ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 9(S1), DOI: 10.17485/ijst/2016/v9iS1/110278 December 2016* ISSN (Online) : 0974-5645

Effect of VR-based Driving Simulator Training on the Speed of Vision-motorand Physical Responses of the Elderly

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Abstract

Background/Objectives: Increase in the number of elderly drivers is causing social problems such as increase in the risk of traffic accident due to decline in their driving performance ability by senility. Thus, the purpose of this study was to investigate the effect of application of VR-based driving simulator on the speed of vision-motor-physical responses for safe driving of the elderly. **Methods/Statistical Analysis:** Subjects of the study were 11 elderly over the age of 65 who can respond to neuropsychological test tools. The tools used to test the speed of cognitive ability and vision-motor-physical responses were 1) Motor-free visual perception test (MVPT) 2) Reaction Time Test 3) Trail-Making Test A and 4) Trail-Making Test B. Simulated driving training was conducted by using VR-based driving simulator and, before and after the training, evaluations were performed on the speed of vision-motor-physical responses. **Findings:** As the result of performing the evaluation on the speed of vision-motor-physical responses on 11 elderly who received VR-based driving simulator training by using Motor-Free Visual Perception Test, Reaction-Time Test and Trail-Marking Test A and B, there were statistically significant differences (P.05). **Application/Improvements:** Simulated driving training using VR-based driving simulator enhanced the speed of vision-motor-physical responses required for driving performance. Therefore, VR-based driving simulator training can be effectively used as an intervention tool for safe driving of the elderly.

Keywords: Driving Simulator Training, Elderly,Response Speed

1. Introduction

Beyond a simple transportation means, driving in modern society is an important task which not only guarantees an individual's independence in local society but also enables him/her to participate in occupations he/she desire. With the development of medical technology, human life span has become longer and the number of the elderly population has also been increasing. According to a report of National Statistical Office in 2006, the elderly population over the age of 65 in Korea would reach 11.0% in 2010 and 20.8% in 2026 respectively, entering a super-aged society[2]. This not only means simple increase of the elderly population but also means that it becomes more necessary for them to secure mobility right to lead independent lives as their scope of social activities becomes wider. Hence, it is expected that the number of the elderly drivers will increase in the future as well. Physical, sensory and cognitive changes with normal aging affect safe driving of the elderly[4]. Cognitive functions required for the performance of safe driving are visual search and finding, spatial cognition, speed of visual treatment, visual memory, consistency of choice and concentration, decision-making, judgment of safety and problem-solving ability, planning, executing multiple tasks, task memory, goal-setting and prediction and speed of response[1]. Since a driver need to process over 90% of visual stimulation, speed of response to visual

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information and visual attention constitute important factors for safe driving[3]. Speed of visual response includes not only the speed of visionary response to treat complex stimulations but the speed of physical response required for executing actions. Visual, cognitive and physical changes caused by aging have negative effect on safe driving of the elderly. Narrowed vision, decline of concentration and decrease in response speed works as stumbling blocks which hinder their performance of safe driving. Decline of these abilities prevents the elderly from making proper responses, increasing higher risk of accidents[5].Programs to enhance driving ability are Useful Field of View (UFOV), Dynavision and VR-based driving simulator training. Among them, VR-based driving simulator training effectively enhances the speed of visual response through 3-dimensional visual stimulation[6]. Therefore, this study aimed to explore the effect ofVR-based driving simulator training on the speed of vision-motor-physical responses.

2. Method

2.1 Subjects of study

The subjects of this study were the elderly over the age of 65 who visited Driving Rehabilitation Center in B city. Before study began, the purpose and methods of the study were sufficiently explained to study subjects, all of whom signed on the letter of consent showing agreement to participate in this study.

