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Effects of a Memory and Visual-Motor Integration Program for Older Adults Based on Self-Efficacy Theory

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Purpose: This study was conducted to verify the effects of a memory and visual-motor integration program for older adults based on self-efficacy theory. **Methods:** A non-equivalent control group pretest-posttest design was implemented in this quasi-experimental study. The participants were 62 older adults from senior centers and older adult welfare facilities in D and G city (Experimental group=30, Control group=32). The experimental group took part in a 12-session memory and visual-motor integration program over 6 weeks. Data regarding memory self-efficacy, memory, visual-motor integration, and depression were collected from July to October of 2014 and analyzed with independent t-test and Mann-Whitney U test using PASW Statistics (SPSS) 18.0 to determine the effects of the interventions. **Results:** Memory self-efficacy ($t=2.20$, $p=.031$), memory ($Z=-2.92$, $p=.004$), and visual-motor integration ($Z=-2.49$, $p=.013$) increased significantly in the experimental group as compared to the control group. However, depression ($Z=-0.90$, $p=.367$) did not decrease significantly. **Conclusion:** This program is effective for increasing memory, visual-motor integration, and memory self-efficacy in older adults. Therefore, it can be used to improve cognition and prevent dementia in older adults.

Key words: Aged; Depression; Memory; Psychomotor performance; Self-efficacy

INTRODUCTION

1. Background

Owing to the rapid aging of society, there is an increasing interest in reduced cognitive function in older adults. Cognition refers to high-level brain functioning that involves the recognition, distinction, and resolution of a variety of external stimuli. Cognitive function consists of memory, visual-motor integration, judgment, execution, attention, orientation, language skills, and so on. Memory, the ability to restore and recall information such as words, faces, and events [1], and visual-motor integration, the ability to integrate physical movement with sensory information from visual perception [2], are most susceptible to changes at the early stage of cognitive decline [3,4]. Decline in memory and visual-motor integration causes various problems in performing almost all activities of daily living, such as saying words and names in conversation, remembering a phone number or a promise, finding things, writing and drawing, or changing positions. Older adults experiencing these problems fear the loss of cognitive function, perceive it as a serious health threat, and seek ways to slow or prevent the decline [5]. However, memory skills continuously decrease with age [6], leading older adults to lose self-confidence in their memory [7], which can finally lead to depression and may affect their quality of life [8].

Memory training is the most common and traditional approach for improving the cognitive function of older adults. Traditional

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memory training consists of and focuses only on teaching specific memory strategies for the effective encoding, consolidation, and retrieval, according to the information processing perspective. However, such interventions do not deal with the other influencing factors related to the memory of older adults. Among them, memory belief is the most feasible aspect for memory interventions [5]. Memory self-efficacy is one's self-efficacy beliefs pertaining to memory performances [9]. Self-efficacy is the belief in one's own ability to successfully accomplish something. It is a theory by itself, but it is also a construct of social cognitive theory. According to self-efficacy theory, verbal persuasion, mastery experiences, vicarious experiences, and somatic and emotional states affect our self-efficacy and, therefore, our behavior [10]. High self-efficacy motivates individuals to perform a desirable behavior and to increase efforts to achieve the expectations [11]. Actually, memory self-efficacy modulates brain activities during intentional encoding for memory executives. People with high memory self-efficacy seem to be more actively engaged [12], more efficiently conduct memory performance by relying on their memory executives [13], and perform better on memory tasks [12]. However, older adults tend to underestimate their memory and have lower memory self-efficacy owing to the memory decline they experience in their everyday affairs [7]. Low memory self-efficacy further decreases memory performance [12]. If specific training strategies based on self-efficacy theory are thoroughly integrated into a program [6], memory performance in even older adults can be improved by increasing memory self-efficacy [12].

Depression is another considerable aspect of memory programs for older adults. Because depressive older adults have more trouble engaging in a program owing to the emotional distress or exhaustion they experience, they rarely complete the program, which can influence its effectiveness [14]. Previous studies have demonstrated the necessity of affectional approaches in memory programs for older adults based on the results that depression is negatively related to memory [15] and self-efficacy in older adults [8,15]. Multifactorial programs that include aspects related to older adults' memory, such as self-efficacy, can improve not only cognition but also depression [16]. Further, alleviation of depression by itself increases self-efficacy and makes them engage in more positive behaviors [8].

