

The Effect of Cognitive–Oriented Video Games on Executive Functions of Preschool Children with Neuropsychological Learning Disabilities

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Abstract— During past decades, play has been a method used by numerous psychologists and researchers for treating a wide range of disorders and problems and they have confirmed its effectiveness. The current study aims to evaluate the effect of cognitive–oriented video games on executive functions of preschool children with neuropsychological learning disorder in Saveh. The type of experimental research plan was pretest–posttest with control group. The investigated society was all preschool children at Saveh during 2010–2015 educational year and among them, 20 children with neuropsychological learning disorder were selected using random, multistage cluster sampling method and considering the entering criteria to the research and categorized into two groups of test (10 people) and control (10 people). Intervention program were performed on test group for three months and twice per week (45 minutes). Demographic questionnaire, list of physical health assessment and biological characteristics of children, Raven colored progressive matrices of children, and Connors's questionnaire for assessment of neuropsychological learning disabilities were used for data collection in the current study. The results of covariance analysis test showed that cognitive–oriented video games are of positive effect on executive function of preschool children with neuropsychological learning disorder in problem solving/planning, behavioral/excitement organization components. Hence, it is necessary to utilize this method for treatment of learning disorders.

Index Terms— Educational Psychology, Preschool Children, Cognitive–Oriented Video Games, Executive Functions, Neuropsychological Learning Disabilities

1 INTRODUCTION

Learning is the major tool of human compatibility with its changing surrounding environment. If today children and adolescents, who are of complex and developed thoughts, cannot fairly learn, so they cannot fairly live [1–8]. Since evolution rate is not predictable during childhood, teachers are generally reluctant to attribute, absolutely and definitely, learning disabilities to preschool children who are seemingly to be disable for learning. They are preferred to address such children with unreasonable topics such as delay in evolution. Researches show that intervention for children is very effective and educational efforts are of high efficiency [9, 10].

The characteristics of preschool children with learning disabilities are including delay in motion evolution, language delay, speech disorders and cognitive evolution and conceptual weaknesses [11, 13, 15, 16, and 18]. Many researches have been shown that children with neuropsychological and developmental learning disabilities are weak in executive functions [11–21].

Executive functions are skills help the person to decide what type of activities or objectives should be considered, which of those should be selected and how organized and managed behaviors [22–29]. In other words, executive func-

tions are cognitive and meta–cognitive functions which perform a set of perfect abilities including self–regulating, encumbering, strategic planning, cognitive flexibility and impulse control. In fact, functions such as organization, decision making, active memory, motion encumbering, time felling and perception, future prediction, rebuilding, internal language and problem solving can be considered as the most important neuropsychological executive function which help to human in the life and performing the learning practices and intelligence action [30–35]. In general, executive functions have two major roles in behavior: (1) Using specific intellectual skills to select and achieve objectives, and (2) helping to progress in problem solving. These functions help to identify a picture of objective, route towards the objective and necessary resources in this route [36–43].

Some researchers have been shown that preschool children with learning disabilities are weakly performed in executive function and attention assessment tests compared to normal children. If such children have identified during the initial years of their life, before encountering with educational failure, it is possible to propose them a useful intervention [44–49]. Researches shown that educating the executive functions are effective on increasing the attention. Numerous researches have been studied one or some components of executive functions among children with learning disorders. For example, some scientists have been found that students with mathematics disorder are weaker than students without mathematics disorder in encumbering, decision making, planning and organization functions. Flexibility weakness or preservation is conversely related to mathematics ability [50, 51] and it can be

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predicted during preschool time because ability of preschool children in components of executive functions such as working memory, encumbering control and transforming ability can fairly predict their abilities in mathematics in the future [52-56].

Hence, regarding this issue, the necessity of utilizing intervention programs to eliminate or mitigate the problems of executive functions is identified. During past decades, play has been a method used by numerous psychologists and researchers for treating a wide range of disorders and problems and they have confirmed its effectiveness [57-60]. Video games are interesting for researchers. For such games, in the form of computer user, educational value and entertainment are taken into account. While computers in education plan are devices to transfer the issues that shall be learned in the future; however, the potential education power of video games may be emerged as increase in growing up some specific cognitive skills [60-66]. In this regard, cognitive-oriented video games are very important for supporting the attention of children. Investigations showed that there is a positive relationship between play and improvement of attention, planning skills and attitudes [67-69]. There are convergent creativity and thinking [70] and emotional-behavioral organization [71, 72] and play is necessary for progressing the basic cognitive skills [73-75].

