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Evaluation of the effectiveness of greentherapy on discretion and executive functions in hyperactive children

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***Abstract*---**This study was conducted with the aim of investigating the effectiveness of green therapy on the decision-making power and executive functions of hyperactive children. Materials and methods: This study was conducted as a semi-experimental study with a pre-test-post-test design. The statistical population included all 7-9-year-old hyperactive students living in Tehran in the academic year 2021-2022. Based on the objectives of the research, 31 hyperactive children were selected by available sampling method and using Connors test, and they were randomly divided into two experimental groups (15) and control group (16). Then they were evaluated by the Cambridge Neuropsychological Test (CANTAB). Parents of experimental group members were trained. Children also received the intervention for 14 sessions of 60 minutes (2 sessions per week), while the control group did not benefit from this intervention during the research process. After completing the treatment sessions, both groups underwent a post-test. After data collection, data analysis was done by statistical analysis of covariance using SPSS21 software package. The results showed that there is a significant difference between the post-test and pre-test scores of the experimental group compared to the control group.

Discussion: A variety of non-pharmacological treatments have been considered in recent years for the treatment of attention-deficit/hyperactivity disorder (ADHD), but these methods only targeted one or more problems such as academic and professional problems, interpersonal relationships, and executive functions, while This method tried to cover the problems of these children as much as possible by considering several treatment methods without drugs.

***Keywords*---**green therapy, decision making, executive functions, hyperactivity.

Introduction

Hyperactivity is the most common behavioral disorder in childhood and adolescence. About 3-5% of children develop hyperactivity before the age of seven. It occurs mainly in elementary school children as well as in adolescence. Most patients with hyperactivity improve with age. Although the cause of most hyperactivity cases is still unclear, it is thought to be a multifactorial disease with genetic and environmental origins. In contrast, there is conclusive evidence for cases of trauma and encephalitis (Thapar A., Cooper M., Eyre O., and Langley K., 2013). Attention-deficit/hyperactivity disorder (ADHD) is a developmental/behavioral disorder. Children often lack attention and concentration on a particular subject, learn slowly, and have unusually intense physical activity. This disorder is associated with attention deficit, hyperactivity, impulsive behaviors, or a combination of them (Millichap J., Gordon, 2010).

*** (Anita Thapar , Miriam Coope. 2014). Decision-making includes a wide set of complex processes, such as inference, choosing an alternative with the highest level of benefit or making social and moral decisions. Decision-making is choosing a solution from two or more options in a behavior. A program cannot exist unless a decision is made. Decision-making is a series of steps that continue in a hierarchical manner until the result and evaluation are achieved. There are eight steps for decision-making, which are: identifying the problem, identifying the decision criteria, determining the weight for each of the criteria, finding solutions, analyzing solutions, choosing a solution, applying the solution, and evaluating. The decision has been made effectively. It has been reported in several studies that decision making as a major cognitive function is related to a person's behavioral inhibition. (Berman, M. G. (2015).

Some attributes, such as anxiety, narcissism, and fear of negative evaluation results, may affect individual performance and are often activated in high-risk success or failure situations. The distraction-conflict theory relates to cognitive processes such as decision-making. Research on distraction-conflict theory demonstrates that stress causes mental distractions and, consequently, reduces efficiency. (Hewig, J.; Hagemann, D.; Seifert, J.; Naumann, E.; and D. Bartusse .2014). Executive actions all have in common the deliberate (willful) inhibition of behaviors, thoughts, and emotions. This inhibition is goal-oriented and requires effort and the use of mental forces. Executive functions are commonly defined as neurological processes that mediate problem-solving skills as well as

independent, goal-oriented behaviors, the basis of many cognitive, emotional, and social skills (*Beyer, F., Sidarus, N., Fleming, S., & Haggard, P. (2018*). Executive functions refer to brain functions, including activation, organization, management, completion, and other important activities, which enable individuals to plan for long- and short-term courses to achieve logical results (*Barkley, R.A. 2015*).