2.2 Study Design

This study used AB design among individual experimental researches. 3 sessions of baseline A and 21 sessions of intervention B were conducted and interventions lasted 60 minutes per session and were conducted 3 times a week. In baseline A, evaluations on Motor-Free Visual Perception Test, Reaction-Time Test and Trail-Making Test A, B were performed without intervention. In interventions B, driving simulator training was applied by choosing a scenario at random. After completion of the intervention, reevaluations were performed on MVPT, Reaction Time Test and Trail-Making Test A, B.

2.3 Method of Analysis

This study was analyzed by using statistical program SPSS ver. 21.0. In order to minimize the problem of normality of the data caused by a small sample, this study utilized nonparametric test method for statistical analysis. Based on the result of pre- and post-test, Wilcoxon signed ranks test was performed. Significance level was set in .05 for all statistical analysis.

2.4 Evaluation Tools

Trail-Making Test A & B (TMT A&B) is a tool to measure processing speed, prioritization, mental flexibility and visual-motor skills[7]. Motor-Free Visual Perception Test is a non-motor test tool devised for the purpose of distinction, diagnosis and research and a standardized tool to evaluate overall performance ability of visual cognition for both children and adults[8]. Reaction-Time Test is a tool to measure the speed of body response to signals devised by Driving Rehabilitation Department of Rancho Los Amigos National Rehabilitation Center. VR-based driving simulator enables a driving trainee to actually drive on the road with scenarios linked with road conditions by attaching operation program and equipments to a simulating car.

3. Results

3.1 General Characteristics of Subjects

Subjects of the study were a total of 11 elderly including 9 males and 2 females. 6 subjects were in the age range of 65-69 and 5 were in the age range of 70-74.

Table 1. General characteristics of subjects

Characteristics		
Gender	Males	9(81.8%)
	Females	2(18.2%)
Age	65-69	6(54.5%)
	70-74	5(45.5%)

Table 2. Subjects' speed of vision-motorand physical responses

Vision-Motor and Physical Responses	Pre (M±SD)	Post (M±SD)	Wilcoxon signed rank
Reaction-Time Test	54.99±32.23	37.96±29.56	-2.934**
Trial-Marking Test A	42.33±20.88	32.95±13.46	-2.045*
Trial-Marking Test B	106.78±56.57	74.44±46.30	-2.667**
Motor-Free Visual Perception Test	5.43±1.80	4.49±1.73	-2.936**

