International Journal of Modern Education Research
2019; 6(2): 12-18
http://www.aascit.org/journal/ijmer
ISSN: 2375-3781

American Association for Science and Technology

Effectiveness of Response Inhibition Training Program on Visual-motor Function, Selective Attention and Cognitive Flexibility in Students

Bahare Safdari, Elham Foroozandeh*

Department of Psychology, Naein Branch, Islamic Azad University, Naein, Iran

Email address

Elham_for@yahoo.com (E. Foroozandeh)

*Corresponding author

Citation

Bahare Safdari, Elham Foroozandeh. Effectiveness of Response Inhibition Training Program on Visual-motor Function, Selective Attention and Cognitive Flexibility in Students. *International Journal of Modern Education Research.* Vol. 6, No. 2, 2019, pp. 12-18.

Received: April 15, 2019; **Accepted**: July 23, 2019; **Published**: July 30, 2019

Abstract: The aim of the present research was determine the effectiveness of response inhibition training program on visual-motor function, selective attention, and cognitive flexibility among primary school's female students in Iran. The research method was semi-experimental with pre-test, post-test design by control group. The sampling has been done by cluster method and two classes were selected among four grade students, randomly from one school in Isfahan, Iran. Also, 15 students were selected in each class, randomly. They were put into two control and experimental groups of 15 students. The Stroop test was used in order to investigate response inhibition, selective attention, and cognitive flexibility; also Bender Gestalt test was applied to investigate visual-motor function. The interventions of education of response inhibition in experimental group were performed in eight sessions, 60 minutes, and three times per week on experimental group. The control group did not receive any psychological training. To analyze data, the one variable covariance analysis (ANOVA) was used. Results demonstrated that the training of response inhibition is effective on visual-motor function, $p<0.05$. The present research suggests that response inhibition training effects positively on visual-motor function, selective attention, and cognitive flexibility among female students at primary schools.

Keywords: Response Inhibition Training, Visual-motor Function, Selective Attention, Cognitive Flexibility

1. Introduction

In educational courses students are considered as intellectual resources of each country [1]. The investigation of students' psychological problems, proper training, and their physical, social, and mental health are the most important objectives of curriculum planners among governments' perspectives [2]. Psychological problems and educational issues involve the wide range among students around the world countries like in Iran. It seems that there are several factors that affect their health.

Childhood, primary, and preschool periods are considered as the most important periods of life time since the adulthood future depends on these age [3]. There are several problems among primary school students; e.g. some students quickly answer the exams questions; however, they stop answering after two questions.

They might not answer to their turn or they want to answer instead to others; they are not able to be silent at home. These students have emotional behavior [4].

Some students might have leaning difficulties, dyslexia, unstable emotions and mode. These students are susceptible to bad events, emotional problems, negative self – concept and their reactive aggression become worse with their awareness to their problems [5]. Children problems are highly due to the disorder of executive outputs [6].

Visual-motor function is the skill of harmonization of visual input with motor output [7]. The necessity to make these skills needs the organization of sensory information that received form muscles, joints, and environment by an individual. Cognitive functions are measured by several domains such as attention, executive functioning, memory, language, and sense. Attention is a cognitive process that is defined as selective focus on one aspect of environment. Cognitive flexibility is one of the main items/components of

executive functioning and adjusts the executive functioning of behavior outputs [8]. According to the findings of Soltani et al., cognitive flexibility has positive correlation with tolerance, contrastive style, problem- solving strategies, social support, and cognitive evaluation. [9]. Besides that, Johnco, Wuthrich, and Rapee concluded that insufficient cognitive flexibility has negative effects on the ability of cognitive renewal as a method to decrease emotional stress; more cognitive flexibility causes the individuals benefit from alternative cognitive changes methods [10]. Based on the research of Akbari et al., the training may enhance the communicative skills, problem-solving, cognitive function correction, saving from insufficient drafts and cognitive flexibility [11]. Response inhibition is one of the components of executive functions. In some children, deficit in inhibition might be the result of some behaviors such as replying before understanding and replying before sufficient information about home work [12]. One of the main processes of executive control is the response inhibition that has an essential role in cognitive processes and adaptable behaviors of human being [13].