Visual-motor integration as well as memory is essential to promote the cognitive function of older adults. Visual-motor integration is particularly necessary for maintaining an optimal quality of life because it coordinates and executes physical activities along with visual perception and commands from the central nervous system for daily living activities such as eating, walking, and writing [4]. The concept of visual-motor integration was originally developed to distinguish learning difficulties in children's cognitive development and to improve their academic achievement and adaptation in school. It has been applied in recent studies to detect and ascertain cognitive decline in older adults [4,17] because those with cognitive decline frequently show a decline in visual-motor integration at the initial stage [3,4]. For intact visual-motor integration, various and extended brain areas must be used to recognize visual stimuli and to plan and execute movements. The occipital, parietal, and temporal lobes help to distinguish and recognize visual stimuli; the frontal lobe facilitates the integration of sensory information and planning of appropriate acts; and the basal nuclei and cerebellum modulate muscle movements [1]. This means that visual-motor integration training can stimulate all brain regions to improve neuroplasticity, and thus improve performance on daily living activities. Therefore, visual-motor integration training can be one of the most effective methods to enhance the cognitive functioning of older adults and it is important to examine the effectiveness of including visual-motor integration in intervention for preventing cognitive decline in older adults.

To sum up, memory and visual-motor integration training can be the most efficient and necessary approach to stimulate neuroplasticity in older adults. In addition, memory self-efficacy is a crucial element to improve memory [12] and alleviate depression in older adults [8]. Although several previous studies [6,12,18] demonstrate the effect of memory training based on self-efficacy, they focus only on memory training. However, evidence [14,19] shows that no significant effect on memory also exists. Furthermore, no previous study has verified the effect of visual-motor integration training in older adults, though it is one of the most sensitive areas that demand prompt intervention. Therefore, it is important to demonstrate whether a memory and visual-motor integration program based on self-efficacy theory is effective for memory self-efficacy, memory, visual-motor integration, and

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depression in older adults. The present study is the first trial to integrate self-efficacy theory into traditional memory training and to include visual-motor integration training. In this context, this study was planned to test the effects of a memory and visual-motor integration program based on self-efficacy as a new and efficient method for increasing cognitive function in older adults.

2. Purpose

The purpose of this study was to test the effects of a memory and visual-motor integration program based on self-efficacy theory on older adults' memory self-efficacy, memory, visual-motor integration, and depression.

3. Hypotheses

Hypothesis 1. Memory self-efficacy will significantly increase in the experimental group members who participate in a memory and visual-motor integration program based on self-efficacy theory for older adults, as compared with that in the control group members.

Hypothesis 2. Memory will significantly increase in the experimental group members as compared with that in the control group members.

Hypothesis 3. Visual-motor integration will significantly increase in the experimental group members as compared with that in the control group members.

Hypothesis 4. Depression will significantly decrease in the experimental group members as compared with that in the control group members.

METHODS

1. Design

A non-equivalent control group pre-test-post-test quasi-experimental design was implemented to verify the effects of a memory and visual-motor integration program based on the self-efficacy for older adults.

2. Participants

The number of participants was calculated using the G-power 3.1.7 program with the following conditions: a significance level of α at .05, a power of .80, and an effect size of 0.73 in an independent t-test. The effect size was verified by the study on memory training for older adults by Verhaeghen et al. [20]. In the present study, the number of participants calculated for each group was 31. Considering the dropout rate of 13% observed in the study by Han et al. [21] that included a group cognitive enhancement program for older adults, 35 participants were recruited in each group.

The inclusion criteria were being aged 65 years or older, not being diagnosed with cognitive impairment or dementia, being able to function independently in daily life without difficulty, and being able to understand and follow the program without communication difficulties resulting from visual and hearing problems. The exclusion criteria were having a severe disease requiring chemotherapy or radiation therapy and having received a diagnosis of a mental disorder or taking medication for severe depression, schizophrenia, or other psychiatric problems.