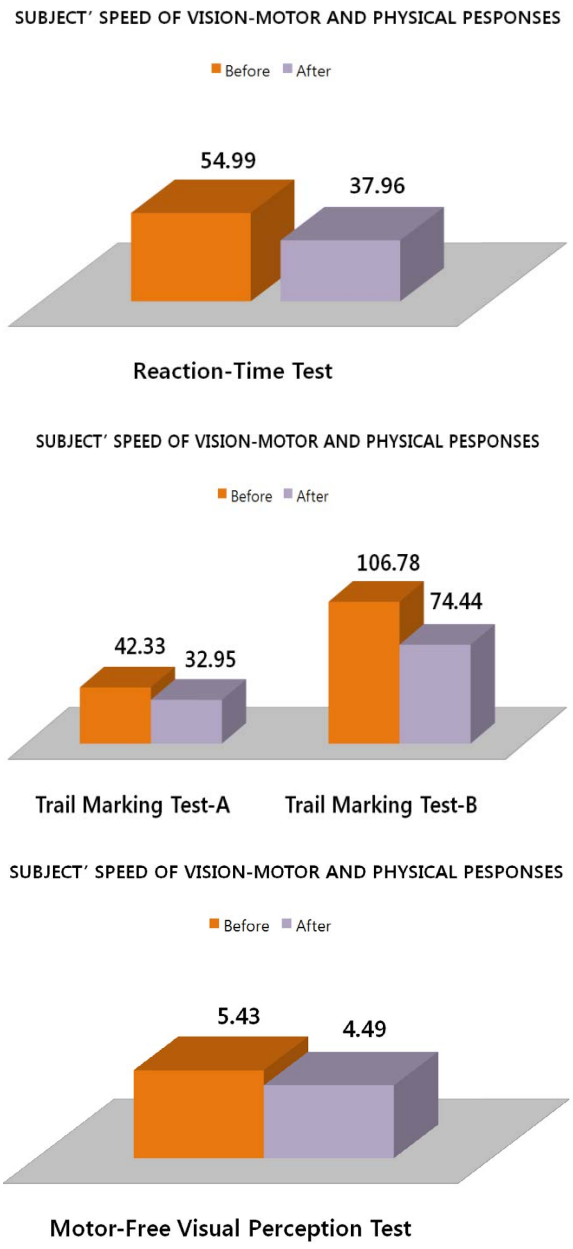

Figure 1.

Reaction-Time Test showed a significant difference between pre-training 54.99±32.23 and post-training 37.96±29.56 ($p<.05$). Trail-Marking Test A exhibited a significant difference between pre-training 42.33±20.88 and post-training 32.95±13.46 ($p<.05$). Trail-Marking Test B displayed a significant difference between pre-training 106.78±56.57 and post-training 32.95±13.46 ($p<.05$). Motor-Free Visual Perception Test demonstrated a significant difference between pre-training 5.43±1.80 and post-training 4.49±1.73 ($p<.05$).

4. Conclusion

The rate of elderly drivers participating in driving is increasing as population aging continues to rage on. Elderly drivers face difficulties in performing safe driving due to their decline in motor, visual, and cognitive functions[9]. The increase in elderly drivers has led to an increase in elderly traffic accidents, which have emerged as a national issue, and thus the timing necessitates an effective intervention for carrying out safe driving.

Driving intervention rehabilitation programs that target elderly drivers displaying decline in driving ability are divided into cognitive, educational, and physical programs[10]. Among these programs, training that makes use of actual vehicles to improve driving ability is the most adequate, but issues of safety or unexpected situations has increased the utilization of VR-based driving simulators that can be implemented indoors.

VR-based driving simulator training reflects the movement of the automobile and the perspective of the driver on the screen simultaneously so that the driver can train while adjusting the wheel, clutch, gas pedal, and transmission. The virtual environment is variously formed using rain, mist, night time, alleyways, highways, city streets, vehicles, and signals, so that it has the advantage of testing and training driving ability in various circumstances[11].

VR-based driving simulator training has been reported to improve many driving skills including visual attention and physical response speed, and Roenker's study reports that driving simulator training for the elderly improves their speed of stepping on the pedal, and that this was effective for improving their response speed[13]. Furthermore, driving simulator training for stroke patients was reported to improve their physical response speed and visual-motor processing speed[12].

The purpose of this study was to investigate the changes in Vision-Motor and Physical Responses by applying VR-based driving simulator to the elderly subjects. After the application of 1 session of baseline A and 21 sessions of intervention B by using AB design, study conducted post evaluation.

The Reaction-Time Test, Trail-Marking Test A and B, and Motor-Free Visual Perception Test were conducted in order to find out the visual-motor-physical response speeds of the subjects, and 31 sessions of training for three times a week were conducted using a VR-based driving simulator as an intervention for improving the

driving abilities of the subjects.

Score comparisons before and after the intervention show a significant difference in visual-motor-physical response speeds which proves that the VR-based driving simulator training is effective for improving elderly driving ability. The results correspond with previous research results which show driving simulator training for the elderly and stroke patients is effective for improving their response speeds and visual attention[12,13].

Consequently, VR-based driving simulator training is effective for improving visual-motor-physical responses which involve receiving and responding to visual information in terms of driving that requires the processing of complicated visual information, so the VR-based driving simulator is expected to be used as an effective intervention tool to enhance the speed of visual-motor-physical responses which may work as serious impediments to the safe driving of elderly drivers.

Therefore, a study capable of generalization by increasing the number of participants and by conducting follow-up research on the durability of the VR-based driving simulator training effect will be needed in future research.

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