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Investigation the Effectiveness of Vision Behavior Therapy, motor training and visual training on Social Interaction of Children with Autism Spectrum Disorder

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Abstract

Background: Social communication deficits is often considered as one of the main characteristic of autism spectrum disorder (ASD). An alternative explanation about social interactions deficits is visual stream deficits in people with developmental disorder such as ASD. Hypothesis of difficulties in performance of visual stream in relation with social interactions provides an action-perception mechanism in which individual should recognize social stimuli, process it and finally provide a suitable response which creates a chain of reception-perception-response to social stimuli. So, the main goal of current study is to investigate the effect of 30 sessions of vision behavior therapy on social performance of children with ASD.

Methods: A double-blind following the randomized and controlled trial was conducted over 2017-2018. 46 children with ASD (33 males and 15 females, aged between 6 and 12 years) were divided randomly into visual-motor (n=16), motor (n=11), computer-based visual training (n=10), and control (n=9) groups. Positive and negative social behaviors were evaluated in the baseline, after treatment, and two months follow up which an objective observation method was used. All The intervention groups trained their intervention for 30 sessions while the control group at the same time received usual care.

Results: Motor group showed significant improvement in positive and negative social interaction ($p<.001$) while the other groups had no significant difference.

Conclusion: Social performance is a process that requires the experience of cooperation and participation in social environments. Our study adds to the emerging body of evidence indicating that motor training for children with ASD almost is an effective approach for social communication of ASD, but maintenance strategies need to be developed.

Trial registration IRN, #IR.UM.REC.1397.014. Registered 16 January 2019, http://ethics.research.ac.ir/PortalProposalListEn.php?code=IR.UM.REC.1397.014

Key words: Autism, Visual Deficit, Vision Behavior Therapy, Motor Intervention.

1. Introduction

Social communication deficits is often considered as one of the main characteristic difficulties of autism spectrum disorder (ASD) (1); that there are several explanations on this issue. One of the most explanations in this regard is the Theory of Mind (ToM). According to this theory, ASD individuals are not able to understand source of others' attention; they cannot move their eyes in coordination with goals of others, so they cannot understand others' intentions (2). However, change in view does not necessarily mean the proper performance of the ToM. For instance, following the view of others has been observed in marmoset but animals are probably not able to understand others' intentions and read humans mind (3). In regards of social communication, ToM is a cognitive theory which states that people with autism are not able to properly respond to social stimuli. Many interventions have been conducted for developing social communication in ASD children according to ToM and direct teaching of social communication which have been reported positive results. As an example, Walton (2012) used family-based intervention method to teach social communication skills to ASD children. This study revealed that children with autism can imitate social interactions from their family, particularly their siblings and show improvement in social interactions (4). In another study, Frea et al. (2001) used Picture exchanging system to improve communication skills in ASD children. Results of this study showed that aggressive behaviors in social communications of ASD children are declines after this intervention (5). Even though this positive task results of ToM training cannot be generalization to untrained or general social interaction in natural setting (2). It is shown that ToM training teach ASD the task rather than the ability of social interaction. On the other hand, it seems that it can be learned through natural play of children. the cooperative nature of play and game with peers is a natural environment which children can learn how to interact to the others. In this study according ToM we conduct a group-based training exercise to determine the effect of it on social communication of children with ASD. Recently, it has been proposed that it can be explained with another hypothesis which proposed that social communication deficit is far from the simply misunderstand of intentions of the other people. All of interventions which are affected by ToM have only focused on direct teaching of social

skills, while there are many studies implying on the role of visual stream processes in social interactions and provided other explanation for social interactions deficits of ASD individuals .

