Efficacy of attention games on the rate of executive functions and attention of preschool children with neuropsychological learning disabilities

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Abstract

This study was aimed at investigating the efficacy of attention games on the rate of executive functions and attention of preschool children with neuropsychological learning disabilities. The design was experimental with pretest and posttest and control group. 20 preschoolers with neuropsychological learning disabilities were selected by using multistage random sampling. Then, they were randomly assigned into two groups (10 in the experimental and 10 in control groups), and the attention games were employed for the experimental group. The instruments were Conners diagnosis test and Raven Progressive matrices. The data was analyzed by multivariate analysis of covariance (MANCOVA). The findings indicated that attention games can effect on the rate of executive functions and attention of preschool children with neuropsychological learning disabilities. The results also showed that attention games have some effects in executive function and attention in preschoolers.

Keywords: Attention, Attention games, Executive functions, Learning disabilities

Introduction

Pre-school children's learning disabilities are called neuropsychological / developmental disabilities. These include biological/genetic disorders, perceptual-motor disorders, and visual processing disorders. In other words, neuropsychological learning disabilities are related to pre-school skills groups that the child requires for learning lesson subjects. One of problems of pre-school children with neuropsychological/developmental disabilities is executive functions and attention [1], which involves abilities needed by children to learn school lessons. Observed characteristics in these children are delayed motor development, language delays, speech disorders, poor cognitive and conceptual development. Executive functions are skills that help the person decide what activities or objectives should be considered, which should be chosen, and how behaviors should be organized and planned [2,3]. In other words, executive functions are cognitive and para-cognitive functions that perform a collection of superior abilities such as self management, inhibition, strategic planning, cognitive flexibility, and impulse control. In fact, functions such as organizing, decision making, working memory, motor control, sense and perception of time, predicting the future, reconstruction, internal language, and problem solving can be seen as important neuropsychological executive functions that help human in life and in performing learning tasks and intelligent actions [4,5]. Attention is a set of complex mental operations that involve focusing on a goal or engaging with it, maintaining or bearing out and being alert for a long period of time, deciphering stimulus characteristics, and changing focus from one goal to another

[1]. Recognizing components of attention is problematic for many reasons. First, attention is usually assessed in association with other activities, and it is difficult to measure. Second, components of attention have been described in different paths [6,7,8]. However, many theoretical bases consider components of attention as follows: regulation of arousal and care, selective attention, sustained attention, span of attention, divided attention and inhibitory and behavior control [6]. A number of researcher have shown that pre-school children with learning disabilities compared to normal children have poorer performance in executive function and attention evaluation tests [10,9,11,12,13,14,15].

Given the negative consequences of learning disabilities, attention to this problem and use of treatment procedures is especially important. Some researchers have referred to effectiveness of neuropsychological interventions to improve performance of executive functions and attention in children with neuropsychological/ developmental learning disabilities [16,17,18]. If these children are identified in early years of their lives, before they encounter academic failure, an early and useful intervention can be provided for them [8]. Researches by Fisher, Barclay, Smallish & Fletcher, Goldberg et al. and Mc Lucky, Schwartz and Sinni have shown that executive function training is effective in increasing attention [19,20,21]. Therefore, the need for intervention programs to eliminate or reduce executive functions problem is clear. In this respect, attentive games have a significant share in improving executive functions in these children. Sometimes students receive movement training through adaptive physical education programs. These programs have been adjusted according to the needs of children with disability. Active and vibrant games help students with disabilities to be compatible with normal classroom learning programs [22].