To recruit participants for this study, the researcher visited senior centers and elderly welfare facilities located in D or G city, Korea, and explained the study purpose and procedures to the manager and facility users. The researcher and five research assistants assessed whether the applicants who wished to participate in this study met the inclusion and exclusion criteria, and they implemented the Mini Mental State Examination in the Korean version of the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) assessment packet (MMSE-KC). The MMSE-KC score was considered to indicate cognitive impairment when the participant fell below the 5th percentile in the norm table categorized by age, gender, and educational level [22]. Based on these findings, the final participants for this study were selected.

3. Instruments

1) Memory self-efficacy

Memory self-efficacy was assessed using the Memory Self Efficacy Questionnaire (MSEQ), which Kim [18] corrected and adapted from the MSEQ developed by Berry et al. [9], considering the characteristics of older adults in Korea. The MSEQ consists of 10 questions rated from 0 to 100 points. Thus, the total score ranges between 0 and 1000 points, and higher scores signify stronger beliefs in respondents' own ability to use their memory efficiently. The Cronbach's alpha coefficient was .88 in the study by Kim [18] and .88 in the present study.

2) Memory

Memory was measured using the Verbal Learning Test (K-VLT) developed by Woo et al. [22] in the Korean version of the CERAD packet. It comprises immediate memory, recall, and recognition tests using a 10-word list. In the memory test, participants look at and repeat a 10-item word list at a constant speed and then state the words that they can remember. Correct responses are assigned 1 point. These processes are repeated three times, and total scores range between 0 and 30 points. A recall test is performed 5 minutes after the memory test; 1 point is awarded for each correct response, and total scores are between 0 and 10 points. In the recognition test, a new 10-word list is added to the previous list, and 1 point is awarded whenever participants distinguish correctly between the previous and new lists. The score is obtained by subtracting 10 points from the total score, treating negative points as 0, resulting in a total score between 0 and 10 points. The total score for the memory test is between 0 and 50 points, obtained from the sum of the immediate memory, recall, and recognition subtest scores. Higher scores indicate better memory ability. The test-retest reliabilities were .65, .65, and .74, respectively, for the immediate memory, recall, and recognition subtests in the study by Woo et al. [22]. The test-retest reliabilities were .63, .58, and .65, respectively, for the immediate memory, recall, and recognition subtests, and the Cronbach's alpha coefficient was .76 in the present study.

3) Visual-motor integration

Visual-motor integration was measured with the Visual-Motor Integration-6R (VMI-6R) developed by Beery and Beery [23]. The instructions of the VMI-6R were translated into Korean by the researcher, and they were confirmed by two nursing professors. The VMI-6R consists of 30 questions. Items 1 to 6 are marking and scribbling questions for children, and items 7 to 30 are drawing questions for all ages. For the drawing questions, 3 questions are presented per page in the upper column, and participants are asked to draw matching shapes in the lower empty column. For adults, the VMI-6R starts from item 7, and items 1 to 6 are credited if item 7 is answered correctly. Participants' drawings are graded as 0 or 1. If there are 3 consecutive scores of 0, scoring is stopped, and a total score is calculated by subtracting the number of wrong responses from the number of items completed at that point. The total score ranges between 0 and 30 points, and higher scores signify better visual-motor integration. The Cronbach's alpha coefficient was .94, and the test-retest reliability was .88 for participants aged 60 to 69 years in the study by Beery and Beery [23]. The Cronbach's alpha coefficient was .80, and the test-retest reliability was .85 in the present study.

4) Depression

Depression was measured using the Geriatric Depression Scale Short Form—Korean Version that Kee [24] corrected and adapted from the one developed by Yesavage and Sheikh [25], considering the characteristics of older adults in Korea. It consists of 15 questions scored 0 points for positive answers and 1 point for negative answers; total scores range between 0 and 15 points. Higher scores indicate more serious depressive states. Severity is classified as follows: normal below 4, moderate between 5 and 9, and severe above 10 points. The Cronbach's alpha coefficient was .88 in the study by Kee [24] and .83 in the present study.