An alternative explanation about social interactions deficits of ASD individuals is visual stream deficits in people with developmental disorder such as ASD. It is mentioned that ASD individuals are very weak in the processing of depth perception, biological motion, perception of the face and looking at eyes, all of which are functions of the dorsal visual stream processing (6). Perception of the face and looking at eyes, as a function of dorsal visual processing, is considered as a one of the main aspects of social communication and understanding others' intention and coordinating actions with others (7). Also, part of eyes and faces process feedbacks are sent to social networks in the brain which are essential for development of social interactions (8). When ASD individuals cannot process certain stimuli, he/she has to suppress it and avoid its process, so ASD individuals refuse eye contacts. Hypothesis of difficulties in performance of dorsal visual stream in relation with social interactions provides an action-perception mechanism in which individual should recognize social stimuli, process it and finally provide a suitable response which creates a chain of reception-perception-response to social stimuli. Thus, deficit in any processes of reception, perception and response to social stimuli can result in poor social interactions in these people. Based on the hypothesis of disorder in dorsal visual stream possessing, it seems that ASD individuals have problem in the first part of the chain i.e. receiving social stimuli and as a result, in perception and response to them. However there is no intervention discussing the role of visual behavior intervention related to dorsal visual stream functions on social performance of ASD individuals. Visual behavior training is one of the effective approach used to remediate processing of visual system in children with developmental coordination disorder (9), dyspraxia (10), as well as Autism (11, 12). Visual therapy is an individualized intervention for the improvement of binocular system, ocular motor control, visual processing, visual motor skills, and/or perceptual–cognitive deficiencies (13-15). The aim of vision therapy, according to Guffreda, and Schoenberg (2010), is to improve visual deficiencies, which then further conduct coordination of eyes with head, neck, as well as the rest of the body (body awareness, spatial orientation, and muscle tone)(13, 10, 16). The case study of Golden and Silverton (2010) on a ten- year – old boy with developmental delay indicate that 20 sessions vision therapy improves visual efficiency skills, while another case study on an eight year – old child with motor planning problems (dyspraxia) showed positive effects on ocular motor control, gross motor skills, and academic skill of child (10). Despite the positive outcomes of vision behavior therapy on body awareness and visual system processing, research continues to be limited in that the visual behavior training tend to affect social performance of ASD children.

Therefore, the main goal of current study is to investigate the effect of vision behavior therapy on positive and negative social performance of children age 6-12 years old with ASD. On the other hand, in this study in addition to vision behavior therapy, two groups of

motor exercise and computer-based visual exercise were also existed to compare the effect of different methods of training on the social interactions of children with autism. The main question of current study is that can vision behavior therapy improve the social performance of ASD children?

2. Method

1-2- Trial design

We applied a double-blind following the randomized and controlled trial over 2017-2018 in six Autism institutes in Iran. The study protocol was approved by the Ethics committee at the University of Iran (#IR.UM.REC.1397.014) and registered in Iran National Committee for Ethics in Biomedical Research. All participant evaluates at base-line, post-test, as well as two months later in follow up.

2-2- Participants

The participants were acquired between July to August 2017. The moral standards for each child participating the test were having child assent, parental consent, and permission for preparing videotape of assessment sessions. The baseline assessments were performed by a psychologist, an Optometrists, and a specialist to confirm the participants qualify for the study. The inclusion criteria for selecting the samples were having the age from 6 to 12 years old at the time of enrollment, suffering from autism spectrum disorder, which was confirmed by a neurologist and psychologist. The confirmation was achieved according to the result of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) and Autism Diagnosis Interview-Revised (ADI-R). The other criterion was a non-verbal cognitive at the level of >70 (children's cooperative ability determines this IQ cut score). Following the inclusion criteria, the integration of visual information and demonstrated difficulty processing is the fourth one, which were measured through vision section of sensory profile. The difficulty is validated in three or more visual subscale. The fifth criterion is that the acuity of all participants was normal (20/20) from the viewing distance of 114 cm and from 20 ft. The visual acuity was measured in terms of monocular and binocular using a Snellen chart at 20 ft and 114 cm. Regarding the point of choosing the sample of study, using PASS software and 85% power of the test with one sample T-test, 12 participants in each group were determined, but due to the possibility of falling in different stages of the research, more participants were added to each group.

3-2- Intervention

Vision behavior therapy employed in one of the experimental group based on dorsal visual stream deficit theory. Several references were used to provide this visual intervention program [1-4] consisting of 30 sessions and each session was conducted for one hour and three days a week by experienced trainers and familiar with autism. In

Appendix 1, the general aims of vision behavior therapy during the intervention has been described. An example of exercises is presented in Appendix 2.

