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Evaluation of the effectiveness of the cognitive empowerment program based on virtual reality technology on working memory for the elderly with mild cognitive impairment

Mahdieh Sasaninezhad[1], Alireza Moradi[2*], Mostafa Almasi-Dooghaee[3], Hamed Azarnoush[4]

1. PhD Student in Health Psychology, Kharazmi University, Tehran, Iran
2. Professor of Clinical Psychology, Department of Clinical Psychology, Kharazmi University, Institute for Cognitive Science Studies (ICSS) Tehran, Iran
3. Assistant Professor of Neurology, Department of Neurology, School of Medicine, Iran University of Medical Sciences, Tehran, Iran
4. Assistant Professor of Biomedical Engineering, Department of Biomedical Engineering, Amirkabir University, Tehran. Iran

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Corresponding author
Ali Reza Moradi, Professor of Clinical Psychology, Department of Clinical Psychology, Kharazmi University, Institute for Cognitive Science Studies (ICSS) Tehran, Iran

Email: Moradi@khu.ac.ir

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Abstract

Introduction: Mild Cognitive Impairment is one of the most common cognitive deficits in old age, including impaired working memory. The present study aims to evaluate a cognitive empowerment program using virtual reality technology to improve these people's visual and verbal working memory.

Methods: The present study belongs to quasi-experimental designs in terms of the data collection method. In this study, the experimental design of pre-test-post-test and follow-up with the control group has been used. In this study, 30 patients with mild cognitive impairment were randomly divided into control (n=15) and experimental (n=15) groups. Subscales of digit span and symbol span were performed in three stages: pre-test, post-test, and follow-up after one month to examine working memory. The intervention included a virtual reality-based program designed for ten sessions, three sessions per week.

Results: The repeated measures analysis of variance showed a significant difference between the experimental and control bands in digit and symbol span. There was a significant difference between the mean digit span in the pre-test stage with the two post-test and follow-up stages, as well as the two post-test and follow-up stages. The results also indicated that a significant effect was reported on the average of the symbol span over time. The mean symbol span in the pre-test stage was significantly different from the two post-test and follow-up stages. However, no significant difference was observed between the two stages of post-test and follow-up.

Conclusion: The results revealed that cognitive empowerment based on virtual reality technology could improve working memory, and the durability of the effect was observed in the follow-up one month later in the digit span.

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Extended Abstract

Introduction

Between 2015 and 2050, the proportion of the world's population over the age of 60 will almost double (from 12% to 22%). Aging is associated with changes in biological, physiological, psychological, behavioral, and social processes. Among these changes is a decrease in cognitive function. Mild cognitive impairment is one of the most common problems among the elderly. Undoubtedly, mild cognitive impairment refers to an intermediate stage of

cognitive impairment seen in average old age and early dementia. Mild cognitive impairment is often characterized by significant deficits in learning, attention, memory, executive function, processing speed, and semantic language. Behavioral research shows that adults with mild cognitive impairment have cognitive impairment in working memory, central executive function, and types of attention compared to healthy older adults. One of the most critical cognitive impairments in mild cognitive impairment is impaired working memory. Cognitive training and rehabilitation are the most widely used methods to improve and enhance cognitive functions. Advances in technology have led to the formation of computer cognitive training and virtual reality cognitive training that have provided more comprehensive, flexible, practical, and accessible interventions. The use of virtual reality for cognitive training with Pathological people is considered a creative innovation that uses computer software to effectively combine visual, auditory, and tactile feedback and recreate real-life environments. The present study designed and evaluated a cognitive empowerment program using virtual reality technology to improve working memory.

