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Effect of Motion Imagery on Visual Motor Perception in Children with Autism Spectrum Disorder: A Randomized Control Trial

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Abstract

Background: Comprehension and visual-motor integration skills are still widely used in the psychological assessments of children. Recent evidence suggests that children with autism spectrum disorder (ASD) might have a general impairment in visual motion perception.

Objectives: This study aimed to evaluate the effects of motion imagery on visual motor perception in children with ASD.

Methods: In a before and after clinical trial study, 30 children with ASD were divided into two groups of 15 subjects, test and control. The intervention group received 3 sessions of 60 minutes per week for 15 weeks with movement visualization exercises. Before and after the intervention and after the follow-up period, visual motor perception and motor imagery questionnaires were completed and implemented. The data were analyzed using $SPSS_{22}$ software ($P \leq 0.05$). The Kolmogorov-Smirnov test was used to determine the normality of the data, and variance analysis was used to compare the averages of the two groups before and after the intervention and follow-up.

Results: The results obtained in all subscales of motor imagery with P = 0.001 indicated that there was a statistically significant difference between the two groups in the pre-test and post-test scores. Additionally, the results obtained concerning visual motor perception showed that in all the subscales with $P < 0.001$, statistically significant differences could be observed after the intervention and in the 3 months of follow-up.

Conclusions: Motion visualization is an easy and accessible method that has positive and effective effects on visual-motor perception skills. Treatment practitioners can use this method to improve ASD children.

Keywords: Motion Imagery, Visual Motor Perception, ASD, Children

1. Background

Autism spectrum disorder (ASD) is a neurodevelopmental disorder (1, 2) with a prevalence of more than 1% in the world (2) and 1 in 150 in Iran (3), which is characterized by problems, such as impaired communication and social interactions and limited and repetitive patterns of behavior (4, 5). Researchers confirm the presence of disorders in fine-gross motor skills, motor planning, and motor coordination in individuals with ASD (6-8). Abnormalities in sensory processes and perceptual-motor disorders can create the basis for many behavioral problems in this group of children, which is one of their problems (9).

It is hypothesized that the central nervous system of individuals with ASD has difficulty in effective sensory selection and correct integration of this information in motor planning and execution (10). In other words, their ability to effectively use visual information to build internal representations of themselves and their surroundings is impaired; therefore, it is likely to disrupt predictive motor control. Visual perception includes several elements whose strengths and weaknesses have been reported in individuals with ASD (11). The ability to distinguish one form from another, which occurs through visual discrimination, is one of the strengths of ASD children. They focus on the details of the overall picture (12, 13).

In a meta-analysis study, Robust showed that motor impairment is a potential main symptom of ASD, which overlaps with developmental coordination disorder and sensory problems (14, 15). Many conventional and non-conventional treatments have been proposed to treat and improve the symptoms and problems of patients with autism disorders, including diet-based treatments, supplement neurofeedback (12), and motion visualization (16). Movement imaging exercises are a type of intervention model based on the hypothesis of internal modeling and the process of predictive control of movements, which has significant effectiveness due to the biomechanical and physiological limitations, such as the actual execution of movements (10).

Research results have shown that children and adolescents with autism, despite being less accurate and slower in doing things, have the ability to use imagery like their peers with normal development (9, 11). Schweitzer et al. emphasized the effect of motor imagery on responding to stimuli (17). However, Boonen et al. emphasized that children with ASD were weaker in motor imagery than their peers (18). Considering the increasing prevalence of ASD and the concern of parents and therapists regarding stereotyped behaviors and their problems, it is more important to conduct more studies to identify and deal with the problems.

2. Objectives

The purpose of this study was to determine the effect of motion visualization on the visual-motor perception of children with ASD.

3. Methods

3.1. Study Design

Patients were enrolled in a double-blind, randomized controlled. Ethical approval was provided by the Research Ethics Committee of Tehran Islamic Azad University, Tehran, Iran (IR.IAU.SRB.REC.1401.374). The trial was registered in the Iranian Registry of Clinical Trials (IRCT20160726029086N7) before implementation. Informed consent was obtained from caregivers for each participant.