The motor intervention program conducted in another of our experimental group was based on Sports, play, and Active Recreation for Kids Active Recreation (SPARK AR) curriculum [5]. The physical activity may develop motor abilities, health attitude, positive social skills (e.g., sharing equipment, cooperative). The motor activities were sequenced from simple to complex. We used four physical education teachers who familiar with autism disorder. This intervention, also consist 30 sessions which lasted for one hour and consist of the warm up, motor exercise which aimed gross motor skills (e.g., throwing, catching, kicking) and cool down. This training conduct in a group based training (2-3 individuals in each group).

Visual group also performed different visual exercises through game software appropriate for children which were approved by psychology experts during the same period which their aim were mostly eye tracking movements, eye and hand coordination and cognitive exercises. We used three psychologist teachers to monitored and guided children to perform exercises, based on their skill levels.

At the same time, control group was receiving the usual care in their institution. Usual care received during study period was similar between the groups. Usual care include non-study related services such as speech and language services, behavioral interventions, educational program and other therapies.

4-2- Measures

In order to determine the impact of conducted interventions on ASD children, social interaction was measured by direct observation of children in school hours. In this study, social interaction according to Ballard (1981) who define interaction ‘as a two-way interaction between the two individuals involved in the game in a way that one creates a stimuli and the other’s response is considered in which way, positive or negative [6]

Social Response is called to any kind of social interaction done and continued by the playmate. Responses are divided into two groups of positive and negative. Positive responses include: Showing positive emotions such as smile or eye contact with the other child –positive touch when their playmate accept the touch, following them and cuddling-imitation, when imitates his playmates’ speech or actions. Negative responses contained refusal and being dissociable i.e. when the child refuses to look at his playmate, doesn't follow the game, goes away from his playmate or push him, close his eye and refuse to look at his playmate, don’t response when called him- aggressiveness means when the child pushes or pulls his playmate, screams and utters impolite sentences. This test was conducted in a school room from 9 to 10 a.m. which provide an environment that children can play and interact safely.

Required equipment and items used during measurements were a large container of water, sponge, spoon and plastic animals which were considered for playing with water. In addition, each child's favorite toy was available in the room to provide a situation of expressing their feelings. There were also two pairs of percussion instruments, blanket for playing hide and seek, tools for game of kitchen and doll for symbolic games that facilitated linguistic and non-linguistic communication. In general, attempts have been made to use devices that stimulate children's senses and to be suitable for them and they also enjoy playing with them and increase the chance of social interaction. It was pointed out to the playmate selected for ASD child that the mere aim of the game is enjoying, even though; he is not willing to play. During the game, ASD children's behaviors were recorded by a camera and also observed by the examiner. The playing time was considered 10 to 15 minute. During this time, the number of social interactions was recorded and monitored.

In order to evaluate positive and negative social interaction, the method of continuous registration was used and each child was observed individually. Also, in order to increase the accuracy of observation, behaviors were defined explicitly, in addition to live observation, video observation was used to reduce the chance of missing the desired behaviors, and also evaluators were trained by a child psychologist who had the history of working with ASD children. Since each of the above factors, or a combination of them, can affect evaluations, reliability method was used for observers to show the reliability between live and video observation results. In order to determine reliability of frequency measurement of social interaction, the following formula was used.

Reliability ratio= the smallest recorded frequency/ the largest recorded frequency × 100

Reliability ratio between these two methods of social interaction evaluation was 0.92.

5-2- Statistical Methods

For the purpose of this investigation we used an ANCOVA for repeated measures according to within and between designs to answer this question of whether there is a change over time and between groups in positive and negative social behaviors, and additional post hoc Bonferroni test were calculated to find the difference between three investigation groups in posttest and follow up. Typical assumption of MANOVA such as normality and homogeneity of variance was checked, by Boxplot and Q-Q plot (residuals versus fitted values). In order to evaluate their clinical significance, findings were also interpreted in term of effect size which were calculated as $\frac{\sqrt{F}}{\sqrt{F}+\sum_{i=1}^{k} ni-k}$ where K is the number of groups and n is the number of sample. The significance level for all tests was considered to be $p < .05$.