They are also helpful in a variety of areas, including self-regulation, response inhibition, flexibility, and future behavior orientation. Executive functions have also been described as cognitive functions of the prefrontal cortex, responsible for cognitive flexibility, initiation of action, self-production, response inhibition, and sequencing (Brown, 2009), including skills such as concentration, consciousness, initiation of action, moderation of emotions, memory, and behavior setting (*Beck, S. J., Hanson, C. A., Puffenberger, S. S., Benninger, K. L., & Benninger, W. B. (2010*Executive functions are directly related to the growth of certain regions of the brain and are particularly affected by the prefrontal cortex and subcortical rings of the brain and are therefore considered neurological skills. Imaging and electroencephalography studies have also shown that these nervous systems are composed of several networks, including the thalamus, basal ganglia, and prefrontal cortex (*Baars, B. J., & Gage, N. M. 2013*), which are dramatically interrelated with areas of the brain and other neuronal currents responsible for maintaining attention, consciousness, and motivation. Nervous systems manage a range of observable behaviors and emotions, including emotion regulation, temporal organization of behavior, motivational responsiveness, social judgment, and motor control. Studies on executive functions have shown that deficiencies such as non-inhibition observed in adolescents with conduct disorder are associated with frontal lobe disorders (*Berown, N.; Evans, S.W.; Wymbs, F*, 2016) also showed that hyperactive children have more problems in executive functions (response inhibition) than normal children. By establishing a connection between brain structures, especially the prefrontal cortex, and psychological functions, such as problem-solving, abstract thinking, and strategy shift, the brain's executive functions as a theoretical structure contribute to the psychological pathology of many disorders (Bakhov I, et. al., 2020; Hanawi SA, et. al., 2020; Bashir, T., et. al., 2021). Executive functions, including impulse control, play an essential role in the successful transfer of children to school, allowing them to ignore their own thoughts and emotions and adapt to the learning skills of the curriculum (*Beck, S. J., Hanson, C. A., Puffenberger, S. S., Benninger, K. L., & Benninger, W. B. 2010*).

Medications act as a tool for hyperactivity, not treatment. Many people believe that the treatment for hyperactivity is the same as the drug. However, it should be noted that hyperactivity medications are not for everyone and do not help solve all the problems or eliminate the symptoms completely. Indeed, although hyperactivity often helps improve attention and concentration, it usually does not help improve symptoms of the disorder, poor time management, forgetfulness, and delay (*Kim ، B. ، Lee ، J. ، Cho ، S. ، & Lee ، D(2016).*), causing the most problems for many hyperactive individuals. Different people show different reactions to hyperactivity medications. Common side effects of stimulants include loss of appetite (anorexia), stomachache, headache, and sleep disorders. Some people experience significant improvement while others There are various

programs to reduce the symptoms of hyperactivity, and today the green treatment is mentioned as one of the best treatments for hyperactivity. This treatment relies heavily on the accompaniment of parents and refers to parenting and changes in the child's lifestyle. Seeks to reduce symptoms. In this regard, one of the appropriate and effective psychological interventions to reduce the symptoms of attention deficit/hyperactivity disorder in children with this disorder, can be mentioned the treatment method based on the child-parent relationship. Comprehensive child-parent training programs have provided a suitable opportunity for parents to understand and recognize attention deficit/hyperactivity disorder and teach them what communication, behavioral and emotional skills to use with children. (*Baars, B. J., & Gage, N. M. (2013)*

Materials and Methods: A quasi-experimental study with a pretest-posttest design was carried out. The statistical population consisted of all 7–9-year-old hyperactive students living in Tehran in the academic year 2021-2022. Based on the study objectives, 31 hyperactive children were selected by means of the convenience sampling method using the Conners test, which was randomly divided into two groups: the experimental group (15) and the control group (16). They were then evaluated by the Cambridge Neuropsychological Test Automated Battery (CANTAB). The parents of the experimental group members were trained. Children also received the intervention for 14 sessions of 60 minutes (2 sessions per week).Description of decision-making test components

Table 1 lists the components of the decision-making test, including 7 subtests or components.

Table 1: Mean and standard deviation of decision-making test components for each group and stage of testing separately

Variable	Stage	Experimental group		Control group		Mean difference	
		Mean	SD	Mean	SD	Experimental group	Control group
AGN – Reaction Time	Pre-test	454/81	94/50	414/47	131/85	-49/12	-33/12
	Post-test	405/69	93/40	381/35	129/87		
AGN – Total Commission Errors	Pre-test	16/34	2/14	16/27	1/44	-2/49	0/11
	Post-test	13/85	3/05	16/38	1/67		
CGT – Deliberation time	Pre-test	745/63	118/66	703/53	116/03	-68/07	-9/41
	Post-test	677/56	115/26	694/12	137/03		
CGT – Overall Proportion bet	Pre-test	0/46	0/11	0/49	0/11	-0/05	0/00
	Post-test	0/41	0/11	0/49	0/12		
CGT –	Pre-test	0/88	0/12	0/86	0/14	0/22	0/02

