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The Effect of Computer-Aided Rehabilitation on Creativity and Computer Problem Solving

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Abstract

The present study aims at investigating the effect of computer-aided rehabilitation on creativity and computer problem solving of industrial design students at the Islamic Art University of Tabriz. A semi-experimental design with two groups of subjects, each consisted of 15 people, the research uses a computer-aided program along with London Tower Computer Tower and Abedi's Creativity Test. At first, an announcement was given in the industrial design faculty of Islamic Art University of Tabriz in 2016 to introduce the experiment and those students, willing to attend the experiment, submitted. Among the submitted, 30 students have been initially chosen in random, then to get divided again randomly in two groups with 15 members each. One is the subject group and the other, the control. Prior to taking the test itself, both groups have been given a creativity and problem solving pre-test. In the next 2 months, the subject group has been given rehabilitation, while the control group has not. After the mentioned time, both groups have taken a creativity and problem solving post-test and comparisons between the pre-test and post-test have been done afterwards. Data analysis has been performed by means of SPSS software program, version 21, based on multivariate covariance analysis, to show that the mean scores of pre-test and post-test of both subject and control groups have varied so significantly (P <0.01) that the computer-aided rehabilitation has improved in creativity and problem solving in the former. Considering the positive effects of this method on improvement of creativity and problem solving of industrial design students, the study shows that computer rehabilitation could be used as a method to achieve optimal performance among industrial design students.

Keyword

Computer-Aided Rehabilitation, Creativity, Problem Solving, Cognition, Industrial Design

Introduction

There are different approaches to explain how creativity is shaped. Torenss (1982) believes that human beings need to develop and use the power of creativity in order to survive. Human creativity is the most important weapon that can reduce or eliminate daily pressures. There are different perspectives on creativity and methods of its cultivation, with different schools of thought looking at it from one particular angle. One of these is the neurological approach, which expresses one of the latest views on creativity (Loosli et al., 2012). This school of thought examines the relationship between structured creativity and brain waves. Neurobiology is the newest field of science to deal with the role of both left and right hemispheres in the creation of creativity. Although some studies indicate the importance of the right brain hemisphere in creativity, others emphasize the integrated contribution of both hemispheres to this phenomenon (Robertson, 2001). Williams and Stekmir have presented a neurological model of the role of right and left hemispheres in development of creativity (Loosli et al., 2012), which requires both cognitive activities. There are researchers who believe that in creative thinking of the right hemisphere, the brain plays a key role and could have a negative effect as creative thinking and rational thinking cannot act simultaneously at the highest possible level (Robertson, 2001). Yet, if creativity is the product of congruent and divergent thinking, the role of both hemispheres must be recognized (Noyes & Garland, 2003). Some scholars, however, also believe that it is not possible to explicitly attribute learning abilities or insights and arguments to either left or right hemisphere. Neuroscientist Carl Peribram believes that if one day we can understand the brain's simple anatomy to be able to divide it in terms of the relationship between its parts and creativity, we would realize that the lateral parts of the brain rather than the right and left parts are involved in creativity (Robertson, 2001). Williams and Stekmir (1984) argue that the two hemispheres typically coincide. For example, when involved in a communication, the left hemisphere forms verbal information while the right one expresses the impact of the content. Together, both hemispheres enable us to understand the realities of the surrounding environment and act on them (Loosli et al., 2012).

Problem solving is the ability of creating a roadmap to achieve a goal or address a problem. It is defined as a skill for planning and organizing behavior along with determining the time and place of behavior in order to achieve goals and intentions (Loosli et al., 2012). Results from neurological studies have shown that the ability to solve a problem in complicated tasks such as London Tower and the Tower of Hanoi is indicative of the health of the prefrontal cortex's functioning. In order to solve an issue first, one must be aware of the nature of the problem, which begins by creating a subjective representation of the problem that helps finding its solution (Robertson, 2001). Furthermore, it is believed that such representations are based on the level of perceived personality of the problem itself, and are influenced by previous knowledge and experiences, making them dependent on the experiences recorded in the person's active memory. Problem solving is not only the application of previous rules, techniques, skills, and concepts learned in a new situation, but rather a process that creates new learning. When a learner is faced with an issue, he/she tries to find a solution by recalling his/her knowledge and experiences and in the process of his/her thinking, he/she examines a combination of his/her learned principles and skills that can match with new situations and solve his/her problem. Therefore, he/she not only solves the problem, but also learns new things (Noyes & Garland, 2003).