Methods

The present study belongs to quasi-experimental designs in terms of data collection method and applied and developmental designs in terms of purpose. It was performed on two experimental and control groups. The study's statistical population included patients with mild cognitive impairment who, in 2019 and the first half of 2020 referred to the Brain and Cognition Clinic and Firoozgar Hospital in Tehran. A neurologist diagnosed Mild Cognitive Impairment, and their disorder was confirmed by Addenbrooke's cognitive examination and MRI. Accordingly, 30 subjects were randomly divided into experimental (n=15) and control (n=15) groups. In this study, the intervention is based on virtual reality as an independent variable and working memory as a dependent variable. Subscales of digit span and symbol span of third and fourth editions of the Wechsler Memory Scale (WMS) have been used to examine working memory. In the executive phase of the research, after obtaining the consent of the participants, a pre-test was performed. After completing the initial evaluations, the administrative process of the intervention began, and the sessions were held for ten sessions, three sessions per week and each session for half an hour. At the end of the course, all participants performed cognitive assessments again. Also, follow-up period evaluations were performed in accordance with previous studies one month later. It should be noted that all assessments were performed in the pre-test, final, and follow-up stages by a senior expert in the field of cognitive rehabilitation, which had received the necessary training in performing assessments. Data analysis in this study was based on the pre-test, post-test, and follow-up scores. Based on this, the mean scores of digit span and symbol span expansions in three-time stages in two training and control groups were compared using repeated-measures analysis of variance. In order to check the test assumptions, the Shapiro-Wilk test was used to check the normality of data distribution, the Levene's test was used to check the homogeneity of variances, and Mauchly's test of sphericity was used to check the combined symmetry. Statistical methods of the present study were performed using SPSS-26 software.

Results

The average age of the research sample is 69.47±6.02, with a minimum of 61 and a maximum of 81 years old. The results of independent t-test revealed that there was no significant difference between the age of the experimental group (mean=69.87, standard deviation=7.16) and the control group (mean=69.07, standard deviation=4.85) (t=36, P=0.72). Table 1 shows the findings related to de-

mographic variables, including gender, job status, and level of education by experimental and control groups. The frequency of women and men is the same in both groups. The amount of chi-square obtained to compare the frequencies of the two groups in the three categories of job status is equal to 3.61, which is not statistically significant (P=0.17), so the groups in terms of job status are not significantly different from each other. Also, experimental and control groups did not have significant differences in terms of frequency in educational levels ($\chi2$=1.73, P=0.89). The results showed a significant difference between the experimental and control groups in the digit span. There is a significant difference between the mean digit span in the pre-test stage with the two stages of post-test (P<0.0005) and follow-up (P<0.0005) as well as the two stages of post-test and follow-up. In symbol span, the results of repeated measures analysis of variance show that over time, a significant effect was observed in the mean symbol span (F (2,56)=17.41, P<0.0005, η^2P=0.38). There was a significant difference between the experimental and control groups. There is a significant difference between the mean symbol span in the pre-test stage and the two post-test stages (P<0.001) and follow-up (P<0.0005). Nevertheless, the two stages of post-test and follow-up are not significantly different.

Conclusion

The results revealed that the designed program affected the working memory of the elderly with mild cognitive impairment. The scores of digit span showed significant differences among the three evaluations of the experimental group; in comparison, the scores of the control group in all three evaluations were relatively constant and did not differ significantly. The results regarding the symbol span also showed a significant difference between the experimental and control groups, and this difference between the pre-test and post-test of the experimental group is also significant, but there was no significant difference from the post-test stage to follow up.

Ethical Considerations

Compliance with ethical guidelines

This article is taken from a PhD Thesis. The present study observes ethical principles such as obtaining written consent to participate in the research, respecting the principle of confidentiality of participants (coding and deleting names from questionnaires), providing sufficient information on how to conduct research to all participants, and their freedom to exit the research process was done. This research was approved by the Ethics Committee of Kharazmi University with the ethics code ID IR.KHU.REC.1399.016 after review.

Authors' contributions

Mahdieh Sasani Nezhad: Presented the initial research, collected information, prepared the article's initial framework, and analyzed the data after collecting data. Alireza Moradi: Was responsible for correcting the article and supervising the research process, as well as part of the program content. Mostafa Almasi: Participated in the sample selection process, patient monitoring, and part of the program content. Hamed Azarnous: Collaborated in designing the virtual reality program.

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Conflict of interest

The authors of this article state that there is no conflict of interest in conducting this research.