Quality of decision	Post-test	1/10	0/38	0/88	0/18		
IST – Errors	Pre-test	37/56	9/30	40/00	5/83	8/37	1/53
	Post-test	29/19	5/59	41/53	5/16		
SST- Total correct trials	Pre-test	143/50	12/37	144/82	9/90	1/75	3/71
	Post-test						

In AGN–Reaction Time test, a 49.12-point decrease was observed in the experimental group and a 33.12-point decrease in the control group in the post-test stage.
In the AGN–Total Commission Errors test, a 2.49-point decrease was observed in the experimental group and a 0.11-point increase in the control group in the post-test stage.
In CGT–Deliberation time test, a 68.07-point decrease was observed in the experimental group and a 9.41-point decrease in the control group in the post-test stage.
In the CGT–Overall Proportion bet test, a 0.05-point decrease was observed in the experimental group and a 0.002-point decrease in the control group in the post-test stage.
In the CGT–CGT–Quality of decision-making test, a 0.22-point increase was observed in the experimental group and a 0.02-point increase in the control group in the post-test stage.
In the IST–Errors test, an 8.37-point increase was observed in the experimental group and a 1.53-point increase in the control group in the post-test stage.
In the SST test, a 1.75-point increase was observed in the experimental group and a 3.71-point increase in the control group in the post-test stage.

- **Description of the components of the executive functions test**
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Table 2 lists the components of the executive functions test, including 11 subtests or components.

Table 2: Mean and standard deviation of executive functions test components for each group and stage of testing separately

Variable	Stage	Experimental group		Control group		Mean difference	
		Mean	SD	Mean	SD	Experimental group	Control group
	Pre-test	8/33	1/56	8/30	1/18	0/44	0/44
	Post-test	8/77	1/63	8/74	1/26		
	Pre-test	7/48	1/05	7/62	1/19	-0/26	0/38
	Post-test	7/21	0/97	8/00	1/20		
	Pre-test	15/70	1/92	15/82	1/19	-2/24	0/41

	Post-test	13/46	2/10	16/23	1/27		
	Pre-test	16/26	1/39	16/18	1/32	-0/33	0/59
	Post-test	15/94	1/66	16/77	1/22		
	Pre-test	5/56	2/00	4/94	1/82	-0/44	0/12
	Post-test	5/13	1/02	5/06	1/92		
	Pre-test	8/14	1/46	7/89	1/14	1/17	0/02
	Post-test	9/32	2/69	7/91	0/98		
	Pre-test	642/31	76/07	656/12	109/76	-94/93	-8/94
	Post-test	547/38	96/10	647/18	128/49		
	Pre-test	659/90	82/92	647/32	68/94	-5/30	-15/11
	Post-test	654/60	93/82	632/21	78/92		
	Pre-test	6/89	1/16	6/69	0/86	0/94	-0/24
	Post-test	7/83	0/94	6/45	0/63		
	Pre-test	38/42	6/89	38/95	4/77	-4/13	-1
	Post-test	34/29	5/83	37/95	4/89		
	Pre-test	56/57	8/64	55/36	14/94	2/31	-1/54
	Post-test	58/88	8/92	53/82	19/55		

In AST–Total correct trials, a 0.44-point increase was observed in both experimental and control groups in the post-test stage.

In the IED–Shift Stages Complete test, a 0.26-point decrease was observed in the experimental group and a 0.38-point increase in the control group in the post-test stage.

In the IED–Total errors test, a 2.24-point decrease was observed in the experimental group and a 0.41-point increase in the control group in the post-test stage.

In the IED–Total adjusted errors test, a 0.33-point decrease was observed in the experimental group and a 0.59-point increase in the control group in the post-test stage.

In the OTS–mean choices test, a 0.44-point decrease was observed in the experimental group and a 0.12-point increase in the control group in the post-test stage.

In the SOC–Total correct test, a 1.17-point increase was observed in the experimental group and a 0.02-point increase in the control group in the post-test stage.

In the SOC–Initial thinking test, a 94.93-point decrease was observed in the experimental group and an 8.94-point decrease in the control group in the post-test stage.

In SOC–Subsequent thinking time test, a 5.30-point decrease was observed in the experimental group and a 15.11-point decrease in the control group in the post-test stage.