4. Memory and visual-motor integration program for older adults based on self-efficacy theory

A memory and visual-motor integration program was implemented for the older adults in each senior center or welfare facility allocated to the experimental group. The successful memory training implemented by West et al. [6] consisted of 6 2-hour sessions for 6 weeks. A multifactorial cognitive progam including physical activities was conducted twice a week in the study by Sun [16]. Additionally, it had to be considered that older adults could have difficulties with long program running time, which might affect the results [19]. Therefore, the memory and visual-motor integration program implemented in the present study consisted of twelve 90-minute sessions conducted twice a week over 6 weeks. The program was based on self-efficacy theory of Bandura [11] and focused on building memory self-efficacy, proposed by the memory training of West et al. [6], and the visual-motor integration program proposed by Yeo [2]. The program was validated by 2 nursing professors, who had experience of

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intervention studies for older adults, and 1 doctor of medicine who majored in exercise and medical physiology, and the program was subsequently modified and refined. The program details are shown in Table 1.

Table 1. Overall Procedures of the Memory and Visual-Motor Integration Program Based on Self-Efficacy Theory

Procedure & length (min)	Program list					
Warm-up (15)	Cheerfully greeting peers Checking date and time Recalling peers' names while passing a ball Recalling the past session					
Main program (60) Instruction (20) and Practice (40)			Exercises			
				Visual-motor integration practice		
	Session	Instruction	Memory practice	Paper-based tasks	Hand gestures with the theme song	Whole body recreational exercise
	1	Program orientation Memory with aging	Reading a poem (every session) Remembering a shape	Following a line	Both hand counting	Breaking balloons
	2	Forgetfulness	Remembering two shapes	Following a line	Both hand counting	Passing a ball
	3	Neuroplasticity	Remembering two shapes	Following a line	Both hand counting Rock paper	Throwing a paper airplane in a basket
	4	Visual-motor integration	Fitting pieces while remembering	Maze game	Rock paper Ssae-ssae-ssae with a partner	Following a rhythm
	5	Memory process and strategies	Finding different points in a picture	Maze game	Rock paper Ssae-ssae-ssae with a partner	Following the line as directed
	6	Attention and rehearsal	Remembering something in previous image	Maze game	Ssae-ssae-ssae with a partner Passing a beanbag	Walking with a beanbag
	7	Chunking	Memory game: Shopping lists	Drawing a line as directed 1	Both hand counting Passing on a beanbag	Running and collecting shopping lists
	8	Story-making	Memory game: Story telling	Drawing a line as directed 1	Rock paper Passing on a beanbag	Ssae-ssae-ssae with changing partners
	9	Association	Memory game: Association	Drawing a line as directed 1	Rock paper Passing on a beanbag	Throwing a wood chip
	10	Imaging	Memory game: Imaging	Drawing a line as directed 2	Ssae-ssae-ssae Passing on a beanbag	Walking with a beanbag
	11	Tips for memory	Memory game: Reviewing strategies	Drawing a line as directed 2	Escaping and catching a finger	Throwing a wood chip
	12	Application in daily life	Memory game: Reviewing strategies	Drawing a line as directed 2	Reviewing hand gestures	Breaking balloons
Closing (15)	Deep-breathing meditation Discussing experiences with peers Homework reminders Writing a daily diary Practicing rhythmic hand gestures daily Solving puzzles and drawing lines Thanking participants, snack time, and announcing details of the next session					

1) Application of self-efficacy sources

Bandura proposed that there were 4 sources of self-efficacy: enactive mastery, vicarious experience, verbal persuasion, and physiological and affective states. Therefore, to increase memory self-efficacy in the present study, these 4 sources were incorporated in all elements of the program (Table 2).

For enactive mastery, all participants were assigned classroom tasks and homework that gradually increased in difficulty, including memory games, drawing lines as directed, rhythmic hand gestures, and so on. The personal level of the participants was considered to facilitate successful performance. The professionals reviewed the entire program, and detailed tasks and homework were supplemented and modified according to the level of the participants.

To foster vicarious experiences, participants had opportunities to observe their peers' successful practice before their own, and they talked with each other about beneficial strategies to achieve success.