According to Barkly, response inhibition is a psychological process that helps children to present responses with pause. Response inhibition includes 3 constant processes: 1) response inhibition or frequent event, 2) to pause the current response and giving the delay chance to decide for responding or continuing to response, 3) keeping the delay period and self - control response that occurred during this period [14].

The study of Hakimirad et al confirms the effectiveness of executive functioning training (response inhibition) under the title of the effective of the response inhibition training on memory recovery and social skills of hyperactive children [4]. Besides that, the research of Kavianpour et al, reported that response inhibition training has significant effect on children's impulsive behavior [15]. With regard to the role of flexibility and selective attention at educational success, the investigation of flexibility and attention at the research group might present strategies for improving health, adulthood life quality, dynamism, and progress in all aspects of life. Therefore, this research aimed at to investigate the effect of response inhibition training on visual-motor function, selective attention, and cognitive flexibility of primary school's female students.

It is designed to answer the question that whether the response inhibition educational program is effective on visual-motor function, selective attention, and flexibility of primary school students or not?

2. Method

The method of the research was semi – experimental with pretest post-test design with control group. All the participants were primary school students in 2017-2018 (October-November educational year) in Iran. The research has been done by the written letter of introduction from the education and training organization. Two classes were selective form fourth grade. 15 students were selected from each class, randomly.

They were put in to two control and experiment groups. The research criteria were the registration as the normal student, and the age range was from 7 to 12. The participants were not included in the study if the participants were absent due to the visual difficulties that they could not answer the computer stroop section.

2.1. Tests

Bender Gestalt visual-motor test: The test includes 9 simple images, that each drawing on a card. The first card symbol has shown with the abbreviation A, and other cards numbered from 1-8. Bender Gestalt visual-motor test has been recognized as a useful instrument to diagnose problems in brain integrative functions. The test validity was reported based on the Pascal and Satel as 0/70. The test validity was reported based on the Koopitz category according to the age and the time of performance from 0 /53 to 0/90 (average 0/77).

The validity and reliability of Bender Gestalt visual-motor test has been reported by Koppitz scoring system in Iran. The Bender Gestalt test by Koopitz scoring system has been performed on 1008 participants in the research of Poursharifi et al., in Tabriz, Iran. The validity of the test has confirmed from 0/60 to 0/90. Moreover, test re-test has been done on 100 participants, randomly in order to investigate reliability during 4-6 weeks after the first test; the reliability was reported as 0/89 [16].

Stroop test: the stroop test has been designed in 1935 to measure selective attention, cognitive flexibility through visual process. The test has been applied in several researches at clinical groups to measure the ability of response inhibition, selective attention, cognitive changing, and cognitive flexibility. The primary Stroop test has been translated to Chinese, German, Sweden, Japanese, and Persian languages. Also, it has been performed and scored in different methods by researchers through the changes of main test. The validity of the test has been reported as 0/80 to 0/91through the test re-test method in Iran [17].

2.2. Research Methodology

After selecting the school, fourth grade teachers were asked to choose and introduce 30 students, randomly. Computerized Stroop test applied for evaluation of response inhibition and Bender – Gestalt test were used for determining visual-motor function. Then, samples divided in to two groups will fifteen individuals in each (experimental and control group) and on test group independent variable (response inhibition program) was performed. Training related to response inhibition education represented in school courtyard. Every session began with reviewing contents and assignments of previous session.

At the end of training sessions, Stroop test and Bender - Gestalt test has been performed in two groups. For independent variable (training of response inhibition program)

eight sessions for experimental group has been arranged. Each training session was held in school located in Isfahan, Iran, for 1 hour and 3 days per week.

