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The effect of cognitive rehabilitation therapy (CRT) on the executive functions of children with autism spectrum disorder (ASD)

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Original Article

Abstract

BACKGROUND: Executive functions (EF) impairments are considered as central deficits in autism spectrum disorder (ASD). The purpose of this study was to determine the effectiveness of cognitive rehabilitation therapy (CRT) on EFs of children with high-functioning ASD (HFA).

METHODS: This was a quasi-experimental study with a pretest-posttest design and control group. The study population included all children with HFA referred to the comprehensive Arman Shayan Rehabilitation Center in Tehran, Iran. Using the high-functioning Autism Spectrum Screening Questionnaire (ASSQ) and clinical diagnostic interviews by two clinical psychologists, 24 children with HFA were selected purposefully and were randomly assigned to experimental or control groups. Subjects in both groups completed the Behavior Rating Inventory of Executive Function (BRIEF) in pretest and posttest. The experimental group received 1-2 sessions (1 hour) per week of CRT for 6 months. Data analysis was performed using analysis of covariance (ANCOVA) in SPSS.

RESULTS: Data analysis showed that the use of CRT resulted in a significant difference between groups in terms of the total EFs score, which was 88.5%, as well as the components of inhibition (57%), orientation (46%), emotional control (42%), initiate (43%), working memory (55%), planning (56%), organizing (36%),and monitoring (36%).

CONCLUSION: CRT, as an evidence-based intervention, seems to be effective in improving neuropsychological functions in children with HFA.

KEYWORDS: Cognitive Rehabilitation Therapy, Executive Function, High-Functioning Autism Spectrum Disorder

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Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by cognitive and neurobiological deficits based on social and non-social information processing defects,[1] and is associated with stereotypical and repetitive behaviors as well as significant conformational constraints[1] and low quality of life (QOL).[2] There are three major disadvantages associated with ASD, including socialization disorder, deficit in verbal and nonverbal communication, and restricted and repetitive patterns of behavior.[3] In recent years, prevalence estimates of ASD have increased for unknown reasons.[4] Estimates of the ASD prevalence varied from 1.2500 in the 1970s to 1.150 in 2000.[5]

However, the most recent reports of the US Centers for Disease Control and Prevention (CDC) published in 2014 reported a prevalence of 1 in 110 children in 2011, and 1 in 68 children in 2014;[5] findings in different countries are not in agreement,[6] and in a study conducted by Samadi and McConkey in 2015

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in Iran, the prevalence of autism in 2014 was 2.95 per 10,000 children.[7] According to previous research, children with autism have a lower level of motor skills development, motor coordination, balance, executive functions (EFs), social skills, and attention.[8]

There is evidence to suggest that children with high-functioning autism (HFA) exhibit better social and behavioral outcomes compared to other children with autism.[9] Individuals with HFA or level 1 autism are considered to be cognitively higher functioning (IQ ≥ 70) compared to people with ASD.[10] individuals with HFA may exhibit deficiencies in the fields of communication, recognition and excitement expression, and social interactions.[11] Despite their moderate or high IQ, children with HFA often present a significant dissonance between cognitive abilities that significantly affects their QOL.[12] In recent years, cognitive theories regarding the relationship between brain and behavior in children with autism have been the subject of scholarly studies. One of these well-known theories is the theory of EFs.[13]

The term executive functions refers to mental control processes related to cognitive and emotional self-control needed to maintain targeted behaviors. EFs include processes such as response inhibition, working memory, cognitive flexibility, planning, fluency, and attention control.[14] The theory of executive dysfunction in autism emphasizes an explicit link between frontal lobe failure and executive dysfunction, which suggests that impairment in basic EFs has many social and non-social characteristics of autism.[15]

There is growing evidence that children and adolescents with ASD present impairments in the EF items, such as cognitive flexibility, working memory, inhibition, and planning.[16] EF impairments are considered as central deficits in ASD. Studies have found that children with ASD have problems with tasks requiring working memory, inhibition, and flexibility.[17] Several studies have shown that children with autism have several EF impairments in characteristics such as inhibition and control,[18] cognitive flexibility,[19] and working memory.[20]

Today, a variety of therapies can be used in children with autism. One of the most novel therapy methods is cognitive rehabilitation therapy (CRT). CRT has recently gained increasing attention as an effective intervention for the improvement of fundamentally cognitive deficits in psychiatric conditions, including schizophrenia, attention-deficit/hyperactivity disorder (ADHD), brain damage, and ASDs.[21] CRT was developed as a special form of intervention in psychiatric populations with Wagner's research on attention and practice of abstraction in people with schizophrenia in the late 60's.