3. Results

3-1- Demographic Characteristics

About 96 families with ASD child who interested to participate in the study, 64 met the inclusion criteria and enrolled in the study. According to further examination six of them exclude because of did not match all the inclusion criteria and four of them refused to participate. Of the 56 participants which remained, randomly divided to four groups, vision behavior therapy (n = 17), motor group (n = 15), computer-based vision training group (n = 12), and control group (n= 10). In post-test two of participants from motor group were excluded because they have seizure. At the follow up stage, five of the participants withdrawn because of deny to participate (n = 1 in vision behavior therapy group, three in motor training group, and n = 1 in computer based vision training group), also one participate from control group had seizure so was exclude from the study.

Baseline data reported in Table 1 lists information on the participants' characteristics. There was no significant difference between the two groups in age F (3.44) = .03, P= .99, NIQ F (3, 44) = 1.21, P =.31, as measured by Cattle Intelligence Scale for Children, Body Mass Index F (3, 44) =.45, P =.71, and Childhood Autism Rating Scale F (3, 44) = 1.21, P =.31. According to ASD prevalence estimates by gender, the majority of participants in both groups were male (33 males and 15 females).

Table 1. characteristics of participants by group in experimental groups and control group

	Groups [a]						
	Control (n = 16)	Vision behavior (n = 10)	Motor exercise (n = 11)	Computer vision (n = 9)	F	df	P.value*
Variables							
CA	8.44 (1.94); 6-11	8.59 (2.12); 6-12	8.40 (2.01); 6-12	8.63 (2.33); 7-12	0.031	3, 44	0.99
N IQ	71.22 (8.20); 61 - 82	72.37 (8.20); 60 - 85	78.20 (8.44); 60 - 85	72.54 (11.75); 60 - 96	1.216	3, 44	0.316
CARS	95.78 (19.76); 70 – 120	91.25 (22.65); 64 - 125	95.50 (20.10); 73 - 124	94.55 (27.20); 70 - 140	0.112	3, 44	0.953
BMI	39.66 (2.44); 35 - 43	38.43 (5.42); 26 - 47	36.70 (5.90); 30 - 47	37.72 (7.56); 29 - 52	0.458	3, 44	0.713
Sex	F=4, M= 8	F=5, M=7	F=3, M=9	F=3, M= 9			

Note. CA: chronological age; N IQ: nonverbal intelligence quotient; CARS: childhood autism rating scale; BMI: body mass index.

[a] mean (standard deviation); range.

* p > .05

2-3- Effect of intervention on Positive and negative Social interaction

The results of MANOVA for positive and negative social interaction in ASD children in vision behavior training, motor exercise, computer-based visual training and control groups with control of variables such as age, gender, intelligence, severity of autism, presented in table 2, reveal significant main effect of group and time, and a significant interaction between group and time ($p < .001$). Thus, there was a significant differences between groups, between pre-test and subsequent testing, and in the interaction between groups and testing times.

Table 2 .Repeted Measure Analysis of Variance for social behaviors

	effect	Freedom degree	Sum sq.	Mean sq.	F. value	P. value	Effect size
Positive social behavior	Time	2	18.36	9.181	11.712	< 0.001*	.49
	Group	3	112.78	37.592	47.954	0.002*	.96
	Time * group	6	130.72	21.787	27.793	< 0.001*	.75
Negative social behavior	Time	2	78.78	39.391	25.910	0.003*	.56
	Group	3	355.03	118.344	77.844	< 0.001*	.84
	Time * group	6	319.48	53.246	35.024	< 0.001*	.67

*Note. *p < .05*

Due to the significance of the effect of time and group, the Bonferroni multiple comparison test was performed to determine the difference between the groups at different times. In relation to positive social interaction, Figure 1 shows that the groups did not differ significantly in the pre-test. In the post-test only in the motor group, there was a significant difference in the frequency of positive social interaction so that the number of positive social interactions increased in this group ($p < .05$). However, in the follow-up, the frequency of positive social interaction in the motor group did not have a significant difference with the control group but there was a significant increase in positive social interactions comparing with the pre-test. Other study groups did not show any significant difference with control group at any time of measurement ($p > .05$).