Table 1. *Explanation of educational session of response inhibition.*

Sessions	Topic	Short explanation
1	*introduction of method	*familiarity and making relationship with testing, definition and explanation of response inhibition
2	Sit & stand game directionally and reversely	*the participants was asked to perform every order, reversely, by saying sit down, she should stand up and by saying stand up, she should sit down. *First, a child should perform the orders sequentially from the first to the last. Then, she was asked to do the new orders from the last to the beginning.
3	Eye to eye inhibition	*child hands are in trainer's hands, and looked in her eyes. Tester asked question and she should answer when the tester pressed her hands.
4	*walking by one foot **standing by one foot / closed eyes ***moving on wooden rolling pin	*child was asked to hop or walk by one foot between two parallel in a 10-meter distance. **child should stand on one foot with closed eyes; the time of standing was important. **child should move on wooden rolling – pin without falling.
5	*walking by a glass of water in hand (palm) **walking with spoon in her mouth *using memory card	*a child was asked to put a glass full of water in her palm, without pouring water walking a 100 meter distance. **child should put a small ball in spoon and put spoon in her mouth and walk 10 meters without dropping of ball spoon. *cards with different pictures were shown to the child and after 30 seconds, they were removed. Child should say the name of all pictures in a specified period of time.
6	*using a spectrum of figures in Wechsler child intelligence scale test	*child repeated the figures as the trainer asked; also she repeated them backward from the last to the beginning. Then, these skills were played by trainer, after that, the child performed them.
7	*coping symbols (from Wechsler child intelligence scale) **memory training based on (Wecs hler child intelligence scale test) ***use of focus card enhancement game with doll (notice enhancement)	*child should write symbols with simple shapes of figures. A child was asked to look at prepared pictures, randomly and regularly; and, cross the told picture in a specific period of time. **In this game, one card with picture was shown to the child and asked her to carefully look at it (30 second). then, she was asked some questions (colors/directions) ***this game was done in two stages. First, the trainer gave a doll to the child to carefully look and present its features, then, the doll was taken, she was asked to draw its picture with colored pencil, next stage, the child looked at the doll again, she/he was asked to say its features.
8	*aerobic movements **dart	*the purpose of doing these movements was setting balance between eye and hand, eye, hand, and foot in a harmonious way as the therapist asked. **balance between eye and hand

After gathering data, they were analyzed by covariance analysis using spss-20.

3. Result

Table 2. *Descriptive index values of Gestalt test in both control and test group.*

Group	phase	number	range	Min	max	Mean	SD	stretching	skewness
control	pretest	15	27	67	36.26	14.68	0.86	-0.26	0.73
control	posttest	15	27	73	44.20	17.37	0.70	-1.25	0.37
experiment	pretest	15	60	26	86	51.80	18.90	0.19	0.89
experiment	posttest	5	52	26	78	49.33	16.06	0.32	0.41

Table 3. *Descriptive index values of Stroop test in both contrary control and test group.*

Group	phase		N	Range	min	max	mean	SD	Stretching	skewness
control	pretest	Exp time	15	37	43	77	56.20	8.41	0.90	1.44
		Response Num	15	9	8	48	38.33	12.91	-1.92	2.64
		Response time	15	654	422	1556	1083	239.73	-1.04	4.37
control	posttest	Exp time	15	34	44	71	57.07	8.51	0.09	1.11
		Response Num	15	40	24	48	43.47	6.06	-2.68	8.24
		Response time	15	1134	923	1549	1187.6	181.67	0.44	-0.55
experiment	pretest	Exp time	15	22	43	81	57.40	8.98	1.02	2.55
		Response Num	15	2	8	48	38.33	12.91	-1.92	2.644
		Response time	15	425	910	1556	1149.6	172.40	1.06	0.98
experiment	posttest	Exp time	15	21	44	71	56.67	8.62	0.22	-1.18
		Response Num	15	2	24	48	43.67	6.14	-2.62	7.93
		Response time	15	41	923	1549	1180.07	183.45	0.55	-0.55

In this section, results from descriptive findings of Bender Gestalt test and Stroop test has demonstrated in table 2 and 3, respectively.

As it is shown, the calculated values for stretching and skewness are indicators of normal distribution for observation of both control and test group in both sections of

pre – test and post – test; that is the necessity for using covariance analysis. Also, data of Lewin and Kolmogrov - Smirnov and homogeneity of line gradient in both groups in pre – test and post - test was more than 0.05 that it confirms the observance of covariance analysis assumptions.

Table 4. *Results obtained from covariance analysis of Gestalt test in congruent group.*

Changes resources	Total squares	Df	Mean squares	F	Sig	Eta square
Intercept	4138.68	2	2069.34	14.33	0.000	0.51
Pre-test	919.97	1	919.97	6.37	0.001	0.91
Group	3941.05	1	3941.05	27.29	0.05	0.50
Error	202.56	1	202.56	1.40	0.24	0.04
Total	3898.68	27	144.36			

As it is shown for classifying variable based on the level of the test that is 0.05 and with regard to significance level (p-value <0.001) that is smaller than level test, it might present that there is a significant difference in post – test scores in both control and test group (table 4); in other word, training has the effect on reduction of test time among samples.

