Effects of Korean Computer-Based Cognitive Rehabilitation Program on the Memory in Healthy Elderly

The number of healthy older adults is rapidly increasing recently owing to the increase of the elderly population. Therefore, programs for improving the cognitive functions of these healthy seniors are actively being expanded. This study aimed to prevent the decline of cognitive function due to aging by applying a program enhancing cognitive functions to healthy older adults. The objective of this study was to evaluate the effects of Korean computer-based cognitive rehabilitation program (CoTras), which is commonly used in cognitive therapy for the aging, on the memory of the elderly. The subjects had scored at least 24 points in MMSE-K. CoTras was applied once a week (30 minutes) for one month. Electronic pegboard programs were used as an evaluation tool: order memory (difficulty=low) and location memory (difficulty=medium). The order and location memories were compared before and after the intervention. The Wilcoxon signed rank-sum test was used for the study at the significance level of α=.05. The results showed that CoTras significantly improved order memory and location memory. Therefore, CoTras can be applied to the healthy elderly for improving that memory improvement training has a positive impact on healthy older adults result in the development of memory enhancement programs can be expanded in the future.

Jung Sook Lee, Ph.Dᵃ, Prof., Sung Won Kim, Ph.D, Prof.ᵇ

ᵃDongju University College, Busan, ;ᵇDongnam Health University, Suwon, Republic of Korea

Address for correspondence
Sung Won Kim, PT, Ph.D
Department of Physical Therapy, Dongnam Health University, 50, Cheoncheon-ro 74, Jangan-gu, Suwon-si, Gyeonggi-do, korea
Tel : 82-31-249-6447
Email : johnswkim@dongnam.ac.kr

INTRODUCTION

The development of medical technologies has extended human life expectancy. As a result, the elderly population of the world's leading countries has abruptly increased. South Korea is aging quickly, at the fastest rate among OECD (Organization for Economic Co-operation and Development) countries, due to a low fertility rate and a longer mean life expectancy [1].

Statistics Korea [2] reported that the ratio of the elderly population in South Korea was 13.3% in 2016. It be 16.4 and 24.5% in 2020 and 2030, respectively. It was projected that South Korea will would enter a post-aged-society or a super-aged-society soon. As South Korea is close to becoming a super-aged-society, brain diseases such as dementia, Parkinson's

disease, and strokes are continuously increasing in South Korea [3]. Notably, it is known that 20-30% of seniors over 85 years of age have Alzheimer's disease [4]. Such degenerative diseases of the central nervous system, or cerebrovascular diseases, increase in proportion to age and they are expensive diseases to treat [5]. Therefore, it is essential to do physical activities (e.g., exercise) and take preventative actions to maintain cognitive functions in order to save on national medical costs and prevent degenerative diseases.

The elderly generally experience decreases in senses such as sight, hearing, and touch. This sensory decline negative affects the cognitive functions of the elderly. The CoTras used in this study stimulates a subject visually and auditorily. Sensory stimuli reminiscence [6] and environmental approaches using

multisensory stimulation stimuli [7] have been applied to elderly with dementia. Many researchers have tried various types of cognitive training such as the transfer of training approach on cognitive function [8] (e.g., stick pinning, puzzle, and maze) and music therapy [9]. Rehacom consists of realistic tasks that encompass seven areas (i.e., attention and concentration, memory, competence, executive function, spatial imagination, visual impairment, and visual motion coordination). Shon [10] conducted graded attention training using Rehacom for the elderly with mild dementia and showed that the training improved attention, memory, and daily life performance of the subjects.

Korean CoTras has two advantages. First, the number of training stimuli, complexity, and speed can be adjusted according to the patient's condition. Moreover, it is possible to train the weakened part of a patient's brain in a planned and repetitive manner. The program was developed to maximize these advantages. This study aimed to evaluate the effects of CoTras on the memory of healthy older adults (≥65 years old) and its ability to improve and preserve their cognitive abilities. This study applied CoTras once a week (30 minutes) for one month.