Concerning the frequency of negative social interaction, the results showed that the groups did not differ significantly in the pre-test. In the post-test and follow-up, only in the motor group, there was a significant difference in the frequency of negative social interaction, so that the number of negative social interaction decreased in this group ($p < .05$). Other study groups did not show any significant difference with control group at any time of measurement ($p > .05$). (Figure 2).

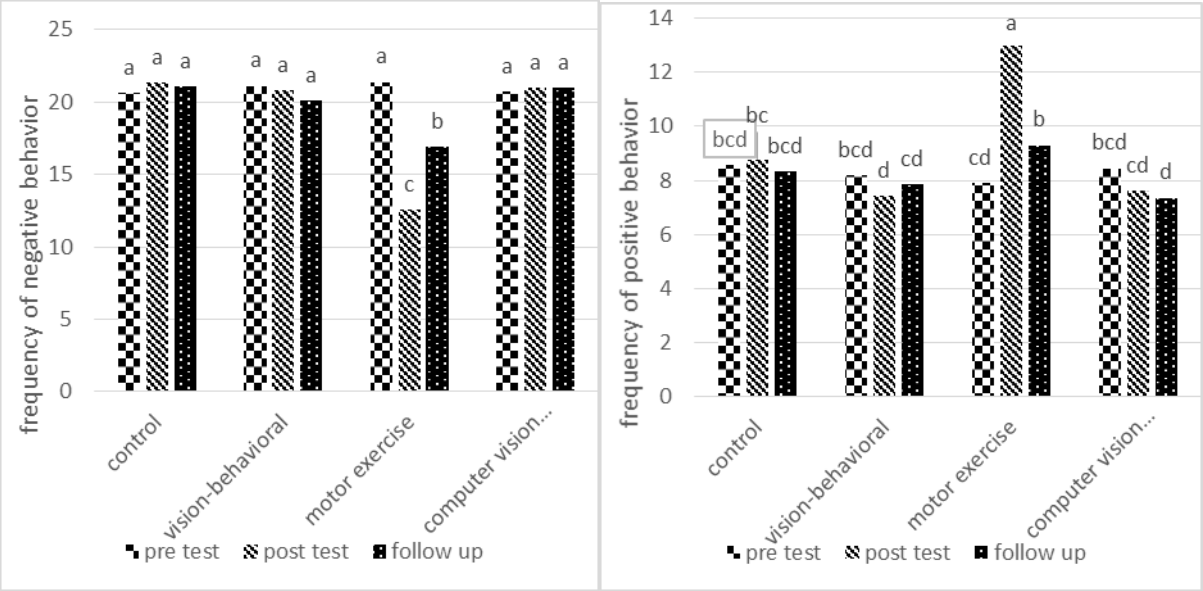

Figure 2. Negative and positive social interaction in experimental groups regarding to the time of experiment. Same letter in each column means that there are not significantly different.

4. Discussion

The purpose of this study was to investigate the effect of vision behavior therapy on the frequency of positive and negative social interactions in children with ASD. In relation to the frequency of positive and negative social interactions, the results showed that there was no significant change in the vision behavior therapy group after the intervention and in the follow-up test for the frequency of positive and negative social interactions. While the motor group showed a significant improvement in the frequency of positive and negative social interactions in the post-test and follow-up.

Social interaction is a complicated process that many factors are involved in its creation. Ludlow and et al. (2012) showed that the disorder of visual perception may interfere with the processing of social information and information contained in facial components in individuals with autism (23). Thus, in order to establish social communication, individual should be able to process information in a gestalt way and avoid local processing of information which is the significant feature of autism disorder (24). Gestalt process of information is one of the functions of dorsal visual stream (7). ASD individuals, while processing visual information of the environment, focus on them, therefore they drop behind of further process of social information available in the environment and miss them (25). The disorder in processing of dorsal visual stream and, consequently, the disorder in social communication (26); is consistent with the theory of embodied cognition in the understanding of social communication. Based on this theory, social understanding is a perception-action mechanism in which individual should be able to choose and process related social stimuli available in the environment (27). When ASD