Since then, CRT has been adapted to various clinical populations, covering many cognitive domains and the different areas of EFs.[22] Cognitive rehabilitation is an intervention based on behavioral education that leads to the development of cognitive processes (such as attention, working memory, EFs, social recognition, and metacognition) with the aim of generalization and sustainability.[23] Cognitive rehabilitation is a potentially effective approach toward the remediation of information processing deficits in people with ASD without intellectual disability.[24]

The goal of CRT is to improve cognitive flexibility, central coherence, and general information processing, reduce perfectionism, and improve response to inappropriate thinking styles.[25] Studies on the effect of CRT have been increasing since 1990, and meta-analysis studies have shown that CRT in patients with schizophrenia can lead to improved cognitive functions, and subsequently, improved psychosocial functioning.[26] In the same vein, Miyajima et al. investigated the effect of CRT on cognitive processes in children with ASD, and found that the use of CRT significantly improved the scores of numerical sequences, verbal fluency, and the Tower of London (ToL) task in children with ASD.[23] Eack et al. also found that cognitive rehabilitation can significantly improve cognitive deficits and EFs in people with ASD.[24] Moreover, Katsumi et al. argued that the cognitive rehabilitation program had a significant impact on improving cognitive processes, including working memory, verbal memory, attention, and other EFs.[27]

Despite evidence of EF impairments in people with autism, few studies have investigated the effect of CRT on the EFs of these children.[28] EFs are cognitive abilities, sensory growth is considered as the basis for cognitive development in different studies, and EFs and sensory processing play an important role in everyday life, social functioning, and adaptive behaviors of children with autism. Therefore, the development of interventions that affect the cognitive processes of children with ASD in order to improve their EFs is crucial and research on the effectiveness of CRT can be of great importance. Therefore, the present study aimed to determine the effectiveness of CRT on EFs of children with HFA.

Materials and Methods

This was a quasi-experimental study with a pretest-posttest design and control group. The study population included all children with level 1 ASD referred to the comprehensive Arman Shayan Rehabilitation Center in Tehran, Iran, for specialized services during November-March, 2012. From among patients referred to Arman Shayan Rehabilitation Center, using the Autism Spectrum Screening Questionnaire (ASSQ) and clinical diagnostic interviews by two clinical psychologists, 24 children with HFA who were eligible to enter the study were selected purposefully and randomly assigned to experimental or control groups.

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM5) was used for the diagnosis of ASD. The study inclusion criteria were the necessary diagnostic criteria based on the ASSQ, children of 8-12 years of age with normal IQ (using the Wechsler Intelligence test), normal speech level (as evaluated by a speech therapist), and written parental consent to participate in the study.

The study exclusion criteria consisted of receiving psychological and therapeutic treatments over the last month, children with intellectual or physical disabilities, psychotic symptoms in a child, and history of neurologic diseases such as epilepsy.

To perform this research, first, the purpose of the research was explained to the parents, then, informed parental consent for the child's participation in the evaluations was obtained. The parents were assured that all the contents presented in the training sessions and the results of the questionnaires would be kept strictly confidential and would be analyzed as a group without mentioning the name of the participants. Furthermore, individuals who demonstrated interest in and willingness to participate in the study were entered into the study. The evaluations and interviews were straightforward with no harm to the person, and the participants did not incur any costs. The participants could leave the assessment and interviewing sessions at any time.

Clinical Diagnostic Interview Based on the DSM-5: The diagnostic interview conducted by a clinical psychologist with the parents of children who have been referred for the evaluation of possible autism spectrum disorders to the Arman Shayan Rehabilitation Center, which lasted about 1 hour. This included biographical information, history and examination of current and past diagnostic symptoms. The initial report of the diagnostic interview included how the child developed and how he/she behaved at school, the medical history (including details on the consumed medications, sleep, exercise, and diet), and the family's status (including parental occupation, number of siblings, and exploring psychiatric symptoms in the whole family). In this research, subjects who received high scores in the ASSQ underwent a clinical diagnostic interview. This interview was conducted to evaluate and diagnose HFA. Subjects who met the DSM-5 criteria for ASD were considered as the final study sample. To measure the validity and reliability of the clinical interviews, the agreement coefficient between interviewers (who were two clinical psychologists) was calculated (agreement coefficient = 0.78).