On the other hand, recent decades have seen an increased interest in the use of computers in the field of recognition, leading to the development of computer-based cognitive training programs that can adjust the assignment's level of difficulty, while simplifying the problem based on individual differences and creating persistent cognitive challenges for each individual (Gatian & Garolera, 2012). In fact, cognitive empowerment or cognitive training refers to teachings that are based on cognitive science, though in form of games — *generally computer games*— which try to improve or enhance cognitive functions e.g. accuracy, attention, perceptual process — *spatial perception*— hearing aids, types of memory — *especially work memory*— and other executive functions all of which refer to neuroplasticity, the brain's flexibility (Thorell et al., 2009).

Owen, Hamshir and Graham (2010) describe rehabilitation as a way of integrating cognitive neuroscience with information technology to enhance brain abilities in cognitive functions such as perception, attention, alertness, memory, etc. In addition to all of the above, many studies have shown that one problem of the students is their poor motivation to address and learn homework that could be solved with computer and train through computer games (Owen et al., 2010). There have been various training programs developed for this purpose. One example is Captain Log, a training software program, beneficial for improvement of brain skills and functions. It also contributes to development of a variety of cognitive skills, such as focus and accuracy, active memory, instant memory, short-term sight and audible memory, improvement of right and left hand alignment, sight processing, and speed of brain processes. Another program is IVA – 2, a continuous auditory-visual test which takes 30 minutes, as it analyzes two factors of *answer control* and *attention*. This test is applicable for people above six years of age. What is more, Brain Club program series help users rapidly improve their verbal thinking and processing skills like problem solving.

Beneficial for the improvement of these functions, the effectiveness of such skills has been confirmed in various researches. Through involving and applying a set of cognitive abilities, computer education and rehabilitation enhance such abilities of individuals (Gatian & Garolera, 2012). One way to use rehab is to utilize software and computer games to fit these abilities. Regarding the discussed issues, the present research seeks to answer the question as whether computer rehabilitation improves problem-solving performance among industrial design students of Islamic Art University of Tabriz.

Method

The present study was a semi-experimental design with two groups of subjects, wherein as many as 15 BA students of industrial design from industrial design faculty of Islamic Art University of Tabriz, aged 18 to 25, were randomly chosen as the subject group in 2016. Moreover, the study featured a control group, composed of the same number of students in the same field of study and at the same faculty and university who did not face any intervention whatsoever throughout the investigation.

Statistical Population and Sampling Method

In order to collect the data, once necessary permissions were obtained, in accordance with the call, as many as 30 industrial design students of Islamic Art University of Tabriz were selected and got randomly assigned to either the experimental and control groups, with the former receiving some intervention in form of eight computer-aided rehabilitation sessions of the researcher by the Institute for Cognitive and Behavioral Sciences of Sina, whereas the latter received none. Both Abedi Creativity Test and London Tower test were performed before and after the intervention as pretest and posttest for both groups.

Measurement Tools

1. *Computer-aided rehabilitation*

Here, computer-aided rehabilitation was provided to the experimental group through an educational software program, called Maghz-e-Man — *My Brain*— by the Institute for Cognitive and Behavioral Sciences of Sina. My Brain is an attractive computer-aided education program, which is designed like computer games. Featuring several games with different levels, this program is one of the best and most efficient computer-aided brain education programs (Aziziyan et al., 2017).

2. *Creativity test*

This tool has 60 items, specified on a three-tier continuum in Likert scale from zero to two. The reliability of Abedi's Creativity Test was obtained via a re-test in 1984 in four parts of the test, respectively: Fluid (0.85), Initial (0.82), Extension (0.80), and Flexibility (0.84). The numbers represent the validity, justifiability, and reliability of this experiment's tests. A validity higher than 0.69 is acceptable for these tests; therefore, the validity of this experiment's tests was approved (Pickering, 2006).

3. *London Tower Test*

One of the most widely used neuropsychological tests for determination of problem-solving ability and planning, this test is used to measure the optimal problem solving function as well as quick and efficient problem solving, not to mention the features of problem solving with the least needed moves. It has been used in several studies in Iran (Lezak, 2004). In the present experiment, this test's validity was reported to be 0.79, the procedure of which ran as below: To obtain the data after getting the design faculty's approval, a sum of 30 students were chosen randomly for the experiment. Afterwards, the procedure was explained to these subjects and moral satisfaction was received from them. The subjects were then divided into two groups: an experimental and a control group. Also, the subjects admitted that they had no other intervention. Finally, following the training intervention, the data taken from the experiment got analyzed by SPSS v.21 under inferential statistics methods, like multivariate covariance.