3.2. Participants

In this study, 30 children with ASD who were referred to two private and public rehabilitation centers in Tehran, Iran, were selected based on the criteria and randomly divided into two groups of 15 subjects. The inclusion criteria included the main and dominant diagnosis of ASD, grades 1 and 2, consent of children and parents to participate in therapy sessions, age range of 3 to 8 years, no previous experience of receiving movement imaging exercises, no structural or functional problems in the visual system, which was confirmed. A specialist physician arrived and entered the study. The inclusion criteria included a definitive diagnosis of ASD, at least 3 months have passed since the diagnosis of autism disorder, consent of parents and therapist to enter the mentioned study, and regular sleep. The exclusion criteria included the presence of any co-occurring disorder other than autism that could be considered the main diagnosis, the existence of physical diseases, receiving treatments effective in motion-imaging therapy in other centers, not attending more than two consecutive sessions during the mentioned treatment period, not cooperating optimally in the evaluation or intervention session and taking illegal drugs.

3.3. Intervention

Movement imaging exercises according to the standard and valid protocol used by Wilson et al. (19) were presented to the test group in 6 states for 60 minutes three times a week. For the control group, current and routine treatments and usual rehabilitation programs that include a special program of occupational therapy, speech therapy, and behavioral therapy were performed in three sessions a week. The treatment was performed in private and public clinics. The timing of the subjects' visits was set in such a way that there was no possibility of exchanging information between them (Table 1).

The implementation of cognitive interventions was measured in a dark room where the only light in the environment was the light of the monitor. Each participant was placed on a chair at a distance of 60 cm from the monitor screen. In such a way that he/she is completely leaning on the seat support and can easily see the monitor screen in front of him/her.

3.4. Data Collection

(1) Demographic questionnaire (e.g., age, gender, duration of mother's pregnancy, and type of delivery)

(2) The third version of the movement imagery questionnaire modified by Wilson et al. was used (19). This scale includes 12 items that evaluate the three components of external, internal, and kinetic imagery of each of the 4 items in the form of a seven-value spectrum from very difficult to very easy. The validity and reliability of this questionnaire in Iran have been checked and confirmed with Cronbach's alpha of 0.87 (16).

(3) Frosting's motor visual perception test includes five operational perception skills, including the ability to coordinate eye and hand, distinguish the shape from the background, understand the stability of the shape, understand the situation in space, and understand spatial relationships. In Iran, its validity and reliability have been investigated, and Cronbach's alpha was 0.78 (20) (Figure 1).