METHODS

This study evaluated the changes in the memory of healthy older adults (≥65 years old) after applying CoTras to them once a week (30 minutes) for one month.

In order to make sure that study subjects had a normal cognitive status, this study used subjects that had scored at least 24 points on the Korean Mini-Mental State Examination (MMSE-K). In the case of brain injury patients, it can be applied twice a week for one month (8 times). However, this study applied it only once a week because it would be still useful for healthy people. However, future studies may need to consider more frequent training sessions.

Subjects

The subjects of this study were ten older adults (≥65 years old) who attended the DJ Silver Center in Pusan City, who had no brain injury, and who scored at least 24 points (normal range) on MMSE-K. The study subjects fully understood objective and study methods and consented to participate in the study before starting the study. The study had ten subjects,

and all subjects were females. The subjects were either in the 60s (7people; 70%) or the 70s (3 people: 30%). All subjects were unemployed. Before the experiment, the objective of this study was explained the staff of the institution and to the study subjects. The subjects consented to participate in the study in written and verbal form to meet the research ethics requirements.

Design and Procedure

CoTras (NubBlue, Daegu, Republic of Korea) was developed by Prof. Yong Geun Kim. CoTras is and was named after "co" of cognition, "tra" of training, and "s" of systems. The program is developed to have five areas: visual perception training, attention training, memory training, orientation training, and others (number and volume, categorization, and ordering). The visual perception training is composed of object recognition, object constancy, landscape-background, face recognition, visual discrimination, visual integration, and spatial perception. Attention training consists of focus attention, conversion attention, simultaneous attention, and selective attention (sight and hearing). Memory training consists of memory width, shape memory, location memory, plan memory, procedural memory, and story memory. Orientating training is composed of personal, temporal, and spatial orientation according to the characteristics. Among these, the first levels of location memory, shape memory, and detailed item were selected and used for the training. These elderly subjects took MMSE-K before participating in this study, and they had scored at least 24 points on the test.

Their memory was tested using the location memory and the ordered memory tests on an electronic pegboard (Rapael Smart Pegboard). The difficulty of the location memory test was 'low' and one level was conducted. The difficulty of the order memory test was 'medium' and one level was conducted. The study was conducted from Oct 1 to Oct 31, 2018, and one session (30 minutes) was given per week for one month.

Training Tool

CoTras

The procedure of the program is as follows. When the program is started, the necessary information of a patient can be entered on the first main page. The accuracy and response time, which are performance indicators, can be confirmed. In order to regulate the

implementation method and difficulty for each detailed content, each sub–content was clicked, and the method and difficulty were adjusted according to the capability of a subject by a user [11]. When a training session begins, an instruction is presented on the screen, and '+' sign appears on the screen to call the attention of a patient. Afterward, a question is given to the patient. When the patient clicks the correct answer, it gives a feedback (○ or ×) with an auditory stimulus [11].

Moreover, CoTras can provide an individualized training program by adjusting the number of training stimuli, complexity, and speed according to a patient's condition. CoTras also can train a weakened part of a patient's brain in a planned and repetitive manner. It is noteworthy that CoTras can maximize these advantages. This study selected the memory portion from the various CoTras programs. This study applied one level of the location memory test and one level of the order memory test.

Evaluation Tool: Electronic Pegboard

Ten selected sophomore college students evaluated the occupational therapy under the supervision of one professor. Students were trained on how to use the training tool and evaluation tool before carrying out the evaluation.

Memory Evaluation

The electronic pegboard (Rapael Smart Pegboard) is electronic, unlike the pegboards commonly used in occupational therapy rooms. The location memory program turns a light on and off at 15 specific locations. A subject is asked to remember the locations and puts 15 pegs in the locations. The number of successful placements is recorded. The order memory program turns on lights in a specific order. After the lights are off, the subject is asked to put 25 pegs in the same order. The number of successful placements is recorded. Since it can quantify and analyze the number of successes for the location test and the order test, it is a tool that can objectively evaluate the memory of a subject.