The high-functioning Autism Spectrum Screening Questionnaire: The high-functioning ASSQ consists of 27 questions completed by the child's parents or teachers. Each question has 3 response choices of "yes", "to some extent", and "no", which, respectively, indicate the scores 2, 1, and 0 in that question. If the parents complete the form, an overall score of 19 or higher indicates high-functioning ASD, and if the teacher completes it, a score of 22 or higher represents high-functioning ASD.[29]

The validity and reliability of this instrument was determined by Kasechi et al.[29] He stated that the Persian version of the high-functioning ASSQ had a satisfactory formal validity and credibility. The retest reliability coefficient of the high-functioning ASSQ was estimated in the parents group (r = 0.467) and in the teachers group (r = 0.614), which indicated the reliability and validity of the instrument in autistic individuals. The Cronbach's alpha coefficient obtained for the parents and teachers of the healthy children and children with ASD showed that the high-functioning ASSQ items were suitable for the screening of children with high-functioning ASD.[29]

The Behavior Rating Inventory of Executive Function: The Behavior Rating Inventory of Executive Function (BRIEF) was developed by Joya, Iscott, and Converti in 2000[30] to assess various aspects of the functions of the anterior part of the brain. The BRIEF is an assessment tool for both parents and teachers to measure EF behaviors at home and at school. The questionnaire is designed for ages 5-18 years and has two parent/teacher report forms, both of which have 86 questions that are scored on a 3-point scale [never (1), sometimes (2), and most often (3)]. BRIEF contains 8 EF components, including inhibition (15 questions), shifting attention or orientation (12 questions), emotional control (9 questions), initiate (7 questions), working memory (11 questions), planning (14 questions), organization (7 questions), and monitoring (11 questions). The overall score of the questionnaire is the sum of the score of these components, and higher scores represent greater EF deficit. The retest reliability coefficient of the questionnaire was 0.81 for the parents' report form and 0.86 for the teacher's report form. This questionnaire has three versions for different ages. In this study, a child and teenage version for ages 5-18 years (parent report form) was used.[31] In the study by Maleki and Alizadeh Zarei, the reliability and validity of the questionnaire were reported. [30] The test-retest reliability of the subscales of inhibition, orientation, emotional control, initiate, working memory, planning, organization, and monitoring was 0.90, 0.81, 0.91, 0.80, 0.71, 0.81, 0.799, and 0.78, respectively, and the overall score of EFs was 0.89. BRIEF had good content validity because all the questions were selected from interviews with parents regarding EFs.[31] In this study, the parental report form was used to measure inhibition and emotional regulation of children.

Cognitive Rehabilitation Therapy: Forehead lobe Exercise Program (FEP) is one of the interventions of the CRT the effects of which on cognitive and social functions are examined here. The FEP includes the 3 scales of cognitive flexibility, working memory, and planning, which are designed to gradually increase in complexity during the sessions. Each scale consists of a set of tasks that include eye movements and processes, information organization, fine movements, etc. The therapist encourages problem-solving strategies and provides instructions for using an effective strategy. For this purpose, the FEP system encourages the subject to perform the tasks as accurately as possible. The FEP consists of 44 sessions, each involving paper and pen tasks, house building with blocks, and fine movements.[23]

The study participants were 24 children with HFA, who were divided into two equally sized groups of 12 after the evaluations. Before the onset of CRT, in the pretest phase, all subjects in the experimental and control groups completed the BRIEF under the same conditions (the same time and place). Experimental group subjects received 1-2 sessions (1 hour) per week of advanced FEP for 6 months and subjects in the control group received 1-2 sessions (1 hour) per week of other routine therapies, such as occupational therapy or psychotherapy, without FEP for 6 months. After completing the sessions, all subjects in the experimental and control group completed the BRIEF as a post-test under the same conditions. Finally, data analysis was performed using analysis of covariance (ANCOVA) in SPSS software (version 21, IBM Corporation, Armonk, NY, USA).

Results

The mean age of the participants in the experimental and control group was 9.55 ± 1.485 years and 9.83 ± 1.258±1.58 years, respectively; 62.5% of the subjects were 8-10 years old, and 37.5% were 11-12 years of age. Regarding their school level, 54.1% of the participants were in the third and fourth grades and 45.9% in the fifth and sixth grades. The subjects in the two groups were compared in terms of age (P = 0.8930, t-136/0) and school level (P = 0.486, X2 = 443.2), and the homogeneity of the groups was confirmed.