Finding related to brain and learning by Jensen (2000), Christ (2001) and First et al. (2001) demonstrated the importance of play during childhood. Active brain makes very important neurological links for learning while inactive brain does not makes such sustainable and necessary neurological links. These researches show that play is a tool for growing up and developing neural structures and is a device for practicing necessary skills in the future life (after Isenberg and Kaisenberg, 2002).

Children may be able to learn something even when they are playing video games only for entertaining. This learning may be happened accidentally and through it, children may be learned specific skills; which may be useful in other fields of computer use. One of the designers of video games describe playing video games as a solving process in which, gamers not only learn how should be played, but also they learn how discover the principles of games and even find the designing deficiencies of games. In this manner, play brings child to higher levels of understanding and perception [76-80]. Children and adolescents have various reasons to play video games but three specific factors with special importance have been identified since the beginning: challenge, curiosity and imagination [81-85]. Application of these three reasons in designing the video games not only leads to be more entertaining, but also adds to their learning feature of them.

In a general categorization, video-computer games are grouped into enigmatic/play, adventuresome/ dramatic and player/competitive [84, 85]. Newman (2004) divided games into a number of groups including active and adventuresome, driving and race, shooting, enigmatic and basic, having impressing, strategic and simulated, sport and competitive.

Maybe from intuitive point of view, it can be argued that playing video games is an imaginal and involving and can be useful in life of children. Since these interacting games

can significantly attract the attention of child and regulate his/her motivation; i.e. mitigate it through deviating the attention of player from problem of real world or improve it in a very competitive game. Video games can equip children to encounter with the conditions of their surrounding world through simulation practices with higher safety. And finally, when child successfully ended the game, the confidence sensation increases [86, 87]

Alden et al. (2005), with emphasizing on this issue that students are currently used from technologies such as cellphone, using internet websites, online games, MP3 player and so on, concluded that the mentioned cases provide a new educational space for students by increasing the possibility of relations of students with others and this issue necessitates changing the traditional education system.

Simultaneously with previously mentioned necessities, some teachers of children and adolescents stated that it is expected that video games which encourage learning, peace, friendship, protecting environment and so on utilize as it is possible to use them as a help for achieving to educational and behavioral objectives [83, 88]. In addition to emphasizing on basic and vital role of teachers in the learning quality of students, Turvey (2006) stated the importance of computer and internet about this issue.

Birnbaum (2001) mentioned in his research report that technology brings an evolution to the modification of education methods for students who are of learning disability. The effects of technology can be seen in issues such as video games, using internet for compiled education programs and multimedia tools. Margalit et al. (1987) performed an investigation on the students of second and fourth classes who had learning disorder and studied the effect of video games on mitigation of their disorder. They mentioned that suitable video games are effective in relative improvement of learning disorder.

Chu (2003), with emphasizing on the effect of video games on increasing the self-efficiency feeling of users, pointed out that the performed studies are implied that utilizing computer, even for playing video games, leads to increasing the self-efficiency feeling of users and their satisfaction. Lopes-Morteo and Lopes (2007) performed an investigation about the effect of a video game on learning of mathematics in an entertaining and recreational and group manner on Mexican high school students. The results implied that playing the considered game is of positive effect on attitude of students about mathematics. In addition, researches showed that playing simulated games in a competitive condition reduces the stress level of students in mathematics [80-88].

Regarding the importance of knowledge about video games for improving their success and lack of researches in this field, it is necessary to perform more investigations about executive functions and the aim of the current study is evaluating the effect of cognitive-oriented video games on executive functions of preschool children with neuropsychological learning disorder [89, 90]. In this regard, the following research hypothesis was investigated:

(1) Cognitive-oriented video games are positively affecting the executive functions of preschool children with neuropsychological learning disorder.