In the SSP test, a 0.94-point increase was observed in the experimental group and a 0.24-point decrease in the control group in the post-test stage.

In the Strategy–SWM test, a 4.13-point decrease was observed in the experimental group and a 1.00-point decrease in the control group in the post-test stage.

In the Total Errors–SWM test, a 2.31-point increase was observed in the experimental group and a 1.54-point decrease in the control group in the post-test stage.

- **The effect of greentherapy intervention on the components of the decision-making test**

This section examines the effect of greentherapy intervention on the components of the decision-making test, with the results presented in Table 3.

Table 3: MANCOVA test results regarding the effect of greentherapy intervention on decision-making test components

Dependent variable	Sum of squares	Degree of Freedom (DoF)	Mean squares	F-value	Significance level	Effect size
AGN – Reaction Time	1104/59	1	1104/59	0/24	0/631	0/01
AGN – Total Commission Errors	50/52	1	50/52	12/72	0/002	0/35
CGT – Deliberation time	28401/38	1	28401/38	4/80	0/038	0/17
CGT – Overall Proportion bet	0/02	1	0/02	3/61	0/070	0/13
CGT – Quality of decision making	0/29	1	0/29	6/72	0/016	0/22
IST – Errors	975/67	1	975/67	40/24	< 0/001	0/63
SST – Total correct trials	122/33	1	122/33	1/54	0/227	0/06

0.158, F=13.74, P<0.001 =Wilks Lambda

Examination of the effect of the Wilks Lambda test (multivariate effect) showed that Wilks Lambda and F-value are 0.158 and 13.74, respectively, which is significant ($p<0.05$) at a confidence level of at least 95%, indicating that

greentherapy intervention has had a significant effect on at least one dependent variable (decision-making test component).

In addition, the results of the ANCOVA test on the effect of greentherapy intervention on 7 components of the decision-making test showed that greentherapy intervention was effective on 4 components out of 7 components of the decision-making test ($p < 0.05$). The results showed that greentherapy intervention had a significant effect on the following components:

- AGN–Total Commission Errors
- CGT–Deliberation time
- CGT–Quality of decision-making
- IST–Errors

Effect size (eta coefficient) indicates the effect of greentherapy intervention on dependent variables. Comparison of effect sizes obtained showed that greentherapy intervention had the greatest effect on the IST-Errors component with an eta coefficient of 0.63. Table 4lists marginal averages (adjusted post-test score, where the post-test score is adjusted by neutralizing the pre-test score).

Table 4: Marginal averages of decision-making test components in experimental and control groups

Variable	Marginal average	
	Experimental group	Control group
AGN – Reaction Time	386/78	399/15
AGN – Total Commission Errors	*13/79	16/44
CGT – Deliberation time	*653/79	716/50
CGT – Overall Proportion bet	0/427	0/477
CGT – Quality of decision making	*1/09	0/89
IST – Errors	*29/56	41/18
SST – Total correct trials	144/82	148/94

Note: * Indicates a significant marginal average difference between groups.

The results showed that greentherapy intervention helped improve subjects' scores in 4 components out of 7 components of the decision-making test.

- **The effect of greentherapy intervention on the components of executive functions test**

This section examines the effect of greentherapy intervention on the components of the executive functions test, with the results presented in Table 5.

Table 5: Results of MANCOVA test regarding the effect of greentherapy intervention on the components of executive functions test

Dependent variable	Sum of squares	Degree of Freedom (DoF)	Mean squares	F-value	Significance level	Effect size
AST - Total correct trials	0/01	1	0/01	0/02	0/901	0/001
IED – Shift Stages Complete	3/21	1	3/21	15/30	0/001	0/433
IED – Total errors	52/18	1	52/18	42/77	< 0/001	0/681
IED – Total adjusted errors	4/65	1	4/65	3/48	0/077	0/148
OTS - mean choices to	0/73	1	0/73	0/35	0/561	0/017
SOC – Total correct	6/27	1	6/27	2/30	0/145	0/103
SOC – Initial thinking	49271/40	1	49271/40	7/73	0/012	0/279
SOC – Subsequent thinking time	257/45	1	257/45	0/12	0/738	0/006
SSP	9/16	1	9/16	20/30	< 0/001	0/504
SWM: Strategy	112/78	1	112/78	9/40	0/006	0/320
SWM: Total error	142/77	1	142/77	2/56	0/125	0/113

0.108, F = 7.51, P = 0.002 = Wilks Lambda

Examination of the effect of the Wilks Lambda test (multivariate effect) showed that Wilks Lambda and F-value are 0.108 and 7.51, respectively, which is significant at a confidence level of at least 95% ($p < 0.05$), indicating that the greentherapy intervention has had a significant effect on at least one variable (component of the executive functions test).