Table 1 shows the mean and standard deviation of the total score of EFs and their components. As can be seen in table 1, the mean total scores of EFs and their components (such as inhibition, orientation, emotional control, initiate, working memory, planning, organization, and monitoring) were higher in the experimental group than that in the controls in the posttest.

Table 1. Descriptive indexes of executive functions and their components in experimental and control groups

The dependent variable	Group	Pretest	Posttest
		Mean ± SD	Mean ± SD
Inhibition	Experimental	26.50 ± 4.73	23.00 ± 4.306
	Control	25.75 ± 3.54	25.08 ± 3.260
Orientation	Experimental	23.08 ± 2.31	20.58 ± 1.920
	Control	22.67 ± 3.05	22.17 ± 2.580
Emotional control	Experimental	17.50 ± 2.43	15.33 ± 1.770
	Control	18.00 ± 2.25	17.42 ± 2.150
Initiate	Experimental	16.00 ± 1.53	13.67 ± 1.430
	Control	16.25 ± 0.87	15.17 ± 1.115
Working memory	Experimental	22.17 ± 2.08	19.25 ± 1.810
	Control	21.75 ± 1.96	21.33 ± 1.820
Planning	Experimental	28.00 ± 1.90	25.50 ± 2.060
	Control	28.75 ± 2.41	28.17 ± 2.120
Organizing	Experimental	15.58 ± 1.31	13.25 ± 1.760
	Control	15.42 ± 1.37	14.50 ± 1.440
Monitoring	Experimental	21.33 ± 1.77	19.00 ± 2.210
	Control	20.83 ± 1.85	19.92 ± 1.730
Executive functions	Experimental	170.16 ± 7.80	149.58 ± 7.270
	Control	169.41 ± 6.25	163.75 ± 6.390

SD: Standard deviation

Table 2. The results of homogeneity of variances and variance-covariance matrices for executive functions and their components*

The dependent variable	Levene's test F	P
Inhibition	1.006	0.3270
Orientation	0.100	0.7540
Emotional control	2.543	0.1250
Initialization	0.028	0.8680
Working memory	0.555	0.6460
Planning	3.158	0.0890
Organizing	2.758	0.1110
Monitoring	0.958	0.3380
Executive functions	1.572	0.2230

* Box's M test: F = 1.820; P = 0.524

Moreover, the results of the statistical distribution of the above variables showed that all variables were distributed in the range ± 1 and the default was the normal distribution of data for the use of parametric tests.

Before applying the parametric test of multivariate analysis of covariance (MANCOVA) for EFs and their components, the homogeneity of variance assumption was examined using Levene's test and the results indicated that this default was set for the total score of the EFs and their components (Table 2). Subsequently, to test the homogeneity of variance-covariance matrices, Box's M test was used. The results of this test were not calculated due to the high multicollinearity in the dependent variables (the total score of the EFs and their components) and the non-observance of this default. Therefore, considering the absence of this assumption for MANCOVA and the existence of multicollinearity risk in dependent variables, one-variable ANCOVA was used to examine the difference between the total score of EFs in the two groups and MACOVA was applied to examine the difference between executive function components. In addition, the assumption of homogeneity of the regression line slope and the existence of a linear relationship between the covariate variable and the dependent variable were studied the results of which showed the establishment of these two defaults for the total score of EFs (Table 3).

The results presented in table 3 show that considering pretest scores as auxiliary variables, the use of CRT resulted in a significant difference between the groups in the total score of EFs ($F = 161.526$, $\eta 2 = 0.885$), which was 88.5%. This showed that part of the individual differences in EFs was due to differences in group membership (impact of the intervention). Therefore, the implementation of CRT led to a decrease in the mean total executive function scores of the experimental group participants (Table 1) compared to the control group. Therefore, it can be argued that CRT was effective on the EFs of children with HFA.

Table 3. Results of analysis of covariance of intergroup effects for executive functions in experimental and control groups

Variable	Source of changes	Sum of squares	Average squares	F	P	ETA square	Statistical power
Executive functions	Pretest group	2.961	2.961	0.352	0.5590	0.017	0.087
	Pretest	862.123	862.123	105.848	0.0001	0.834	1.000
	Group	1315.621	1315.621	161.526	0.0001	0.885	1.000
	Error	171.044	8.145				

Table 4. The results of multivariate analysis of covariance for the two groups in the executive functions components

Title of exam	Value	F	P	ETA coefficient	Test power
Wilks' lambda	0.968	26.306	0.0001	0.968	1
Piley effect	0.032	26.306	0.0001	0.968	1
Hotelling's effect	30.064	26.306	0.0001	0.968	1
Biggest root	30.064	36.306	0.0001	0.968	1