Data Analysis

This study applied CoTras to ten healthy older adults, who had scored at least 27 points in MMSE–K, to evaluate the program's effects on their memory using an electronic pegboard (Rapael Smart Pegboard).

All data collected from this study were coded and analyzed using a statistics program (SPSS 18.0 K/PC). Wilcoxon signed rank test was used to evaluate the effects of CoTras on the memory of the elderly. The statistical significance was determined at $\alpha = .05$, unless stated otherwise.

RESULTS

Changes in Location and Order Memory using Electronic Pegboard (Rapael Smart Pegboard)

The effects of CoTras on the memory of the elderly were evaluated using an electronic pegboard (Rapael Smart Pegboard). The number of successful pegs significantly ($p < .01$) increased on the location memory test (Table 1). Moreover, it significantly ($p < .01$) increased on the order test (Table 2).

Table 1. Comparison between pre–intervention and post–intervention on the location memory (N=10)

	Location Memory		p
	Pre (M±SD)	Post (M±SD)	
Electronic Pegboard	13.10±1.20	14.70±.48	.006**

Mean±SD, **p<.01

Table 2. Comparison between pre–intervention and post–intervention on the order memory (N=10)

	Order Memory		p
	Pre (M±SD)	Post (M±SD)	
Electronic Pegboard	20.80±3.56	23.50±2.46	.007**

Mean±SD, **p<.01

DISCUSSION

This study was conducted by applying CoTras, which is one of computer–based cognitive rehabilitation (CBCR) programs in order to enhance the memory of healthy older adults. The results of this study showed that CoTras was effective in improving their memory.

The results concurred with the results of Park [12], who showed that the cognition–exercise treatment group (three times per week for 12weeks) had significantly higher cognitive functions than the exercise only group (three times per week for 12weeks).

Moreover, when the concentration was evaluated after applying CoTras and traditional cognitive rehabilitation to adult with intellectual disabilities, it was found that the concentration of both groups improved, however, the concentration levels of the two groups were not significantly different. However, it was revealed that CoTras was useful in that it could set an appropriate age, provide immediate feedback, and offer diverse programs. Additionally, the results of this study agreed with the previous studies evaluating the effects of CoTras on individuals with stroke [13, 14], brain damage [15], and developmental disability [16, 17]. Moreover, the results concurred with the results of Lee [18], who evaluated the effects of computerized cognitive training programs (ComCog) on the attention and memory abilities of children with the tendency of ADHD, who found that ComCog significantly improved their attention and memory abilities. Additionally, the results of this study agreed with the results of Kim [19], who evaluated the effects of CoTras on the visual perception of patients with brain injury, and those of Shon et al. [10], who applied a graded attention training to older adults with mild dementia according to the cognitive level of the subject (four times per week (15 minutes each) for four weeks (n=16) using RehaCom (a computer−based cognitive therapy).

Recently, the number of older adults with normal cognitive abilities has increased, and their quality of life is increasing as well. However, there are not many studies on the cognitive abilities of healthy older adults. We hope that the results of this study will enhance the memory ability of healthy older adults and promote the development of memory enhancement programs for healthy older adults.

CONCLUSION

The objective of this study was to evaluate the effects of CoTras on the memory of older adults (≥65 years old) with normal cognitive abilities (n=10). CoTras was applied to the subjects once a week (30 minutes) for one month. The results of this study showed that CoTras was effective in increasing a subject's ability to memorize order and location. Therefore, it is recommended to apply CoTras to healthy older adults for enhancing their memory abilities. Moreover, it will be necessary to develop diverse cognitive programs for patients with cognitive

disorders. However, since this study could only evaluate two specific domains (order and location memorization), future studies are needed to evaluate the effects in more diverse domains to prove its therapeutic efficacy more accurately.

