Original Article

Effectiveness of Audiovisual Stimulation on Executive function in Children with High-functioning Autism

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Objectives: Autism is one subsets of pervasive developmental disorders that are characterized by abnormal behaviors and verbal communication. In recent years, the reason for this communication disorder has been developed for determining executive function. The current study investigated the feasibility of audiovisual stimulation intervention focused on enhancing executive function in children with high-functioning autism.

Method: 41 children diagnosed with high functioning autism randomly selected and assigned in to experimental (20) and control (21) group. Initially both of groups were administered by the "Behavior Rating Inventory of Executive Functioning Test".then intervention group received 18 sessions of audiovisual stimulation across 6weeks and two groups were administered by test again.

Results: Multivariate analysis was used to compare significant advances in variables progress. Considering significance level, outcome indicates that audio visual stimulation used in the present study increased executive function (inhibition, shifting and planning ability) based on Behavior Rating Inventory of Executive Functioning measures (F= 5/55, P<0/05, F= 24/587, P< 0/05, F= 15/28, p<0/05).

Discussion: These findings suggest that the audiovisual stimulation platform is a promising tool for improving executive function subsets. Similarly, the use of such technology that is user friendly appears to prevent onset of early behavioral problems and executive dysfunction in children with autism.

Key words: Audiovisual stimulation, High-function autism, Executive function, inhibition, shifting.

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Introduction

Autism is one subsets of pervasive developmental disorders that are characterized by abnormal behaviors and verbal communication (1). High-functioning autism is a group of children with autism that have sustained impairment in nonverbal behaviors, using repetitive patterns in favorite things and interpersonal relationship dysfunction (2). Statistics obtained from research centers in US implies an increase of 10% to 17% annual risk of this disorder (3).

However the core impairment in autism is communication disorder. In recent years, the reason for this communication disorder has been developed for determining executive function in autism (4, 5). Executive functions is an umbrella term for cognitive processes that regulate, control, and manage other cognitive processes such as planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, task switching, initiation and monitoring of actions (6-8). Executive dysfunction not only causes difficulty in communication skills to children with autism but can also destroy activities of daily living in this group of children (9). In 2009, results of study conducted by Kenworthy on children with high-functioning autism indicated a significant relationship between executive dysfunction and symptoms of autism (impaired communication skills, social skills and repetitive behaviors). In this study, planning, shifting and inhibition abilities were more emphases (10). Therefore, in this study, these three variables have been studied. Despite this, few research have been conducted in the field of executive dysfunction in children with autism spectrum disorder preschoolers and its interventions (11). During a recent investigation, it has been demonstrated that effective behavioral interventions for children with high-

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functioning autism such as Applied Behavior Analysis and developmental interventions such as sensory integration therapy have positive effects on children's cognitive skills, such as working memory, planning and decision-making (12). Alternatively, a new form of treatment for children with high-functioning autism is neurofeedback that aims to influence or change irregular activities of brain waves. Neurofeedback is designed to train individuals to enhance poorly regulated brainwave patterns by using sophisticated computer technology (13). The beneficial effects of neurofeedback on shifting, working memory, attention control and reduction of negative behaviors in children with high-functioning autism have been reported (14). While interventions based on education through rehabilitation approaches can be effective in improving impaired executive functioning in autistic children, Pharmacotherapy and psychosocial interventions such as family therapy and behavior therapy for improving social deficits and reduce impulsive behavior would be useful in this group of children (14, 15). But audiovisual stimulation has been selected as intervention in this study, using entrainment would Try to change the brain's response to external changes and would do this by changing the link between different areas of the cortex (16). AVE consists of constant, repetitive stimuli of the proper frequency and sufficient strength to "excite" the thalamus and neocortex. These stimuli do not transfer energy directly into the cortex. The direct transmission of energy from AVE only goes so far as to excite retinal cells in the eyes and pressure sensitive cilia within the cochlea in the ears. The nerve pathways from the eyes and ears carry the elicited electrical potentials into the thalamus. From there, the entrained electrical activity within the thalamus is "amplified" and distributed throughout other limbic areas and the cerebral cortexes via the cortical thalamic loop. AVS involves the continuous electrical response of the brain in relation to the stimulus frequency plus the mathematical representation (harmonics) of the stimulus wave shape (17). AVS is believed to achieve its effects through several mechanisms simultaneously. These include: altered EEG activity, dissociation / hypnotic induction, limbic stabilization, improved neurotransmitter production and altered cerebral blood flow (17).