In order to use MANCOVA for executive function components, the homogeneity of variance-covariance homogeneity assumptions was examined using Box's M test; the results presented in table 2 indicated that the test was insignificant for the executive function components (F = 1.028, P = 0.4250). Therefore, considering the existence of this assumption, MANCOVA and the lack of multicollinearity risk in the dependent variables were used to analyze the differences between the executive function components in the two groups. Furthermore, the hypothesis of homogeneity of the regression line slope and the existence of a linear relationship between the covariate variable and the dependent variable were investigated, which resulted in the establishment of these two defaults for the EFs components (Table 4).

After controlling the effect of pretest, the significance level of Wilks' lambda showed that there was a significant difference between the two groups in at least one of the components of EFs, indicating that 97% of the observed difference in the mean of the executive function components was related to the effect of CRT. The statistical power of 1 also indicates the adequacy of sample size and acceptable statistical accuracy for this conclusion (Table 5).

Table 5. Results of analysis of covariance of inter-group effects of the components of executive functions

Variable	Source of changes	Sum of squares	Average squares	F	P	ETA coefficient	Test power
Inhibition	Pretest group	0.518	0.518	0.299	0.6040	0.0470	0.075
	Pretest	210.741	210.741	115.620	0.0001	0.8920	1.000
	Group	34.311	34.311	18.824	0.0010	0.5730	0.981
	Error	25.518	1.823				
Orientation	Pretest group	0.018	0.018	0.041	0.8470	0.0070	0.053
	Pretest	25.415	25.415	26.134	0.0001	0.6510	0.997
	Group	11.631	11.631	11.960	0.0040	0.4610	0.895
	Error	13.615	0.972				
Emotional control	Pretest group	0.001	0.001	0.001	0.9820	0.0001	0.050
	Pretest	60.742	60.742	44.916	0.0001	0.7620	1.000
	Group	13.837	13.837	10.232	0.0060	0.4220	0.845
	Error	18.933	1.352				
Initiate	Pretest group	0.834	0.834	0.871	0.3870	0.1270	0.124
	Pretest	14.625	14.625	18.228	0.0010	0.5660	18.228
	Group	8.604	8.604	10.724	0.0060	0.4340	0.861
	Error	11.233	0.802				
Working memory	Pretest group	0.732	0.732	0.476	0.5160	0.0740	0.476
	Pretest	22.794	22.794	12.602	0.0030	0.4740	12.602
	Group	31.455	31.455	17.391	0.0010	0.5540	0.972
	Error	25.322	1.809				
Planning	Pretest group	1.054	1.054	0.650	0.4510	0.0980	0.105
	Pretest	42.111	42.111	32.931	0.0001	0.7020	1.000
	Group	22.590	22.590	17.660	0.0010	0.5580	0.974
	Error	17.902	1.279				
Organizing	Pretest group	2.316	2.316	1.413	0.2790	0.1910	0.172
	Pretest	21.228	21.228	15.048	0.0020	0.5180	0.950
	Group	11.170	11.170	7.910	0.0140	0.3610	0.744
	Error	19.749	1.411				
Supervision	Pretest group	2.706	2.706	1.613	0.2510	0.2120	0.189
	Pretest	44.064	44.064	39.389	0.0001	0.7380	1.000
	Group	8.804	8.804	7.869	0.0140	0.3600	0.742
	Error	15.662	1.119				

The results presented in table 5 show that, considering the pretest scores as the auxiliary variables, the use of CRT led to a significant difference between the groups in the components of inhibition (F = 18.82, η2 = 0.57), orientation (F = 11.96, η2= 0.46), emotional control (F = 10.23, η2= 0.42), initiate (F = 10.72, η2 = 0.43), working memory (F = 17.39, η2 = 0.55), planning (F = 17.66, η2 = 0.56), organizing (F = 7.91, η2 = 0.36), and monitoring (F = 7.87, η2 = 0.36). The effect level of the components of inhibition, orientation, emotional control, initiate, working memory, planning, organizing, and supervision was, respectively, 57%, 46%, 42%, 43%, 55%, 56%, 36%, and 36%. This showed that part of the individual differences in the components of EFs was due to the difference in group membership (the impact of the intervention). Therefore, the implementation of CRT resulted in a decrease in the mean scores of the experimental group participants (according to table 1) in the components of inhibition, orientation, emotional control, initiate, working memory, planning, organizing, and supervision compared to the control group. Therefore, it can be argued that CRT is effective on the EFs of children with HFA.