Verbal persuasion consisted of 12 sessions that incorporated instruction, didactic persuasion, and personal coaching. The educational contents covered changes in memory function with aging, neuroplasticity, information processing and memory strategies, visual-motor integration training, and the effectiveness of the training. They focused on correctly understanding the

Table 2. Strategies of the Visual-Motor Integration and Memory Training Program Using Sources of Self-Efficacy

Sources of self-efficacy	Strategies		Specific practices
Performance accomplishment	Classroom tasks		Checking the date and time
			Remembering peers' names
			Reading and remembering a poem
			Engaging in a memory game
			Drawing lines as directed
			Engaging in a maze game and puzzles
			Performing rhythmic hand gestures
			Engaging in physical recreation using gross muscles
	Homework		Writing the date
			Practicing daily rhythmic hand gestures
			Writing in the daily happiness diary
			Doing puzzles related to memory strategies
			Drawing lines as directed
Vicarious experience	Modeling		Giving good examples, modeling before practice
			Suggesting group leaders to go first
	Mentoring		Talking to each other about good strategies for success
Verbal persuasion	Instruction	Session 1	Explaining changes in memory function with aging
		Session 2	Explaining the differences between the characteristics of forgetfulness and dementia
		Session 3	Explaining about neuroplasticity
		Session 4	Implementing visual-motor integration training and memory
		Session 5	Information processing and memory strategies
		Session 6	Increasing memory with attention and rehearsal
		Session 7	Increasing memory with chunking
		Session 8	Increasing memory with story making
		Session 9	Increasing memory with association
		Session 10	Increasing memory with imaging
		Session 11	Suggesting household tips to increase memory function
		Session 12	Explaining applications in daily life
	Didactic persuasion		Emphasizing on potential memory ability
			Providing positive feedback on any improvement
	Personal coaching		Homework check and praise
Emotional relaxation	Supportive environment		Slowing down and relaxing; not competing and rushing
			Discussing similar memory problems and supporting each other
	Relaxation		Engaging in recreational activities and singing together
	Deep-breathing meditation		Engaging in deep breathing with mindfulness

changes in cognitive function in the normal aging process and learning specific methods to enhance cognitive function. In addition, participants had opportunities to recognize their positive changes in a supportive and encouraging environment, emphasizing on their potential memory ability, and they were provided with positive feedback for their tasks and homework.

For emotional relaxation, program facilitators provided participants with a supportive environment in which they could complete their tasks without competing and rushing. Moreover, they could discuss their memory problems with peers and ascertain that everyone has similar cognitive problems. Additionally, recreational activities, singing together, and 5 minutes of deep-breathing meditation were conducted to reduce their anxiety.

2) Memory training

Memory training comprised classroom tasks and homework throughout the program. Specific lectures and practice for memory training were intensively executed in 5 of the 12 sessions. Memory strategies in this program included attention, chunking, and association from the study by West et al. [6] as well as storing, rehearsal, and imaging in a metamemory class [26]. To use memory training strategies, various practice exercises and homework tasks (recalling peers' names, reading and reciting a poem, memory games, writing a daily happiness diary, and puzzles) were conducted in this program.

3) Visual-motor integration training

Visual-motor integration training also comprised classroom tasks and homework. Based on the study by Yeo [2], specific lectures and practices about visual-motor integration training were conducted. Because paper-and-pencil tasks and sensory motor integration exercises to use upper extremities and the whole body are essential for visual-motor integration training [2], this program consisted of paper-and-pencil tasks of following and drawing lines and maze games; hand gestures with the theme song, such as both hand counting, alternating rock paper hand motion, ssae-ssae-ssae with a partner, and passing a beanbag for visual-motor integration training to use the upper extremities; and recreational exercises such as passing a ball, throwing a wood chip, breaking balloons, and following the lines for visual-motor integration training using the whole body. This program included one additional session of didactic education and homework for visual-motor integration.

5. Data collection

Data for this study were collected at 4 senior centers and 2 elderly welfare facilities located at D or G city from July 14 to October 14, 2014. The researcher visited several senior centers and elderly welfare facilities and explained the study purpose and procedures to the manager and facility users. The researcher also ensured that the facility users did not already participate in any cognitive enhancement program. Among them, 6 organizations provided informed consent, and participants who belonged to the organizations were recruited. Four senior centers and 2 elderly welfare facilities had a similar socioeconomic level. Therefore, 2 senior centers and 1 elderly welfare facility were assigned to the experimental or control groups, respectively.

After eliminating 2 persons with dementia and 3 with hearing difficulties among 79 applicants wanting to participate in this study, 74 participants who satisfied the inclusion and exclusion criteria were selected.

In the experimental group, 39 participants participated at the beginning. Two individuals did not complete the pre-test, and 7 dropped out from the program due to moving, personal schedules, and so on. Thus, 30 participants participated until the post-test.