Data Analysis

The data, obtained from this study, were analyzed using descriptive statistics — *mean and standard deviation*— as well as inferential statistics, including multivariate covariance analysis via SPSS v. 21.

Results

This section analyzes the data, obtained from the implementation of the research project which was in accordance with the studied question, studied from two perspectives. Additionally, the studied variable is presented using the descriptive statistics method — *including mean and standard deviation*—. Then, based on the research question, the hypothesis process is carried out.

Table 1. *Mean and standard deviation of problem solving dimensions (London Tower Test) in pre-test and post-test for both experimental and control groups*

	Pre-test						Post-test					
	Experimental group			Control Group			Experimental group			Control Group		
Variables	The mean	Standard deviation	Total number	Total number	Total number	Total number	The mean	Standard deviation	Total number	The mean	Standard deviation	Total number
Problem Solving	30/86	3/18	15	30/60	3/77	15	37/20	2/83	15	30/60	3/52	15
Creativity	61/93	7/72	15	59/66	9/55	15	65/46	8/34	15	60/13	8/95	15

As indicated in the Table 1, the studied groups did not differ significantly in terms of the studied variables of the pre-test stage. This is because the mean and standard deviations of the groups were almost the same, yet in the post-test phase these quantities were more affected by the variance, causing the mean and standard deviations of the groups to change.

Before using the multivariable covariance analysis test for the variables, the homogeneity assumption of variance was investigated using Loon Test. Based on the results, homogeneity of variances was confirmed by both groups in the variables studied. This test was not meaningful for any of the variables.

As Table 2 shows, the significant levels of tests allowed the use of multivariate covariance analysis. These results indicate that there was a significant difference between two groups in terms of one of the dependent variables.

Table 2. *Multivariate covariance analysis for comparing experimental groups and creativity control and problem solving*

Source of dispersion	The dependent variable	Sum of squares	Degrees of freedom	Average squares	F	P
Problem solving		294/05	1	294/05	60/23	0/001
Creativity		127/97	1	127/97	4/45	0/046

According to Table 2, there was a significant difference between the two groups in creativity [P<0.046, F=4.45] and problem solving [F=60.23, P <0.001].

1. *Graphical Model*

As it is shown in Figure 1, the scores of subjects in creativity and problem solving post-test increased obviously in comparison with the pre-test, which means that rehabilitation of industrial design students raised their levels of problem solving and creativity.