Table 5. *Results obtained from covariance analysis of time of response variable in congruent group.*

Changes resources	Total squares	Df	Mean squares	F	Sig	Eta square
Intercept	68.67	2	34.33	0.72	0.49	0.05
Pre-test	1148.64	1	1148.64	24.13	0.000	0.47
Group	23.04	1	23.04	0.48	0.49	0.01
Error	32.71	1	32.71	0.68	0.41	0.02
Total	1284.82	27	47.58			

As it is shown in table 5 with regard to significance level (p-value < 0.0001) it can be said that there is a significant difference in post – test score in both control and test group; in other word, response inhibition training has effect on reduction of test time among samples.

Table 6. *Results obtained from covariance analysis of response variable in congruent group.*

Changes resources	Total squares	Df	Mean squares	F	Sig	Eta square
Intercept	281.09	2	140.54	3.10	0.06	0.18
Pre-test	27.46	1	27.46	4.16	0.001	0.002
Group	103.46	1	103.46	2.28	0.14	0.07
Error	34.07	1	34.07	0.75	0.39	0.02
Total	1221.87	27	45.25			

As it is shown in Table 6, it presents that post – test scores in both control and test groups have significant difference; in other word, training has effect on decreasing the test time of studying samples.

Table 7. *Results from variance analysis of reaction time of variable in congruent group.*

Changes resources	Total squares	df	Mean squares	F	Sig	Eta square
Intercept	140856.31	2	66344.93	4.39	0.02	0.24
Pre-test	140856.31	1	140856.31	9.32	0.05	0.25
Grouping	124289.73	1	124289.73	8.23	0.08	0.33
Error	4404.77	1	4404.77	0.29	0.59	0.01
Total	407675.99	27	15099.11			

According to table 7, it presents that post – test scores of reaction time in both control and test groups have significant difference; in other word, training has effect on reducing the reaction time among experimental group.

4. Discussion

Based on the findings, effect of response inhibition training on visual-motor function of primary school's female students has demonstrated that response inhibition training has a significant effect on visual-motor function. These findings are in line with findings of Arjmandnia et al., for the efficacy of computer cognitive training on active visual-spatial memory of students with mathematic problems [18]. Also, Asadi doost in his research for determining the efficacy of sensory stability and training motor – cognitive skills dyslexia emphasized on the effect of these interventions to improve the students cognitive skills [19].

To confirm the efficacy of response inhibition training it should be mentioned that most activities are influenced by harmonious skill of eye and hand such as our ability for coloring, pictography and letter writing, passing the maza and point to point drawing, writing with one hand, catching the ball with one hand. Visual-motor function is only effective when visual and motion skills have been developed well. Insufficient growth of each of these skills has a negative effect on harmony of visual-motor skills. Response inhibition with active memory is the most important elements of executive functions and have important role in visual-motor function, educational success, and social skills in

children. The ability in response inhibition leads to the maintenance of sufficient function on durable tasks such as motor – sensory function. Those children with difficulty in these functions cannot harmonize their hands movement in response to what they see and in writing and other tasks that need the balance of visual-motor functions. Due to the importance and necessity of strengthening the harmony between eyes – hand movement in diverse activities, there is a need to get some exercises for strengthening and correct functioning of this skill. Prefrontal cortex that supports inhibition behavior and pulse control has close relationship with important brain center for movement. Inhibition and executive performance need more control, time adjustment, flexibility, and harmonizing objective motor functions.

Evidence based on the effect of response inhibition training on selective attention of primary schools students showed that response inhibition training have a significant effect on selective attention of primary schools students. These results are in line with findings of Heidari farsani based on the effect of working memory software education on attention and impulsive behavior of 7-12 years children that suffered from attention deficit hyperactivity [20, 21]. Also, Hakimirad et. al investigated the efficacy of response inhibition program and active memory on recovery of social skills of children with attention deficit hyperactivity; it suggest that response inhibition program and active memory have significant effect on increasing social skills [4]. In another research the effectiveness of education of executive function on attention of preschool students with developed disorders is investigated. The results showed that the amount of attention deficit decreased by training of response inhibition executive function in these children, and their educational function improved [22].