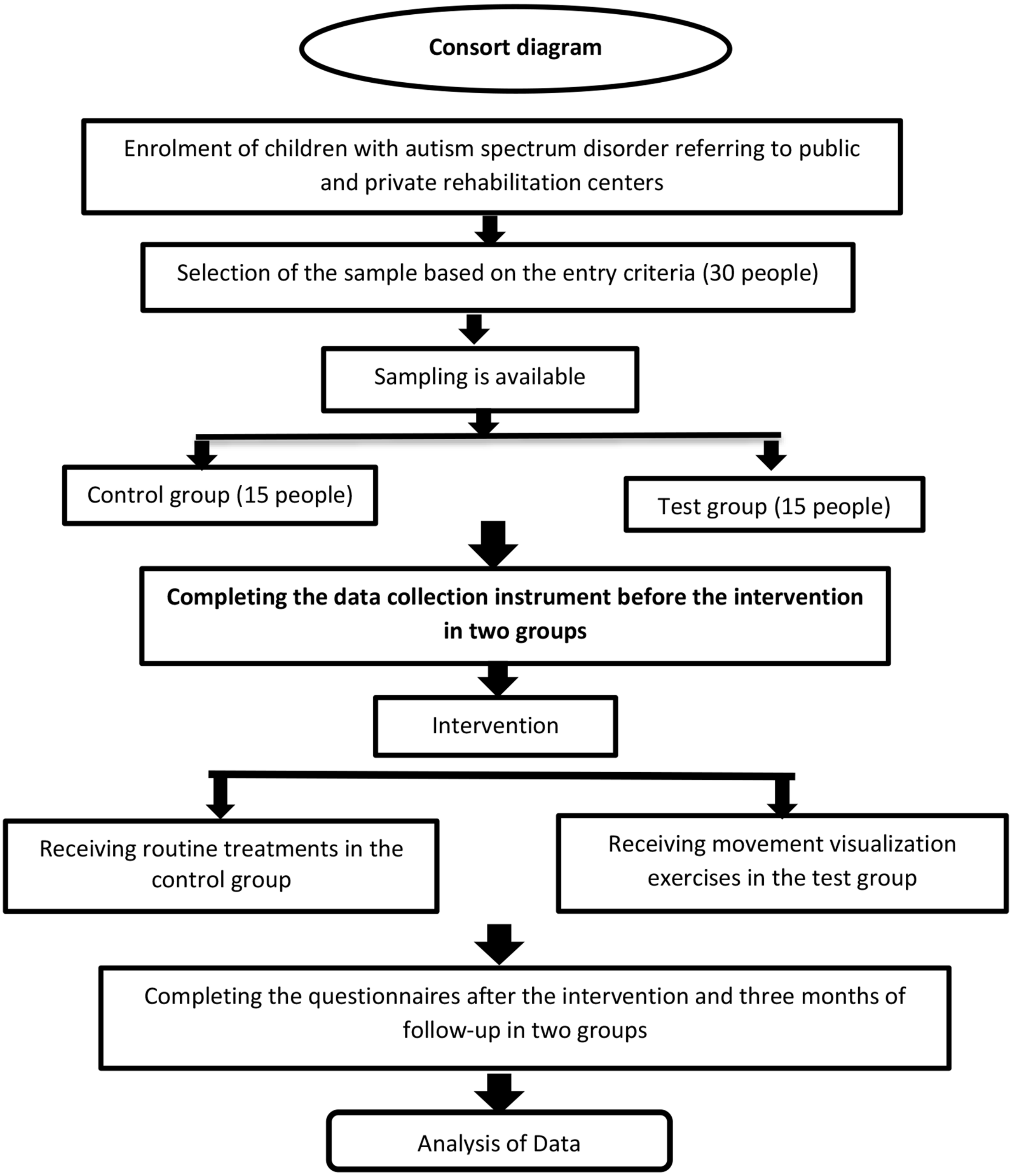

Figure 1. CONSORT diagram of study participants by randomization schedule

Table 1. Structure of the Sessions and the Summary of the Content of the Training Sessions

Levels	Exercises	How to Run
First	Imaging requires attention to timing.	In this step, the task of tracing a disk in different colors and speeds was presented. Accordingly, the child can follow the discs with his/her eyes based on the schedule. This step lasts 10 minutes.
Second	Relaxation and mental preparation	At this stage, the child is talked to, and by playing some cooperative games, he/she is mentally ready to start the main effort of mental exercises. The duration of this stage is 5 minutes.
Third	Modeling of basic movement skills	The pattern of skillful execution of the basic movement skills of walking, running, jumping, rolling, trotting, running, throwing and catching, dodging, and placing parts on the screen, which is edited in the form of three-dimensional videos, to accurately control the presentation of exercises. High-quality Polaroid glasses will be provided individually to each participant. This step took 10 minutes.
Fourth	Mental practice of the skill from an external perspective	At this stage, first, the skill of an identical child (third person) was performed. It is shown as a video, and then the subject is asked to visualize the skill and review it mentally. The duration of this stage is 10 minutes.
Fifth	Mental practice of skill from an internal perspective	At this stage, first, the skill is performed in such a way that the person is performing it. The movement (first person) was shown in the form of a video, and then he/she was asked to visualize the skill and review it mentally. This step lasts 10 minutes.
Sixth	Actual performance of the skill with mental practice between each attempt	At this stage, a real performance of each skill is presented by the child, and so on. After each performance, he/she is asked to visualize and re-perform the skill to the skill, which should be reviewed mentally and visualized accurately. Duration: This stage was 5 minutes. The total time for all steps is 60 minutes (1 hour).