A major part of human behavior is acquired from learning, and learning itself is a cognitive process. When playing, through touching objects and contact with environment stimulants, a child discovers reality of things and gains experience, and facing reality makes him think and ponder, hence, widens his thoughts, and increases his ability, and accuracy [23]. Studies indicate that there is a relationship between playing and improved attention, planning skills, attitudes, perspective taking, divergent thinking, insight, and language development, and playing is essential for cognitive skill development [24]. Also, studies by Yousefi, Shore, Jensen, and Christ, First et al. quoting Eisenberg, Kisenberg, Dan, and Clingberg acknowledge the importance of playing in childhood [25, 26,27,28]. Since pre-school children with learning disabilities probably show ambivalence in language development, cognitive development, and visual motor skill development, therefore, timely intervention may be necessary in these developmental skills before the child's academic performance in language, literacy, or mathematics is affected. Thus, given the importance of the issue, these children require early diagnosis and intervention to acquire pre-requisite skills needed for success in future academic learning. Accordingly, in this study, attempts have been made to investigate the effectiveness of attentive games on the level of attention and executive functions in pre-school children with neuropsychological learning disabilities. To this end, two hypotheses were tested; 1) the effect of attentive games on executive function level in pre-school children with neuropsychological/ developmental learning disabilities, 2) the effect of attentive games on level of attention in pre-school children with neuropsychological/ developmental learning disabilities.

Method

Given the nature and objectives, this study was conducted in experimental design. The statistical population included all pre-school 5- to 6-year-old boys in Isfahan City in the 2010-2011 academic year. The study sample consisted of 20 boys (10 in control and 10 in experiment group), selected in multi-stage random sampling. Of the 5 regions in Isfahan, 2 regions (3-2) were randomly selected, then, of the 8 centers in these 2 regions, 4 pre-

school centers were randomly selected and 2 classes from each center were also randomly selected. For ethical considerations, parents were issued with informed consent forms. To assess children's intelligence level, a clinical interview was conducted using Raven Colored progressive matrices test. Also, Connors neuropsychological diagnostic test was taken from all children in these classes to assess attention level and executive functions. Given the study inclusion criteria, and that, all children were physically and mentally healthy (normal intelligence score), 20 children with low scores in Connors test were selected and randomly divided into control and experiment groups (10 in each group). The children in experiment group, individually or sometimes in groups of three, participated in 8 play-therapy sessions. By the end of these sessions, connors neuropsychological test was taken from both groups again. The attentive games intervention package was prepared by the authors according to clinical experiences and review of relevant books and articles. Its reliability was estimated by Cronbach's alpha of 0.72, and its face validity was confirmed by three experts in the field. Study tools: The following tools were used in this study: connors test: This test was designed by connors in 2004 to evaluate neuropsychological problems in 5- to 12-year-old children. This test evaluates attention problems, sensory, motor, language functions, executive functions, memory, learning, and cognition in 4 domains (not observed to severe). Jadidi et al. in 2011 translated and normalized this questionnaire, and found it valid by using factor analysis. They also reported cronbach's alpha of 0.79 for its reliability.

Raven's colored progressive matrices test for Children:

This test was revised in 1956 by Raven. It has been designed to assess 5- to 11-year-old children's reasoning ability, and involves 36 geometric shapes in 3 sets of A, AB, and B, with 6 shapes underneath each. In fact, this test

Table 1 *Summary of attentive playing sessions on executive functions in the experiment group*

Session	Topic	Brief description	Aim
1	Familiarization, performing the tests	Explaining the disorder to parent, meeting children, taking psychology tests	Familiarization
2	Aiming	Aiming for the target, from easy to hard over obstacles	Enhancing visual attention, eye-hand-leg coordination
3	See and tell	Child must be able to detect changes made in the surroundings	Enhancing visual attention Enhancing memory
4	Balancing games	Children dancing, ball and spoon game, hold the water game	Enhancing attention, body control, improving hand-eye coordination
5	Sorting games	Trainer and child practiced sorting objects, jobs, animals,…	Enhancing attention, improving sorting skills
6	Spot the difference games	Spotting the differences in two similar pictures, finding the odd picture among the rest	Enhancing visual attention, accuracy, and concentration
7	Memory games	Asking questions about pictures shown for 30 seconds Making shapes with matchsticks	Enhancing visual attention, accuracy, memory, and visual memory
8	Variety games	Shape and background, recognizing sounds heard, drawing relevant codes, describing events of the day in detail, continuing second half of a story told by trainer	Enhancing attention, accuracy, visual and listening memories
9	Similarity game	Child must detect similar shapes in a collection	Enhancing attention and concentration
10	Maze	The child is given easy to hard mazes	Enhancing attention, and body members coordination
11	Post test	Connors post test	Determining efficacy of attentive games