Discussion

The aim of this study was to determine the effectiveness of CRT on EFs of children with HFA. The results of the present study showed that CRT significantly reduced the total score of EFs and their components, including inhibition, orientation, emotional control, initiate, working memory, planning, organizing, and supervision, in children with HFA. In other words, CRT was effective on EFs of children with HFA. This finding is consistent with the findings of Miyajima et al.,[23] Eack et al.,[24] Eack et al.[32] Marceau et al.,[33] Katsumi et al.,[27] and Wykes et al.[34] CRT, as an evidence-based intervention, can be effective in improving the psychological neuropsychiatric processes and the daily functioning of children with autism. In this regard, Glenthoj et al., in a study reviewing researches on the effectiveness of CRT, provided strong evidence of the effect of CRT on improving cognitive processes such as working memory.[35] Marceau et al. reported that CRT has a significant effect on EFs and leads to improvements in functions such as inhibition, control, and flexibility.[33] A meta-analysis study and a clinical trial have shown that CRT can significantly improve cognitive and psychological functions.[34,36] The content of CRT includes repetitive exercises, strategies for modifying cognitive deficits and how to extend the tasks of exercises to daily tasks, and learning. One of the goals of CRT is to improve patients' social compatibility and to improve certain cognitive dimensions. CRT can simultaneously reduce cognitive deficits and behavioral symptoms of patients.[37] Studies conducted on the effect of CRT on EFs have suggested that the use of CRT may have altered the brain function of patients in the prefrontal cortex and improved brain structures such as increasing the amount of gray matter in the brain in disorders such as schizophrenia, stroke, and brain damage.[38] Similarly, recent research on anorexia nervosa has also reported changes in the activity of the prefrontal cortex during the program's homeopathic program.[39] It has also been pointed out that cognitive activation techniques used in CRT are likely to lead to psychological adaptation of the brain through tissue enlargement as a result of neuroplasticity (the ability of the brain to reset itself by creating new neural connections throughout life that leads to more efficient neurophysiological processing). Neuroplasticity allows brain neural cells to adapt to damage and disease in response to new situations or changes in the environment.[40] Furthermore, Penades et al. reported a significant improvement in brain function of patients after applying CRT, which may be due to an increase in the transmission of information between the pelvic regions between the prefrontal cortex regions through the pink body.[41] These techniques increasingly relate to computer assignments that are used for common exercises to enhance learning through CRT.[41] The exercises used in most programs include graded changes based on the difficulty level resulting in a program that adapts to the dynamic performance of a person over time.[42] Penades et al. showed that changes in EFs were accompanied by significant changes in personal autonomy and overall performance after receiving CRT.[41] Despite the empirical evidence that CRT has an impact on the EFs of children with autism, further research is needed to understand the underlying mechanisms for the effectiveness of CRT in EFs of children with autism disorders.[43]

Conclusion

One of the most important limitations of this study was the use of paper-and-pencil scale administration for measuring the performance of children. It is suggested that in future research, a computer psychological nerve be used to measure cognitive and rehabilitate performance based on the brain function of the subject. The lack of a follow-up phase was another limitation to the study. Therefore, the use of follow-up research projects in future studies can be effective in obtaining reliable results on the therapeutic effects of this approach. Although the results of this study have great implications for the treatment of cognitive and rehabilitate performance in children with HFA, further research is needed to generalize the results of this study.

Conflict of Interests

Authors have no conflict of interests.