3.5. Data Analysis

In this study, the analysis of a covariance test with repeated measures design was used in the three stages of pre-test, post-test, and follow-up between the two groups. All statistical tests were performed at $P < 0.05$.

4. Results

The majority of the sample in this study were male, with an average age of 5-7 years. The length of pregnancy of weeks in both groups was mostly 36 weeks, and the type of delivery was cesarean section. The average age of the parents was 37-34 years, and they had an educational level of a diploma.

To evaluate the effectiveness of the intervention, Table 2 shows the results of the independent *t*-test to compare the motor imagery subscales in the two control and experimental groups. The results showed that the pre-test scores in the subscales of visual-internal imagery, visual-external imagery, and motor imagery were 0.61, respectively. P = 0.51, P = 0.32 and in the post-test the results obtained in all subscales are P = 0.001, which indicates that there is a statistically significant difference between the two groups in the pre-test scores and It is the post-test (Table 2).

The paired *t*-test showed that the pre-test and post-test scores of the intervention group had a significant difference ($P < 0.001$) regarding the effect of motion visualization on visual motion perception. However, in the control group, this difference was not significant in any of the variables. In other words, the scores of the components of hand-eye coordination, separation of shape from background, understanding of shape stability, clarity of space situation, and understanding of spatial relationships increased, compared to the pre-test, and the improvement of these components was observed after the intervention (Table 3).

In Table 4, eye movement coordination scale scores (P = 0.03, F = 141/075), shape and context (F = 15.921, P = 0.001), shape stability (P = 0.001, F = 23.817), position in space (F = 45.534, P = 0.001), and spatial relationships (P = 0.001, F = 8.695) are significant. Therefore, it can be concluded that motion visualization improves visual-motor perception.

5. Discussion

The purpose of this study was to investigate the effect of movement imagery exercises on the visual perception of movement in children aged 5 - 12 years with autism in 2001. In this study, the test group received motion imaging exercises based on the model recommended in Wilson et al.'s (19) study. The results obtained after the test and follow-up showed a significant difference, compared to the control group (P = 0.001). One of the findings of the study was the improvement and coordination of hand movements and visual power of the research samples. The results of Carson et al.'s study showed that the use of the Beery-Buktenica developmental test can help control and coordinate hand movements and visual power. Despite the difference between the intervention in the present study and the aforementioned study, it can be concluded that the use of methods that help increase visual perception can help coordinate hand movement (21). Contrary to the aforementioned studies, Faber et al. (22) showed that motor skill is not related to visual perception and vision-motor integration.

Table 2. Comparison of Pre-test and Post-test Motor Imagery Scores in the Test and Control Groups

Subscales and Status	Group	Mean ± SD	P-Value [a]
Internal visual imagery			
Pre-test	Control	15.34 ± 4.09	0.61
Post-test	Test	22.62 ± 5.2	0.001
External visual imagery			
Pre-test	Control	14.25 ± 7.3	0.51
Post-test	Test	21.12 ± 3.08	0.001
Motion visual imagery			
Pre-test	Control	15.25 ± 6.3	0.32
Post-test	Test	20.14 ± 3.06	0.001

[a] $P < 0.05$ was considered statistically significant.