person refuse to identify and process the related social stimuli due to dysfunction of visual processes; consequently social performance disorder occurs. In this study, the goal of vision behavior therapy is improvement in dorsal visual processing, which consequently affect social interaction. The results showed that there were no significant difference in social interaction in vision behavior therapy group compare with visual and control groups, although improvement in visual stream performances were showed in post-test and follow-up in this group. This result is not consistent with embodied cognition theory and shows that improvement in visual process is not solely effective on social performance of ASD children. It seems that improvement in visual processing did not have a significant effect on the social performance of these children.

Although, it is hypothesized that the disruption in social performance is beyond the disturbance of sensory information processing. Result of the current study revealed that social performance in motor group improved comparing with other groups. This result provides further evidence showing social communication performance requires direct experience of social interaction, cooperation and sharing of the tools with the peers in social environments and also understanding others feelings (28). In the present study, motor exercise group trained in groups of two to three individuals and children played together and share the toys. Probably, this kind of intervention has a significant positive effect on social performance of these children and this result is in line with ToM. Our result is consistent with Duronjić (2010) study which showed 60 minute exercise for twice a week improves social performance of ASD children. Children essentially learn social skills first in the family by interacting with family members and when they grow up; they learn social skills from other sources like their friends and peers (29). Also our results is consist with Walton (2012) and Frea et al (2001) who used ToM theory in social communication of children with ASD. Playing with peers starts from two to three years old and playing for children is like talking for adults. As adults interact with each other with words, children engage in social interaction with their games and toys. Playing with peers causes that the children to be gained compatibility with peers, their rights and the rights of others, and thus prepared for entry into the real world and social life. The social skills that must be learned include co-operation, sense of responsibility, self-control and self-defense (30), which several factors such as family, social environment, peer relationships, school, communication facilities, and even games and sports can affect development of these skills (31). Playing is also the best time to identify children's social interactions and can be the best environment for intervention in the development of children's social skills (32); therefore designing an environment in which the child can work freely and interact with their peers can enhance the social skills of children and reduce their behavioral problems. Playing with peers provides a kind of social experience for children and helps them to know themselves, defend themselves, accept others, and respect their rights. Thus parents, teachers and therapists who work with ASD children are suggested to provide environments in which ASD children can cooperate with their peers in order to enhance their social communications, and if this cooperation to be

conducted by an adult, it also causes that these children to gain social experiences and show improvement in social interactions.

5-1- Conclusion

In general, the results of this study revealed that social performance is a complicated process in which factors more that sensory processes like visual sense are involved. Social performance is a process that requires the experience of cooperation and participation in social environments which is in line with ToM. Despite the positive results shown in this study, this study also has some limitations. In this study, ASD children with mild to moderate intensity were selected for participation in the study. Future researchers are recommended to examine children with severe autism through this intervention so that the results can be generalized to the entire range of autism. It is also recommended that, in addition to observing social performance, other methods, such as social performance measurement questionnaires, to be also used in order to assess the difference in social performance measurement by two methods of evaluation

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Appendix 1. Goals of vision behavior therapy sessions

Sessions	Goals
Session 1-9	Body awareness
Sessions 9-16	Spatial awareness
Sessions 16-23	Peripheral vision
Sessions 23-30	Pursuits and saccades

Appendix 2. Two examples of vision behavior therapy

Sessions 1-9	**Sessions 23-30**
Angles in Snow	Marble in pan
Pointer dog	Marsden ball
Swimming in place	Marble roll
Walking rail	Rotating pegboard
Hopscotch	Penlights saccades
Chalkboard circles	Sticker saccades
Windshield wipers	Groffman tracking
Balloon, ball or ring toss	Hart chart
Jumping jacks	Pegboard
Soldier crawl	Tracking worksheets

Note. Adapted from Coetzee, D., & Pienaar, A. E. (2017); And Hurst, C. M., Van de Weyer, S., Smith, C., & Adler, P. M. (2006).