (cm): Pre- and Post- intervention scores (Total, ASD & DS, 17 girls & 24 boys)

	Ruler Drop Test, before intervention (cm)	Ruler Drop Test, after intervention (cm)
Girls	26.3	26.03
Boys	32.64	28.17
Total	29.47	26.6

Table 3: Grooved Pegboard Test (min: sec): Pre- and Post- intervention scores (Total, ASD & DS, 17 girls & 24 boys)

	Test before intervention (min: sec)	Test after intervention (min: sec)
Girls	5.45	4.47
Boys	4.3	3.36
Total	5.07	4.11

Table 4: Descriptive Statistics (Pre & Post Intervention) Results for ruler drop test

	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation
rulerdrop_pre	41	13.95	24.72	38.67	30.594	1.025	4.58
rulerdrop_post	41	13.16	23.40	36.56	27.083	.656	2.94

4. Discussion

The aim of this study was to to identify the effects of motor skill training on eye-hand-subject coordination and reaction time in 6 - 16 years old children with ASD and Down Syndrome (DS). All subjects showed differences from pre-test to post-test results proving the efficacy of the motor skills training programs benefits. Also, we noticed that integrating and organizing the exercise training sessions in several different units/stages including different and mixed exercises was a suitable way to achieve the improvement of overall children's motor skills. A critical component of the development is locomotion, and walking being the chief mode for children and adolescents to perform activities of daily living independently, displays a significant delay and disruption [31]. According to the literature, chronologically 8-year-old children with Down syndrome present with a developmental age of 4 years, and none of the children below 6 years of age develop 100% of the motor functions on Gross motor function measure [30]. Based on the improvements observed in reaction speed, in all the motor abilities tests conducted, we can say that this type of exercises can be adapted and be part of as a support of traditional therapy aiming the improvement of motor performance and overall everyday physical activity participation of this subjects. This result is consistent with a previous report by Yildirim [12], who found that young individuals with ID showed significant improvements in reaction time following a 12-week structured physical fitness training program when compared with a control group. Therefore, based on our study results we can say that following a 12 weeks motor skills training exercise intervention program with 3 training

sessions/week, can improve coordination and reaction time in 6 - 16 years old children with ASD and DS.

5. Conclusion

We have concluded that motor skill training had a positive effect on eye-hand-subject coordination and reaction time in the subjects participated in this study showing that this type of exercise, if possible, can and should be included in the overall rehabilitation therapy for this category. Also, we have concluded that the organization of training phases such as; warm up, socialization with the daily exercises before the training session, individual encouragement during training session and proper cool-down were a suitable way to improve the children's participation and overall test results. Health care providers also school teachers based on their possibilities can integrate different recommended motor skill training exercises for this particular category focusing in the improvement of their health and their cognitive abilities.

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6. Study limitations

This study has his own limitations. Subjects' number is small due to specifics of these categories. Exercise program was complex and for a short period of time. Also, another study limitation is that we conducted the exercise program the same for both DS and ASD despite the problematics and specifics of each category but as they were part of the same schools, we decided to enroll all together.

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