It should be mentioned that brain encounters with large amount of environmental stimuli, and according to its objectives select the stimuli to notice, process, and save them and ignore some stimuli. More stimuli omission leads to the more focus of attention. Selective attention is the most fundamental form of attention and help individuals to control interventions; as attention maintenance influenced the cognitive capacity and the ability of discrimination and selection of proper stimuli, mind deficit in response inhibition function resulted in some disorders in selective attention.

Cognitive inhibition control performed when it is not necessary to accept responses that are related to the environmental stimuli. In most cases, the ability to control attention for concentration on information is more important and ignorance of unrelated data is a basic factor for successful function [23]. Inhibition control is a regulatory function that progressively grows from childhood to adolescence. Children with inhibition disorders cannot avoid that information that they need; or suddenly stop one thought or function.

Moreover, response inhibition deficit control might decrease the ability of working memory and leads to the damage at working memory; and as the selection of stimuli, the selection of response, and response task needs the inhibition in different processing stages, therefore, the response inhibition disorder of these children deal with problem in their school tasks and response inhibition training can lead to improvement of selective attention.

The other result of the this study based on the effect of response inhibition program on cognitive flexibility of primary school's female students demonstrated that response inhibition training programs have a significant effect on cognitive flexibility. These findings are in line with Corbett et. al research titled the investigation and comparison of executive normal function (active memory and flexibility) in autism and 7-12 years old children; it has shown that autistic children in comparison with normal child had significant difference in cognitive flexibility, changeability, and working memory [21].

To confirm research findings it should be stated that cognitive flexibility not only consider as one important skill for educational success, but also it is vital for a healthy social life. Usually, a child in his/ her routine life encounters unexpected situations and unpredictable changes. In these cases, children can conquer disappointment by using cognitive flexibility skills, and hopefully search for finding a solution to remove the existent dilemma. Flexible children and adolescent can easily do their duties and adjust themselves with new condition. They can easily change from one situation to another situation. When they fail in one game or exam, they can easily cope with their disappointment. They have the ability to view one situation from others point of view and perceive it. However, children and adolescent who have weak cognitive flexibility skill in new situation and changes in normal situation and process experience several problems, e.g. get angry, adopt improper approaches; when they receive negative feedback they get angry and disappointed. They have problem in understanding parents and teachers expectations. They like to continue their activities like previous ones as they have been taught, and cannot easily change their programs. Therefore, limited creativity and inflexibility in thoughts indicate problem in executives function. Training the executive function (response inhibition) leads to improvement of these abilities in children. According to the result, it can be concluded that the training response inhibition program has had significant effect on. Important of visual-motor, selective attention and cognitive flexibility. It is recommended that this plan presents for psychologists.

One of the main constraints of this research is the non-matching of sample individuals based on interventional variables such as economic status and other demographic variables. Also, because the sample was made by elementary school children, there were problems with homework education and homework and some of the children did not do homework properly. Therefore, it is suggested that in subsequent studies, the role of teaching the rehabilitation program on other variables related to primary school children, such as emotional-behavioral problems, should be considered. And in subsequent studies, the sample should be matched

based on intervening variables such as parental education, gender, socioeconomic status, and the results are compared with the present study.

5. Conclusion

Students from each country are considered to be the intellectual and intellectual capital of that country. Studying psychological issues of students, successful education and providing their physical and psychosocial health is one of the most important goals of government education planners. Considering the role of visual-motor function, selective attention and cognitive flexibility in the academic achievement and future of primary school girls, the study of flexibility and attention in the studied groups (elementary school girls) can be considered as strategies for the growth of health and well-being, as well as strategies for improving the quality of adult life, dynamics and advancement in all aspects of life, which is influenced by the Response Inhibition, which is one of the components of the executive functions. The research has shown that education and the development of executive functions play an essential role in expanding social capabilities and academic and academic capabilities, and deficiencies in executive functions create many problems, such as problems and deficiencies in organizing, remembering homework assignments, initiating doing something and finishing it, reminding rules, performing complex math tasks, reading text, completing tasks on time, punctuality, emotional control and planning for the future. So regarding the results of the effectiveness of response inhibition training program on visual-motor function, selective attention and cognitive flexibility in students, it is suggested that these trainings in specialized clinics for children and experimental, as well as in counseling centers for interventions to be applied.

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