(2) Cognitive-oriented video games are positively affect problem solving and planning of preschool children with neuropsychological learning disorder.

(3) Cognitive-oriented video games are positively affect behavioral-emotional organization of preschool children with neuropsychological learning disorder.

2 RESEARCH METHOD

2.1 Research Plan and Participants

The type of experimental research plan was pretest-posttest with control group. The investigated society was all preschool children at Saveh during 2010-2015 educational year and among them, 20 children with neuropsychological learning disorder were selected using random, multistage cluster sampling method and considering the entering criteria to the research (including (a) Having average intelligence and higher; (b) Without hearing and seeing shortcomings; (c) Without severe emotional and behavioral disorders; (d) Having physical health; (e) Having disorders inneuropsychological skills regarding the clinical assessments and marks of Canners's questionnaire) and categorized into two groups of test and control.

2.2 Research Tool

Four tools were used for data collection including:

(1) Researcher-developed demographic questionnaire for collecting general characteristics of children. This questionnaire contains questions such as sex, age, interested games and cognitive situation of children in the considered class which was completed by teachers.

(2) List of physical health assessment and biological characteristics of children. The list of physical health assessment and biological characteristics of children also was developed by researcher and completed by teacher regarding the health case of children to use in homogenizing the test and control groups and evaluating the criteria for entering to the research. These questions were about seeing, hearing, motion illness and disabilities and physical damages, lack of behavioral and emotional disorders and difference in performance of child with mates.

(3) Raven colored progressive matrices of children. This test was modified in 1956 by Raven. It is designed to evaluate argument ability of children between 5 and 11 years old and including 36 geometrical figures in three sets of A, B and AB. Marking is in the order of 0 and 1 and the lowest and highest possible marks are 0 and 36, respectively. Some researchers reported stability coefficient of two half of test for 6 to 14 years old as 0.46 to 0.92. In addition, Raven (1956) reported the repeatability coefficient of modified Raven test for 6.5 to 9.5 years old children as 0.6 and 0.8 for two consecutive years which indicates the sensitivity of test to fluctuations of mental activity output during initial years of childhood. Some scientists reported the internal stability coefficient of Raven test with 5000 participant between 0.89 and 0.97.

(4) Canners's questionnaire for assessment of neuropsychological learning disabilities. This test was constructed in 2004 in order to evaluate neuropsychological skills including attention, executive functions, memory, sensational-physical activi-

ties and seeing-spatial processing in four spectra (missed to sever) for children between 5 and 12. Some researchers were translated and normalized this test. The internal stability coefficients were reported with amplitude between 0.75 and 0.90 and repeatability stability coefficient with eight weeks interval was reported between 0.60 and 0.90. The validity of Canners's forms was obtained using factor analyses methods and differential validity of them were confirmed by statistical investigation of abilities of questionnaire in distinguishing between people suffered from hyperactivity-impulsiveness disorder and normal and other clinical groups. Some scientists evaluated the structural tolerance of this tool and reported the stability of this tool based on Cronbach method as 0.72.

2.3 Intervention Program

Intervention program of cognitive-oriented video games were performed on test group in 12 sessions of 45 minutes, individually on school's computers. In these 12 sessions, video games confirmed by National Video Games Foundation were used. For example, Tetris which is a puzzle type game and designed for improving the organization and compiling suitable models for designing was used. The main program of games is from cognitive games software which has been designed based on cognitive growing of preschool children and with various games.

2.4 Performing Method

To select the considered sample from five educational regions of the city, four schools were selected by multistage random cluster sampling method and among preschool students, 20 children with neuropsychological learning disorder were randomly categorized into two groups with 10 people which were homogeneous from intelligence abilities point of view; for data collection, Raven intelligence test and Canners's neuropsychological test were used. The considered sample was replicated by Raven intelligence test. The activity of cognitive-oriented video games was performed on each group as intervention program after satisfying the parents for three months and twice per week (45 minutes). In this research, 8 video games from game collection software including intellectual, tractability, speed operation, colors and figures, distinguishing between differences and intelligence and neuropsychological video games were used. These games were selected level by level and from simple to hard and then, were confirmed by academic experts and were operated in association with teachers in schools. Each of these games is including attention, problem solving, self-operating, encumbering, strategic planning, cognitive flexibility and impulse control.