Previous studies with Audiovisual stimulation, has been conducted mostly in children with ADHD (18). The results in these researches indicated a significant improvement in the children's working memory, sustain attention and planning (16). In another study of audiovisual stimulation effects on school-age children with autism, the results cleared significant increase in attention, shifting and decrease repetitive movements (16). The present study investigated the effects of audiovisual stimulation on executive functioning in high function autistic children. It appears that due to the growing and unpredictability prevalence of autistic disorder, damaging effects on quality of life (especially the activities of daily living), the lack of a specific treatment plan and executive difficulties of previous methods, Using a low-cost approach, specific, measurable, and fewer complications such as audiovisual stimulation, could affect the areas of executive function in autistic disorder improving underlying impairments in social skills, communication skills and reducing repetitive behaviors in these children (16, 18).

Methods

This study is a clinical trial. The participants in this study consist of 41 high-functioning autism spectrum disorders in children 5 to 8 years old who were referred to Tehran's Autism Charity. After selection of the patients referred to Tehran's Autism Charity, the participants were randomly assigned to specific category. The independent variable in this study was audiovisual stimulation; on the other hand, the dependent variables were increasing three main subgroups of executive function (inhibition, shifting and planning). All children who participated in the study needed to 5 to 8 years old diagnosed as high-functioning autism by a verified child psychiatrist. On the other hand, after clear description of the research objectives, parents were asked to complete a consent survey form to have their children participate in the research.

It is worth noting that the authorization of this study was under supervision and verification of University of Social Welfare and Rehabilitation Sciences. Autism Charity Foundation announced readiness to cooperate with the researcher for this study. There is no limit to the use of the drug and the researcher was committed if manifest of beneficial effects of audiovisual stimulation were observed in the experimental group, this intervention will be performed free of charge for control group as well. However, children who had participated in similar studies, a history of seizures, neurological disorders, IQs lower 70 and lack of cooperation during the assessment and treatment, were excluded from the study. Data were collected using' Behavioral Ratings of executive function (parent form) ". The evaluation was conducted in two stages, prior to and after the intervention. The Behavior Rating Inventory of

Executive Function (BRIEF) developed by Gerard Gioia, Ph.D., Peter Isquith, Ph.D., Steven Guy, Ph.D., and Lauren Kenworthy, Ph.D., is an assessment of executive function behaviors at home and at school for children and adolescents aging 5 to 18. The 86-item questionnaire has separate forms for parents and teachers, and typically takes 10–15 minutes to administer and 15–20 minutes to score. The BRIEF is useful for evaluating children with a variety of disorders and disabilities. Specifically, it is often used for assessing executive functioning in children with developmental and/or acquired neurological conditions including: learning disabilities, Tourette syndrome, traumatic brain injury, pervasive developmental disorders, high functioning autism, low birth weight . The BRIEF is most often used to assess Attention Deficit/Hyperactivity Disorder (19). Each form of the BRIEF parent- and teacher- rating form contains 86 items in eight non-overlapping clinical scales and two validity scales. These are theoretically and statistically derived scales form two indexes: a) Behavioral Regulation (Inhibit, Shifting and Emotional Control), and b) Meta cognition (Initiate, Working memory Plan/organize, Organization of materials, Monitor).

Experimental instrument in this study was David Pal's unit that is manufactured by Mind Alive Inc. This device consists of a main controller, a headset, a forward glasses a wire and power supply interface. There are buttons on the unit to adjust the power button, select button (to select the type of incentive program), light intensity and volume buttons, as well as a part input adapter to connect with. It has 18 default programs of audiovisual stimulation that have been used in children with ADHD or LD. The audiovisual stimulation plan in this study was A 5 program with volume 2 and light intensity 3. It includes 35 minutes of decreasing Stimulation 19 to 10 Hz frequencies which have been extremely effective in increasing ability to control attention and planning in children with attention deficit disorder, according to recent research (17). Following that, the children are referred to the Autism Charity Foundation in which they would be prepared with a soft toy phone and glasses during two sessions to be conducted for constant 35 minutes use of audiovisual unit in each session. The intervention procedure consisted of 18 sessions of 35-minute long over 6 weeks by 3 sessions per week. Both intervention and control groups continued their usual rehabilitation programs such as occupational therapy, speech therapy, education and play therapy during conduction of audiovisual stimulation sessions. Data were analyzed using the SPSS.20 software. After testing Kolmograph-Smirnov and ensure normal distribution of the data, parametric tests were used. Descriptive statistics (mean and SD) in each group were reported. In the following section, multivariate analysis was used to compare significant advances in executive function progress.