In the control group, 35 participants participated at the beginning. Thirty-two participated after eliminating 1 person who did not complete the pre-test and 2 who did not take part in the post-test. A final total of 62 participants, 30 in the experimental group and 32 in the control group, participated in this study for a participation rate of 83.7%.

6. Study procedures

To verify the effects of the memory and visual-motor integration program based on self-efficacy theory for older adults, the following procedures were carried out in the present study.

1) Researcher preparation

To conduct this program effectively, the researcher completed a professional training course for teaching a meta-memory class and participated in laughter, art, music, occupational, and exercise therapies for older adults with dementia; an educational program for dementia prevention; and a program to support families of older adults with dementia in a provincial dementia center and daycare centers in D city, Korea from April to May of 2014.

Two program assistants were selected from applicants. They were junior nursing students at Y college and were provided with information about the purpose and procedures of this study. They also received instruction regarding attitudes and roles, and they watched videotapes of a cognitive program for older adults and were trained in the basic gestures of this program.

Five applicants among nursing students at Y college were recruited as research assistants for collecting the data. The researcher explained to them the questionnaires and the data collection process, and trained them to gather participants' responses until their concordance rates for the same participants were over 90%. However, they did not receive information regarding whether the participants belonged to the experimental or control group.

2) Preliminary study

The preliminary study was performed with 5 older adult applicants who satisfied the inclusion criteria in G city, Korea, after the purpose and procedures of this study were explained. The researcher conducted the main program for these participants, after which their level of understanding, task execution, and disability were examined.

3) Pre-test

For baseline data collection, the researcher and 5 research assistants visited the senior centers and elderly welfare facilities from July 17 to August 29, 2014, had face-to-face interviews with all participants, and helped them mark their own responses, except for the VMI-6R. All participants completed the VMI-6R by themselves. It took about 30 minutes to complete the pre-test, and all participants were given a present in gratitude for participation after completing the assessments.

4) Experimental treatment

The memory and visual-motor integration program based on self-efficacy theory for older adults developed for this study was conducted for the 3 experimental subgroups. The experimental subgroups comprised 7 to 15 people. The program consisted of 12 sessions and was carried out by the researcher and 2 program assistants twice per week over 6 weeks from July 21 to September 1, 2014. Each 90-minute session consisted of the beginning, mid, and terminal sections. The first 15 minutes made up the beginning section that comprised warm-up activities of greeting, checking the date and time, recalling peers' names while passing a ball, and talking about the past session. The following 60 minutes made up the mid-section of the main program, which comprised didactic educational activities and memory and visual-motor integration practice. The last 15 minutes comprised the terminal section, consisting of deep-breathing meditation, discussing experiences with peers, homework reminders, thanking the participants, and snack time.

The participants' levels of task performance were individually assessed, and they could ascertain their changes and recognize their achievement after each session.

5) Post-test

Data for the post-test were collected with the same questionnaires and researchers 6 weeks after the pre-test in the experimental and control groups. Small presents to express gratitude for their participation were provided to all participants after the data collection.

7. Ethical considerations

To protect the rights of the participants, this study was conducted after receiving approval from the K University Institutional Review Board (IRB No. 2014-0048). Each participant signed a written consent form after receiving an explanation of the study goals, data collection, and confidentiality procedures. They received information that the data collection process could be stopped at any time without penalty. After the post-test data collection, the control group was provided with the same educational booklets given to the experimental group, including daily homework tasks and information to enhance memory.

8. Data analysis

Data were analyzed to verify the hypothesis, using the SPSS (PASW Statistics) WIN 18.0 program as follows. Descriptive statistics were conducted with mean, standard deviation, medians, and interquartile range, and normality distributions were verified with the Kolmogorov–Smirnov test. Homogeneity with reference to general characteristics and outcome variables at baseline and differences in the pre–test and post–test scores between the experimental and control groups were examined with chi–square test, independent t–test, and Mann–Whitney U test.

RESULTS

1. Homogeneity test for the general characteristics of the experimental and control groups

General characteristics of the participants, including age, gender, educational level, marital status, whether they lived alone, economic status, subjective health status, drinking, smoking, regular exercise, disease, memory, and instrumental activities of daily living, were investigated, and the homogeneity between the experimental and control groups was examined. The homogeneity test did not indicate any significant differences. Therefore, the experimental and control groups were considered homogeneous at baseline (Table 3).