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References

1. Pugliese CE, Anthony L, Strang JF, Dudley K, Wallace GL, Kenworthy L. Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: Role of executive function. J Autism Dev Disord 2015; 45(6): 1579-87.
2. de Vries M, Geurts H. Influence of autism traits and executive functioning on quality of life in children with an autism spectrum disorder. J Autism Dev Disord 2015; 45(9): 2734-43.
3. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5®). Washington, DC: American Psychiatric Pub; 2013.
4. Elsabbagh M, Divan G, Koh YJ, Kim YS, Kauchali S, Marcin C, et al. Global prevalence of autism and other pervasive developmental disorders. Autism Res 2012; 5(3): 160-79.
5. Carpenter LA, Boan AD, Wahlquist AE, Cohen A, Charles J, Jenner W, et al. Screening and direct assessment methodology to determine the prevalence of autism spectrum disorders. Ann Epidemiol 2016; 26(6): 395-400.
6. Jalil Abkenar SS, Razavi F, Ashori M. analytical investigation of autism spectrum disorders in diagnostic and statistical manual of mental disorders. Journal of Exceptional Education 2016; 16(141): 69-59. [In Persian].
7. Samadi SA, McConkey R. Screening for autism in Iranian preschoolers: Contrasting M-CHAT and a scale developed in Iran. J Autism Dev Disord 2015; 45(9): 2908-16.
8. Moradi H, Sohrabi M, Taheri H, Khodashenas E, Movahedi A. The effects of different combinations of perceptual-motor exercises, music, and vitamin D supplementation on the nerve growth factor in children with high-functioning autism. Complement Ther Clin Pract 2018; 31: 139-45.
9. Dijkhuis RR, Ziermans TB, Van Rijn S, Staal WG, Swaab H. Self-regulation and quality of life in high-functioning young adults with autism. Autism 2017; 21(7): 896-906.

10. Carpenter LA, Soorya L, Halpern D. Asperger's syndrome and high-functioning autism. Pediatr Ann 2009; 38(1): 30-5.
11. Sanders JL. Qualitative or quantitative differences between Asperger's disorder and autism? Historical considerations. J Autism Dev Disord 2009; 39(11): 1560-7.
12. Shipman DL, Sheldrick RC, Perrin EC. Quality of life in adolescents with autism spectrum disorders: Reliability and validity of self-reports. J Dev Behav Pediatr 2011; 32(2): 85-9.
13. Parvizi F, Lajevardi L, Alizadeh ZM, Ashaieri H. Comparing set-shifting in high functioning children with autism and normal ones (6 to 12 years). J Mod Rehabil 2012; 5(4): 15-20. [In Persian].
14. Rabinovici GD, Stephens ML, Possin KL. Executive dysfunction. Continuum (Minneap Minn) 2015; 21(3 Behavioral Neurology and Neuropsychiatry): 646-59.
15. Nejati V, Izadi-Najafabadi S. Comparison of executive functions in high-function autistic children and their typical matched peers. J Res Rehabil Sci 2012; 8(1): 28-39. [In Persian].
16. Kouklari EC, Tsermentseli S, Auyeung B. Executive function predicts theory of mind but not social verbal communication in school-aged children with autism spectrum disorder. Res Dev Disabil 2018; 76: 12-24.
17. Adams NC, Jarrold C. Inhibition in autism: Children with autism have difficulty inhibiting irrelevant distractors but not prepotent responses. J Autism Dev Disord 2012; 42(6): 1052-63.
18. Geurts HM, van den Bergh SF, Ruzzano L. Prepotent response inhibition and interference control in autism spectrum disorders: Two meta-analyses. Autism Res 2014; 7(4): 407-20.
19. Leung RC, Zakzanis KK. Brief report: Cognitive flexibility in autism spectrum disorders: A quantitative review. J Autism Dev Disord 2014; 44(10): 2628-45.
20. Wang Y, Zhang YB, Liu LL, Cui JF, Wang J, Shum DH, et al. A meta-analysis of working memory impairments in autism spectrum disorders. Neuropsychol Rev 2017; 27(1): 46-61.
21. Keshavan MS, Vinogradov S, Rumsey J, Sherrill J, Wagner A. Cognitive training in mental disorders: Update and future directions. Am J Psychiatry 2014; 171(5): 510-22.
22. Philip RC, Dauvermann MR, Whalley HC, Baynham K, Lawrie SM, Stanfield AC. A systematic review and meta-analysis of the fMRI investigation of autism spectrum disorders. Neurosci Biobehav Rev 2012; 36(2): 901-42.
23. Miyajima M, Omiya H, Yamashita K, Miyata T, Yambe K, Matsui M, et al. The effects of cognitive remediation therapy using the frontal/executive program for autism spectrum disorder. Int J Psychiatry Med 2016; 51(3): 223-35.
24. Eack SM, Greenwald DP, Hogarty SS, Bahorik AL, Litschge MY, Mazefsky CA, et al. Cognitive enhancement therapy for adults with autism spectrum disorder: Results of an 18-month feasibility study. J Autism Dev Disord 2013; 43(12): 2866-77.
25. van Passel B, Danner U, Dingemans A, van Furth E, Sternheim L, van Elburg A, et al. Cognitive remediation therapy (CRT) as a treatment enhancer of eating disorders and obsessive compulsive disorders: study protocol for a randomized controlled trial. BMC Psychiatry 2016; 16(1): 393.
26. Matsui M, Arai H, Yonezawa M, Sumiyoshi T, Suzuki M, Kurachi M. The effects of cognitive rehabilitation on social knowledge in patients with schizophrenia. Appl Neuropsychol 2009; 16(3): 158-64.
27. Katsumi A, Hoshino H, Fujimoto S, Yabe H, Ikebuchi E, Nakagome K, et al. Effects of cognitive remediation on cognitive and social functions in individuals with schizophrenia. Neuropsychol Rehabil 2017; 1-13.
28. Buissonničre-Ariza VL, Schneider SC, Storch EA. Cognitive remediation of executive functioning in youth with neuropsychiatric conditions: Current knowledge on feasibility, effectiveness, and personalization. Expert Rev Precis Med Drug Dev 2017; 2(2): 133-44.
29. Kasechi M, Behnia F, Mirzaei H, Rezafiani M, Farzi M. Validity and reliability of Persian version of high-functioning autism spectrum screening questionnaire age 7-12. Pajouhan Scientific Journal 2013; 12(1): 45-54. [In Persian].
30. Maleki S, Alizadeh Zarei M. Correlation between executive function behaviors and educational achievement of children with developmental coordination disorder. Middle East J Rehabil Health Stud 2016; 3(3): e37378. [In Persian].
31. Demehri F. Considering the effectiveness of psychosocial intervention on inhibition and emotion regulation in children with high functioning autism spectrum disorder. Journal of Exceptional Education 2017; 17(147): 41-8. [In Persian].
32. Eack SM, Hogarty SS, Greenwald DP, Litschge MY, Porton SA, Mazefsky CA, et al. Cognitive enhancement therapy for adult autism spectrum disorder: Results of an 18-month randomized clinical trial. Autism Res 2018; 11(3): 519-30.
33. Marceau EM, Berry J, Lunn J, Kelly PJ, Solowij N. Cognitive remediation improves executive functions, self-regulation and quality of life in residents of a substance use disorder therapeutic community. Drug Alcohol Depend 2017; 178: 150-8.