3 RESULTS AND DISCUSSION

To analyze data, descriptive and inferential statistics were used and according to similarity of variances in Wilks's Lambda test and normality of data, parametric tests were used.

The average mark for problem solving/planning, behavior-

al/emotional organization and executive function in test group is reduced from 4.40, 5.40 and 2.90 for pretest to 3.20, 4.10 and 2.20 for posttest, respectively. It demonstrates the improvement of performance in tests group according to these scales.

After controlling the effect of pretest, the difference between average marks of posttest in two groups of test and control are meaningful ($P \leq 0.05$). Therefore, considering pretest marks as covariate (auxiliary) variable, it can be concluded that video games are positively affected mitigation of problems in executive functions scales (problem solving/planning, behavioral/emotional organization) and general executive functions of preschool children with learning disabilities. Considering the square root of etha and effectiveness of video games, it can be said that 59% of these variations is due to the effect of video games on problems of executive functions in test group.

Video games are involving a set of opportunities and threats. One of the most important opportunities is cognitive effects of video games. These games are initially used as a tool for progressing some researches in various motivational, motion and etc. fields and secondly, were used as a tool for diagnosing some psychological and physical disorders.

The general hypothesis of the current research about effect of video games on neuropsychological learning disorder is confirmed. It means that the difference between average neuropsychological learning disorder in test and control groups is meaningful. There is evidences show that children with learning disorder are of problems in executive functions. They are frequently disabled for using self-regulating strategies such as checking and correcting during a learning practice. In fact, students with learning disabilities are of problem in organizing the information. They are severely focused on details. These weaknesses are related to problem in executive functions which emerge in complex education practices that need to organizing and combining a high amount of students' information. The current findings are in agreement with the researches of Birunbaum (2001), Margalit et al. (1987), Chu (2003), Qwan and Yip (2006), Lopes-Moriato and Lopes (2007). Margalit et al. (1987) performed an investigation on the students of second and forth classes who had learning disorder and studied the effect of video games on mitigation of their disorder. They mentioned that suitable video games are effective in relative improvement of learning disorder.

It can be said that executive functions are abilities which are very important for learning process. Executive functions help child to evaluate him/herself and recognize and eliminate the obstacles of improvement and progress. Video games are education methods which can be effective in improving executive functions of people due to their high attraction and involving people, deeply, into the game. Video games give freedom to child to have independency in selecting considered faces for game, selecting color, type of clothes, considered graphic designs, necessary directions for motion in the game space, setting sound effects of game and selecting language. In addition, some performed studies indicated that dopamine enzyme increasing in the brain of children. Dopamine is one of the enzymes secreted between neural synapses and plays a role in transferring neural messages from the environment to neural

system and reverse. It shows that increasing the secretion of this neural transferring enzyme can be effective on learning, improve in behavior, attention, executive functions and combining sensational-physical information. Using tomography brain imagination shows that dopamine concentration is considerably increased during playing video games. This neural transferring agent can be led to emotion, happiness and motivation which are strongly affected learning in children.

One of the applications of these video games is developing cognitive and meta-cognitive skills of preschool children with cognitive disorders. Developing such skills can be a good predictive for increasing the abilities of such children in progression of education skills in the future. Equipping with abilities of executive functions can leads to independency in learning for students during elementary school.

4 CONCLUSION

Regarding the above mentioned researches and results, it seems that video games can be a new window towards developing the skills of children with learning disabilities in early interventions and can be effective on cognitive, behavioral and emotional skills of such children. Therefore, enrichment of the environment and preparing a foundation for video games may be led to improving and growing the executive functions of children. One of the most important findings of the current study is that such skills can be achieved through experiment, education and learning. Most children perform these skills automatically but children with learning disability did not easily learn such skills and hence, video games can improve their infrastructural skills. Further, it is suggested that the effect of video games can investigate in the future during preschool sessions as formal and informal education.

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