ACKNOWLEDGEMENTS

REFERENCES

1. Korea Development Institute. A study on measuring and managing longevity risk. 2015; 78.
2. Statistics Korea. Statistics of the elderly. 2016.
3. Ministry of Health and Welfare. Statistics of dementia prevalence. http://www.mohw.go.kr/react/al/sal0. 2012.
4. Lobo A, Launer LJ, Fratiglioni L, et al. Prevalence of demential and major subtypes in Europe: a collaborative study of populaton−based cohorts. Neurologic diseases in the elderly research group. Neurology 2000; 54911 Suppl 5: 4−9.
5. Hotting K, Roder B. Beneficial effects of physical exercise on neuroplasticity and cognition. Neurosci Biobehav Rev 2013; 37(9 Pt B): 2243−2257.
6. Namazi KH, Haynes SR. Sensory stimuli reminiscence for patients with Alzheimer's disease: Relevance and implications. Clin Gerontol 1994; 14(4): 29−46.
7. Klages K, Zecevic A, Orange JB, et al. Potential of snoezelen room multisensory stimulation to improve balance in individuals with dementia: a feasibility randomized controlled trial. Clin Rehabil 2011; 25(3): 1−10.
8. Baik JY. The effect of transfer of training approach on cognitive function and functional recovery of stroke patients with cerebral infarction and intracerebral hemorrhage. Journal of Korean Society of Occupational Therapy 2001; 9(1): 11−24.
9. Giovagnoli AR, Oliveri S, Schifano L, et al. Active music therapy improves cognition and behaviour in chronic vascular encephalopathy: A case report. Complement Ther Med 2014; 22(1): 57−62.

10. Shon JH, Park SY, Kim JK. Enhancing activity daily living and memory of older adults with mild dementia through a graded attention training. The Journal of Occupational Therapy for the Aged and Dementia 2013; 7(1): 1–14.

11. Kim YG, Development of a Korean computer–based cognitive rehabilitation program (CoTras) for patients with cognitive disabilities and the validation of its effects, Unpublished doctoral dissertation Pusan National University. 2011.

12. Park JD, The Effectis of Cognition Exercise Program Participation on the Elderly Cognitive Function. Unpublished master's dissertation Ulsan University. 2017.

13. Kim YG. The effects of Korean computer–based cognitive rehabilitation program (CoTras) for the cognition and ADL in stroke. Journal of Korean Society of Occupational Therapy 2011; 19(3): 75–87.

14. Cho AY, Kim JM. The effects of computer–based cognitive rehabilitation program (CoTras) for visual perception and ADL in stroke. The Journal of Korean Society of Community Based Occupational Therapy 2012; 2(1): 49–63.

15. Park SW, Bak IH, You SJ. The effects of Korean computer–based cognitive rehabilitation program (CoTras) for the cognition and visual perception and ADL in brain injury. Society of Occupational Therapy for the Aged and Dementia 2013; 7(2): 47–57.

16. Kim YG. Development of a korean computer–based cognitive rehabilitation program (CoTras) for patients with cognitive disabilities and the validation of Its effects. Unpublished doctoral dissertation Pusan National University. 2011.

17. Park SW. The effects of the computer–based cognitive rehabilitation program on visual per–ception, cognition, and activities of daily living for School–Aged children with developmental dis–abilities. Unpublished doctoral dissertation Daegu University. 2014.

18. Lee KH. Effects of a computerized cognitive training programs attention abilities and memory abilities of children with tendency of ADHD. Korea Society for the Emotional and Behavioral Disorders 2012; 28(4): 91–108.

19. Kim YG. The effect on computer–based cognitive rehabilitation program (CoTras) for the visual perception in brain injury. J Rehabili Res. 2012; 16(3): 401–419.