The results of the ANCOVA test on the effect of greentherapy intervention on 11 components of the executive functions test showed that greentherapy intervention was effective on 5 components out of 11 components of the executive functions test ($p<0.05$). The results showed that greentherapy intervention had a significant effect on the following components:

- AST-Total correct trials
- OTS–mean choices
- SOC–Initial thinking

- SSP
- SWM–Strategy

Effect size (eta coefficient) indicates the effect of greentherapy intervention on dependent variables. Comparison of effect sizes obtained showed that greentherapy intervention had the greatest effect on the IED – Total errors component with an eta coefficient of 0.681. Table 4-15 lists marginal averages (adjusted post-test score, where the post-test score is adjusted by neutralizing the pre-test score).

Table 6: Marginal averages of executive function test components in experimental and control groups

Variable	Marginal average	
	Experimental group	Control group
AST - Total correct trials	8/73	8/78
IED – Shift Stages Complete	*7/28	7/94
IED – Total errors	*13/50	16/19
IED – Total adjusted errors	15/95	16/76
OTS - mean choices to	4/93	5/24
SOC – Total correct	9/07	8/14
SOC – Initial thinking	*556/27	638/71
SOC – Subsequent thinking time	646/14	640/17
SSP	*7/70	6/58
SWM: Strategy	*34/14	38/09
SWM: Total error	63/08	58/64

Note: * Indicates the significant marginal average difference between groups.

The results showed that greentherapy intervention helped improve subjects' scores in 5 components out of 11 components of the executive functions test.

Discussion

Developmental changes are generally examined in three contexts: physical, cognitive, and psychosocial. Physical development refers to changes that occur in the body, including various systems and organs. Cognitive development is defined as the changes that occur in mental activities, including emotions, perception, memory, thinking, reasoning, and language. Also, psychosocial development

basically involves changes in personality, emotions, and interpersonal relationships (Seyyed Mohammadi, 2002).

The most important executive functions are response inhibition and sustained attention. Response inhibition is described as the ability to think, assess the position, and behave before taking action (XXX, 2010).

Executive functions are essential for adaptive and goal-oriented behaviors driven by frontal lobes. In particular, the prefrontal cortex is associated with working memory, the ability to deter inappropriate actions, and cognitive emotion regulation. Response inhibition is one of the most important executive functions, which is directly related to self-regulatory goal-oriented behavior (XXX, 2012).

Many reasons can be named for the lack of relationship between cognitive training and behavioral dimensions of executive functions and decision-making power. (Routledge, van den Bas, McClure and Schweitzer, 2012). The family does not see much change in the child's daily performance; despite the progress, the child shows in exercises and goes to higher stages in homework. When the exercises are designed based on real life conditions or how they are implemented in natural life situations, parents report better performance from the child. According to research, when the effects of cognitive education on children's behavior are seen in the evaluations, there is no change in the behavior of these children at home or at school (Klinberg, Frenell, Elsen, Johnston, Gustafson et al., 2005; Holmes, Gathercole, Pals, Dunning, Hilton et al., 2009). The communication between the parent and the therapist and the parent's correct response to the child's behavior is another reason that can be investigated. Due to the low age of the children in the sample group, insufficient communication sessions between parents and therapists can cause problems in measuring the effectiveness of treatment. Another significant aspect of the current research is that a wide range of cognitive functions has been intervened instead of one or two cognitive skills. When a limited number of skills are taught, not all deficits of children with ADHD are covered. A wide range of cognitive abilities are defective in these children, therefore, in the design of rehabilitation assignments, each one should be trained separately. In this research, decision-making and executive performance were selected and studied. The analysis of the findings obtained from attention deficit and hyperactivity symptoms showed that these symptoms changed significantly in the post-test evaluation. This finding is consistent with the research of Jiang and Johnston, 2015; Johnston et al., 2012, Johnston et al., 2010, Beck et al., 2010; Klingberg et al., 2005; Jiang and Johnston 2015 and Johnston, 2010 have been consistent. Reducing these defects and signs at a young age will be associated with reducing academic, social and occupational problems in the future.

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