has been described as a non-verbal reasoning test and as an indicator of mental development competence [30]. Scoring for each question is 0 or 1, with minimum overall score of 0 and maximum of 36 [31]. Reliability coefficient for two halves of the test for 6 to 14 year olds has been reported 0.46 to 0.92 [30], also the retest coefficients of the revised Raven test for 6.5 to 9.5 year old children with one-year interval were reported 0.6 and 0.8, indicating sensitivity to fluctuations in intellectual activity output in early childhood. In Iran, Rajabi reported retest reliability and convergent validity coefficients 0.62 and 0.41, respectively [32]. In the current study, to describe and analyze the data, SPSS-15 software was used.

Results

In the experiment group, the mean executive function score in the pre-test was 18.5, reducing to 11.1 in the post-test stage, which indicates a reduction in executive function problems in children. In the control group, the mean executive function score in the pre-test was 19.8, increasing to 21.9 in the post-test. The mean attention problem score in the experiment group in the pre-test stage was 27.3, reducing to 17.2 in the post-test stage, which indicates a reduction in attention problem in children. In the control group, the mean attention problem

Table 2 *mean and standard deviation of scores of executive functions and attention in children with learning disability*

	Group	Number	Pre-test		Post-test	
			Mean	Standard deviation	Mean	Standard deviation
Executive functions	Experiment	10	18.50	5.25	11.10	3.81
	Control	10	19.80	6.54	21.90	4.95
Attention difficulties	Experiment	10	27.30	6.56	17.20	6.54
	Control	10	25.10	8.02	25.90	5.70

Table 3 *Mancova analysis results in relation to the effect of attentive games on subscales of executive functions and attention of children*

Index source of change		Sum of squares	Degree of freedom	Mean squares	F	Significance	Level of effect	Statistical power
Pre-test	Problem solving-planning	87.020	1	87.020	40.51	0.01	0.71	1.00
	Behavior-emotion organizing	87.071	1	87.071	35.31	0.01	0.68	1.00
	Center of attention	8.582	1	8.582	30.84	0.01	0.25	0.99
	Sustained attention	24.11	1	24.11	23.16	0.01	0.29	0.99
	Displacement attention	26.066	1	26.066	19.09	0.01	0.59	0.98
	Divided attention	8.800	1	8.800	6.803	0.02	0.34	0.67
	Capacity attention	976/21	1	21.976	11.43	0.01	0.45	0.87
Post-test	Problem solving planning	132.79	1	132.79	61.82	0.01	0.079	1.00
	Behavior-emotion organization	103.56	1	1003.56	42.00	0.01	0.72	1.00
	Center of attention	1.258	1	1.258	4.522	0.05	0.77	0.50
	Sustained attention	5.678	1	5.678	5.454	0.03	0.64	0.58
	Displacement attention	1.655	1	1.655	1.21	0.29	0.08	0.17
	Divided attention	16.949	1	16.949	13.10	0.01	0.50	0.91
	Capacity attention	24.420	1	24.420	12.70	0.01	0.49	0.90

score in pre-test was 25.1, slightly increasing to 25.9 in the post-test stage.