34. Wykes T, Huddy V, Cellard C, McGurk SR, Czobor P. A meta-analysis of cognitive remediation for schizophrenia: Methodology and effect sizes. Am J Psychiatry 2011; 168(5): 472-85.
35. Glenthoj LB, Hjorthoj C, Kristensen TD, Davidson CA, Nordentoft M. The effect of cognitive remediation in individuals at ultra-high risk for psychosis: A systematic review. NPJ Schizophr 2017; 3: 20.
36. McGurk SR, Twamley EW, Sitzer DI, McHugo GJ, Mueser KT. A meta-analysis of cognitive remediation in schizophrenia. Am J Psychiatry 2007; 164(12): 1791-802.
37. Fan Q, Liao L, Pan G. The Application of Cognitive Remediation Therapy in the treatment of mental disorders. Shanghai Arch Psychiatry 2017; 29(6): 373-5.
38. Thorsen AL, Johansson K, Loberg EM. Neurobiology of cognitive remediation therapy for schizophrenia: A systematic review. Front Psychiatry 2014; 5: 103.
39. Brockmeyer T, Walther S, Ingenerf K, Wild B, Hartmann M, Weisbrod M, et al. Brain effects of computer-assisted cognitive remediation therapy in anorexia nervosa: A pilot fMRI study. Psychiatry Res Neuroimaging 2016; 249: 52-6.
40. Eack SM, Hogarty GE, Cho RY, Prasad KM, Greenwald DP, Hogarty SS, et al. Neuroprotective effects of cognitive enhancement therapy against gray matter loss in early schizophrenia: Results from a 2-year randomized controlled trial. Arch Gen Psychiatry 2010; 67(7): 674-82.
41. Penades R, Pujol N, Catalan R, Massana G, Rametti G, Garcia-Rizo C, et al. Brain effects of cognitive remediation therapy in schizophrenia: A structural and functional neuroimaging study. Biol Psychiatry 2013; 73(10): 1015-23.
42. McIntyre RS, Cha DS. Cognitive impairment in major depressive disorder: Clinical relevance, biological substrates, and treatment opportunities. Cambridge, UK: Cambridge University Press; 2016.
43. Penades R, Boget T, Catalan R, Bernardo M, Gasto C, Salamero M. Cognitive mechanisms, psychosocial functioning, and neurocognitive rehabilitation in schizophrenia. Schizophr Res 2003; 63(3): 219-27.