Results

In this research, for the quantitative data collected and testing the hypothesis, descriptive and inferential statistical methods were used. To demonstrate variable frequency table were also used showing the frequency, mean, standard deviation and descriptive diagrams. The mean and standard deviation of the test subjects in both groups, before and after the intervention are shown in Table (1).

Table 1. Parameters of the study variables in experimental and control groups before and after intervention

Variable	Group	Pre-Test			Post-Test		
		Frequency	Mean	Standard Deviation	Frequency	Mean	Standard Deviation
Inhibition	Experiment	20	23/25	4/216	20	18/60	4/453
	Control	21	21/95	3/576	21	22/25	6/703
Shifting	Experiment	20	14/55	3/576	20	12/50	2/417
	Control	21	16	2/513	21	17	3/026
Planning	Experiment	20	26/80	4/408	20	22/90	4/191
	Control	21	28/55	4/310	21	28/25	4/229

As it can be seen from the mean of each variable, inhibition, shifting and planning, have been significantly reduced in the experimental group. Table (2) presents the results of covariance analysis in order to prove the research hypothesis. The followings are the results of covariance analysis to test each of the research hypotheses:

1. Audiovisual stimulation used in this study, increase inhibition ability in high-functioning autism children based on Behavior Rating Inventory of Executive Functioning measures.

2. Audiovisual stimulation used in this study, increase shifting ability in high-functioning autism children based on Behavior Rating Inventory of Executive Functioning measures.

3. Audiovisual stimulation used in this study, increase planning ability in high-functioning autism children based on Behavior Rating Inventory of Executive Functioning measures.

Table 2. MANCOVA results for the comparison between control and experimental groups

		Square	df	Mean square	F	Sig.
Inhibition	Pre-Test	97/749	1	97/749	3/193	0/082
	Group	170/056	1	170/056	5/554	0/024
	Error	1132/801	37	30/616		
	Total	18051/000	40			
Shifting	Pre-Test	75/446	1	75/446	13/326	0/001
	Group	139/296	1	139/296	24/587	0/000
	Error	209/534	37	5/663		
	Total	9190/000	40			
Planning	Pre-Test	232/607	1	232/607	19/518	0/000
	Group	182/095	1	182/095	15/280	0/000
	Error	440/943	37	11/917		
	Total	27123/000	40			

Based on the results shown in Table (2), the F between group variable for inhibition, shifting and planning are respectively 5/55 ،24/587, 15/28. Considering significance level, outcome indicates that audio visual stimulation used in the present study increased inhibition, shifting and planning ability based on Behavior Rating Inventory of Executive Functioning measures (F= 5/55, P<0/05, F= 24/587, P< 0/05, F= 15/28, p<0/05).

As can be seen in Figure (1) inhibition, shifting and planning ability scores in the experimental group had declined and this means that audiovisual stimulation used in this study, increase inhibition, shifting and planning ability in high-functioning autism children based on Behavior Rating Inventory of Executive Functioning measures while the control group had not.