As Table 3 shows, considering pre-test scores as auxiliary variables, the following results are found;

1. It can be seen that there is a significant difference in mean post-test scores in children problem solving/planning between the experiment and the control groups ($P<0.01$), which indicates that attentive games were effective in problem solving/planning in children with neuropsychological learning disabilities. Also, there is a significant difference in post-test scores in children behavior/emotion organization between the experiment and the control groups ($P<0.01$), and taking into account the squares, 72 to 79% of these changes are due to the effect of attentive games. The statistical power of 1.00 is indicative of adequacy of sample size.

2. There is a significant correlation between pre-test and post-test in terms of sustained attention $P<0.03$, divided attention ($P<0.01$), capacity of attention $P<0.01$, and center of attention $P<0.05$. Taking into account eta square, 49 to 77% of these changes were due to the effect of attentive games. Statistical power of 0.5 to 0.91 indicates adequacy of sample size. However, even after controlling the effect of pre-test, the difference in children's mean post-test scores between the two groups was significant ($P<0.05$). Thus hypotheses number 2 is confirmed.

Discussion

This study was conducted with the aim to assess efficacy of attentive games in executive functions and attentions of pre-school children with neuropsychological/developmental learning disabilities. The study hypothesis number 1 states that attentive games are effective on executive functions of pre-school children with neuropsychological learning disabilities. It can be seen in table 3 that there is a significant correlation between pre-test and post-test ($P<0.05$). These findings are explainable with study theoretical basis.

The results of the present study are consistent with studies by Marlow, Zalzo and Muller, Esther Horne, Fisher, Barclay, Smalish and Fletcher, Goldberg et al. Mars, Mc Lucky, Schwartz, and Sinni in relation to effectiveness of attentive games on executive functions in pre-school children with neuropsychological disabilities [16,17,18,19,20,21]. Also, Jensen, Christ, First et al. Yusoufi, Dan, Eisenberg, Clingberg, Mc Clintack have referred to the importance of playing in childhood, and research shows that playing is a tool for growth and development of neuron structures and a means for practicing skills required in future life [25,26,27,28].

To explain this, improvement in executive functions is largely associated with sensory experiences of the child. The child acquires sensory experience through various games during growth. Therefore, if the environment can be enriched for group and motor games, it will help children's executive function growth and development. In other words, these functions are a function of growth. Different situations arouse different reactions in children, for example, a child may not talk to his brother while doing his tasks at home, and inhibit himself, but it is not clear if he can do the same at school. About the 2nd hypothesis, attentive games are effective on attention of pre-school children with neuropsychological learning disabilities, according to the results in table 3, except for the attention displacement sub-scale, there was a significant correlation between pre-test and post-test in all sub-scales ($P<0.05$). This result is explainable with theoretical basis of the study.

Conclusion

It can also be inferred from the results of the study that executive functions and attention are abilities that children will require in future school learning [33,34]. Finally, it should be noted that even though pre-school children with neuropsychological learning disabilities are not yet faced with serious learning activities, and due to problems in attention and executive functions they often exhibit signs of academic failure, nonetheless, they still need to master a series of skills to tackle

their school tasks. These skills are executive functions/attention, language, motor-sensory functions, visual-spatial processing, memory and learning. These skills are acquired through experience, training and learning. Most children do these automatically, but children with learning disabilities have difficulty in learning these skills, and they must be trained. Thus, attentive games are able to improve foundation skills including attention and executive functions. Hence, in the cognitive development process, educational programs can have a significant share in orientating and adjusting attention, enhancing memory, and improving executive functions. Accordingly, attentive games can prevent future academic and social problems.

Study limitations included the following:

This study was merely conducted on 5 to 6 year old children, thus, care must be taken in generalizing its results to other age and academic groups. Also, a post hoc test was not used in this study, and due to pressing time, the control group was not tested. Thus, it is recommended that future studies also perform attentive games on other age groups and use post hoc test, as well.

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Contributions

Study design: SHGH, MM, AA

Data collection and analysis: SHGH, MM, AA

Manuscript preparation: SHGH, MM, AA

Conflict of interest

"The authors declare that they have no competing interests."

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