Table 3. Comparison of Pre- and Post-test Mean of Sub-tests and Overall Score of Visual Motor Perception in Two Test and Control Groups

Assessed Skill and Group	Difference of Means	*t* Statistic	Degrees of Freedom	P-Value
Hand-eye coordination			12	
Test	-3.66	-8.482		0.004
Control	0.267	0.654		0.32
Clean shape from the background			12	
Test	-2.067	-6834		0.001
Control	0.134	3.78		0.26
Understanding stability			12	
Test	-3.66	-3.66		0.001
Control	-3.583	-3.583		0.731
Change of situation in space			12	
Test	-6.75	-6075		0.001
Control	3.044	3.044		0.521
Understanding spatial relationships			12	
Test	-7047	-7.047		0.02
Control	2.054	2.054		0.32
Overall score			12	
Test	-9.621	-9.621		0.001
Control	-0.342	-0.342		0.29

Table 4. Results of Covariance Analysis of the Effect of Motion Visualization on Visual-Motor Perception in Children with Autism Spectrum Disorder

Effect of Group on the Post-test and Source of Changes	Sum of Squares	Degrees of Freedom	Mean Square	F	P-Value	Eta Squared
Hand-eye coordination	1865.183	1.26	1865.183	141.075	0.001	0.848
Clean shape from the background	682.932	1.26	682.932	15.921	0.001	0.365
Understanding stability	598.320	1.26	598.320	23.817	0.001	0365
Change of situation in space	377.450	1.26	377.450	45.534	0.001	0449
Understanding spatial relationships	231.089	1.26	231.089	8.695	0.001	0223

Movement visualization exercises in the intervention group have improved the post-test in different visual-motor perception subtests. In other words, the scores of hand-eye coordination components, separation of shape from the background, understanding of shape stability, clarity of the situation in space, and understanding of spatial relationships increased, compared to the pre-test, and the improvement of these components after the intervention was significantly different ($P < 0.001$). However, in the control group, this difference was not significant in any of the variables. Sakihara et al. demonstrated that changes in motor skills have a positive effect on social skills and motor understanding. In the present study, the motor-visual understanding of the studied children improved after the study (10). In both studies, the intervention has improved the motor understanding of autistic children.

Additionally, the results of the studies by Wilson et al. (19) and Ahar and Ghadiri (23) showed that the effects of motion imagery on improving the motor skills of children with autism spectrum showed a significant superiority over the experimental group in the three subtests of manual dexterity, reception, and balance, and the overall motor proficiency score. Chi and Lin emphasized that positive correlations were observed between self-care performance and visual perception ability in young children with ASD (24). It should be acknowledged that in terms of the physiology of the auditory and motor cortex, both are involved in the simulation of rhythmic movements; therefore, the coordination of body movements with a rhythm can produce motor responses by influencing the nervous system and the secretion of neurotransmitters. Stimulating and inhibiting meters are adjusted depending on the type of rhythm and finally lead to functional adaptation in body movements (16, 22).

5.1. Research Limitations

The current study also has limitations. Among other things, due to the limitation in the selection of subjects in terms of the criteria for entering the research, it was not possible to include more children in the research. Additionally, part of the resulting data was based on parents' reports. Therefore, it is suggested that the results of children's performance be evaluated by other methods, such as imaging.

5.2. Study Highlights

This current study bridged the gap in knowledge, providing valuable information for healthcare providers, educators, and families.

The effectiveness of motion imagery in visual-motor perception is considered an important feature of visual perception.

The findings of this study show that children with autism who have visual motor deficits can benefit from rehabilitation services.

Further research is needed to better understand the choice for and effect of alternative treatments for autism, and mainstream care should be improved.

5.3. Conclusions

The effectiveness of motion imagery in visual-motor perception, including perceptual abilities, such as perception of movement, shape, context, depth, and integration of visual motion, is considered an important feature of visual perception and affects motor performance and visual-spatial functions. Therefore, it is suggested that future research investigates the effectiveness of different psychological and movement interventions in the ability of movement imagery in children with this disorder. In addition, coaches, teachers, and therapists in this field can solve most of the problems of individuals with ASD by developing developmentally appropriate protocols with an emphasis on improving motor skills and significantly helping with the well-being and self-help of these children.

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Footnotes

Authors' Contribution: The first author contributed and corresponded at all stages of this project. The second author collaborated in ideation, reviewing studies, and writing the article.

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Data Availability: The authors cannot report the obtained data.

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