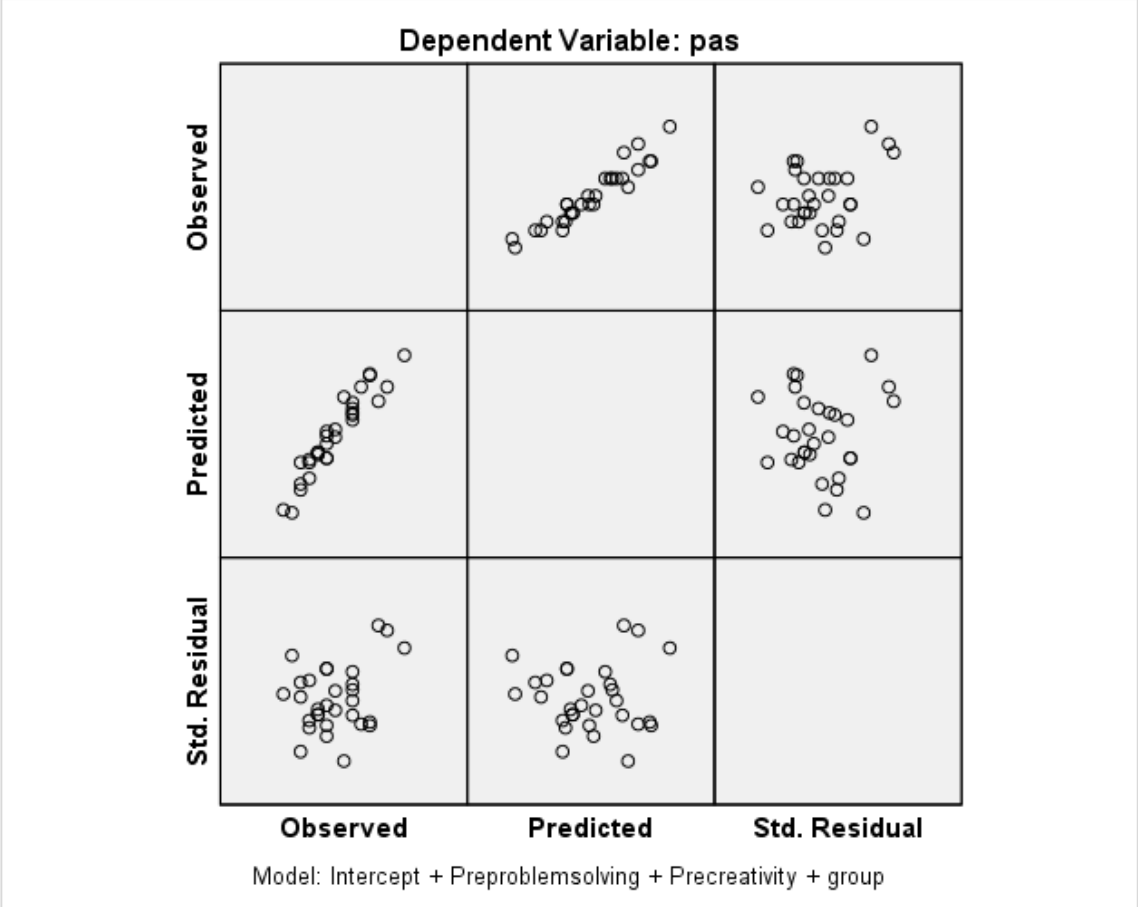

Figure1: *Graphical Model*

Discussion and Conclusion

The findings of this study proved that computer-aided rehabilitation improved creativity and computer problem solving function. In a parallel study, Ponce, Lopez and Meyer (2012) showed that learning in a computer-based environment was very effective in their study, which aimed at examining the effectiveness of computer programs for teaching comprehension strategies in Chile (Ponce et al., 2012). In their study, Loosli et al. (2011) concluded that a significant difference could occur in active memory performance and reading of the experimental group, only following a two-week active computer-based workload that focused on active memory, including animal pictures designed in both the processing/encoding and reminder stages (Loosli et al., 2012). Pickering and Chubb (2005) and Pickering (2006) also confirmed the impact of the use of technology and educational software programs on improvement of memory performance (Pickering & Chubb, 2005; Pickering, 2006); Kesler and Lacayo (2011) conducted a study, entitled Preliminary Study of the Online Cognitive Rehabilitation Program, wherein they dealt with executive performance skills. Results from this study showed that computer-aided cognitive rehabilitation program boosted the processing speed, cognitive flexibility and verbal and visual memory scores significantly, while playing an important role in the improvement of spinal cord cortex's activity as well.

One of the main theories of recent decades concerning computer-aided rehabilitation is the cognitive and neuropsychological theories that have contributed greatly to understandings of the mechanism of such type of teaching practices, providing a great deal of research data to support the theory of self-presentation. The most important assumption of cognitive approaches is that successful learners make sense of their past experience along with their intellectual processes about new information. They use processes or meta-cognitive functions to determine how new pieces of information are searched, perceived and linked to previously-stored data that have been selected and recalled. Based on this approach, what differs between a skilled and non-skilled learner is the inability of the learner to effectively and efficiently utilize executive processes (Buchan, 2009). On the whole and based on the hypothesis of brain ductility, it can be explained that the potential effects of this software are due to cognitive exercises and their repetition. Therefore, it is assumed that the same mechanism, underlying the process of experiencing plasticity, creates self-directed or guided improvements — *through rehabilitation*— (Bakker, 2006). Hence, well-designed cognitive training in the field of executive action can provide sustainable improvements in this field. From repeated and guided cognitive training - *such as cognitive rehabilitation*- the neurons responsible for such activities in the brain, undergo some structural and action changes that can be persistent and durable, given the hypothesis of human brain's self-healing (Casey, 2012). The present study did face some limitations, e.g. the scarce number of samples; therefore, generalized findings should be taken with caution. It is suggested that future studies about computer rehab programs ought to be used for other cognitive functions.

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