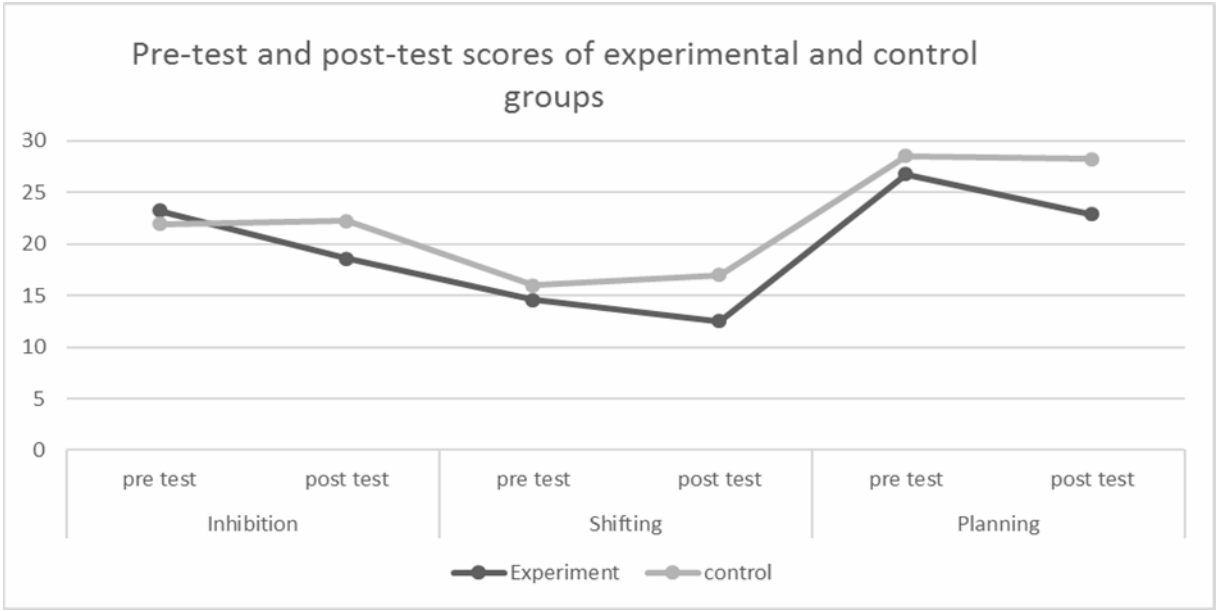

Figure 1. Pre-test and post-test scores of experimental and control groups

Discussion

This study is among the first studies in the field of audiovisual stimulation to enhance the capabilities of executive function in children with high-functioning autism. Audiovisual stimulation is fully configurable by therapists that use repeated, instant

and safe stimulation for effectiveness in inhibition, shifting and planning abilities. After 18 sessions of intervention by the audiovisual stimulation, according to the significant differences in pre-test and post-test scores of the variables, considerable progress on all three variables (the ability to inhibit the ability to shift and ability to plan) has been made. These findings indicate the potential utility of this stimulus to test the possibility of using other subsets of executive function such as working memory, organization of material, and emotional control in children with high functioning autism.

Similar to previous research, the results of this study suggest audiovisual stimulation is effective in enhancing inhibition ability in children with high-functioning autism. As Woodbury in 1996 stated this stimulation increases ability to inhibit and control impulsivity in children with high functioning autism, the findings of this study also showed the same results (16). Similarly, Damasio in his studies cited that one of the reasons for, impaired inhibition ability in autism disorder would be poor performance of prefrontal region of the brain that audiovisual stimulation also impacts on this area (20).

In addition, the findings in this study show the ability of shifting in children participating in the study increased as a result of audiovisual stimulation and this is consistent with results in Olmstead study 2005, in children with attention deficit hyperactivity disorder and learning disability (16). Of course Interventions including 12 sessions, two times a week, were conducted by Olmstead in comparison with intervention in this study was longer and expensive to the researcher. On the other hand, it was found reducing the length of time in intervention sessions would not be barrier for effectiveness of audiovisual stimulation.

Another important subset of executive function was examined in the present study, planning ability; there was a significant improvement in results. Carter and Russell In 1994, a study was done on children with learning disorders, have also achieved such results (21). In addition to the results in the shifting ability in children with attention deficit hyperactivity disorder and learning disorder had taken by Olmstead, in 2005, satisfying results on planning ability also reported in her study (16).

Conclusion

Overall, the interventions were used in this study as a method of rehabilitation programs and software to improve executive function of autistic children. Limitations of the study included differences in symptoms, age and cultural conditions of each of the participants that complicated generalizability of results to other autistic children. Because children with autism have sensory problems, wearing sunglasses and head phones in a certain period of time in initial sessions seemed to be difficult. Moreover, the original study with more control is needed to validate the findings. In future research, it is better to use the larger sample sizes for the intervention of the new methods that can be varied according to patient age and diagnosis.

Also, conducting a follow-up study on the effects of such interventions could help to register sustainability of results. However, regarding the mechanism of audiovisual stimulation conducting this research in other disorders such as cerebral palsy, neurological, brain damage and mental retardation considered to be useful. Furthermore, the use of more precise assessment measures such as QEEG during audiovisual stimulation intervention can prove essential in providing additional useful information on the mechanism of action of these stimuli to the researcher. Overall the current investigation provides preliminary evidence for the feasibility and use of audiovisual stimulation intervention in children with high functioning autism. Similarly, the use of such technology that is user friendly appears to prevent onset of early behavioral problems, cognitive and executive dysfunction in children with autism.

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