2. Homogeneity of baseline outcome variables between groups

Homogeneity of baseline outcome variables between the experimental and control groups was examined before applying the program. The homogeneity test did not reveal any significant differences in the baseline outcome variables. Thus, the experimental and control groups were homogeneous in terms of their memory self–efficacy, memory, visual–motor integration, and depression scores at baseline (Table 4).

3. Hypothesis verification

Before hypothesis verification, post–test and post-pre differ–

Table 3. Homogeneity Test of Baseline Characteristics Between Groups (*N*=62)

Characteristics		Exp. (n=30)	Cont. (n=32)	χ^2, t or Z	*p*
		n (%), M±SD or Median (IQR)	n (%), M±SD or Median (IQR)		
Age (yr)		79.93±4.06	78.03±4.58	1.72	.090
Gender	Male	1 (3.3)	6 (18.8)		.105*
	Female	29 (96.7)	26 (81.2)		
Education level (yr)		6.00 (0.00~6.00)	6.00 (1.50~9.00)	−1.76	.078†
Marital status	Married	11 (36.7)	13 (40.6)	0.90	.710*
	Widowed	17 (56.7)	15 (46.9)		
	Separated	2 (6.6)	4 (12.5)		
Living alone	Yes	18 (60.0)	15 (46.9)	1.07	.301
	No	12 (40.0)	17 (53.1)		
Economic state	Moderate	11 (36.7)	15 (46.9)	0.66	.416
	Poor	19 (63.3)	17 (53.1)		
Subjective health status	Good	4 (13.3)	6 (18.7)	3.56	.320*
	Moderate	8 (26.7)	14 (43.7)		
	Poor	13 (43.3)	10 (31.3)		
	Very poor	5 (16.7)	2 (6.3)		
Drinking	Yes	1 (3.3)	3 (9.4)		.613*
	No	29 (96.7)	29 (90.6)		
Smoking	Yes	1 (3.3)	1 (3.1)		1.000*
	No	29 (96.7)	31 (96.9)		
Regular exercise	Yes	18 (60.0)	23 (71.9)	0.97	.323
	No	12 (40.0)	9 (28.1)		
Disease	Yes	28 (93.3)	25 (78.1)		.149*
	No	2 (6.7)	7 (21.9)		
Cognitive function		21.70±3.07	21.78±2.99	−0.10	.916
Instrumental activities of daily living		10.67±1.06	11.16±2.49	−0.99	.324

Cont.=Control group; Exp.=Experimental group; IQR=Inter Quartile Range.
*Fisher's exact test; †Mann-Whitney U test.

ences of each group were evaluated in terms of the normality with Kolmogorov-Smirnov test. In the post-test, memory self-efficacy and memory of each group and visual-motor integration of the control group were satisfied with the normality assumption (the range of D: 0.07~0.14, p>.05), but visual-motor integration of the experimental group and depression of each group were not satisfied with that (the range of D: 0.18~0.19, p<.05). In the normality test of post-pre differences, memory self-efficacy was satisfied with the normality assumption in both experimental (D=0.11, p=.200) and control groups (D=0.13, p=.182), but memory (Exp., D=0.12, p=.200; Cont., D=0.20, p=.002), visual-motor integration (Exp., D=0.13, p=.183; Cont., D=0.18, p=.014), and depression (Exp., D=0.13, p=.200; Cont., D=0.20, p=.002) were not satisfied with that. According to the results for normality, an independent t-test for the effect of memory self-efficacy and a Mann-Whitney U test for the effect of the other outcome variables were conducted.

1) Hypothesis 1

Memory self-efficacy significantly increased in the experimental group members who participated in the memory and visual-motor integration program based on self-efficacy theory for older adults as compared with that in the control group (t=2.20, p=.031). Hypothesis 1 was therefore supported (Table 5).

2) Hypothesis 2

Post intervention, memory significantly increased in the experimental group as compared with that in the control group (Z=-2.92, p=.004). Hypothesis 2 was thus supported (Table 5).

3) Hypothesis 3

Post-intervention, visual-motor integration significantly increased in the experimental group as compared with that in the control group (Z=-2.49, p=.013). Hypothesis 3 was thus supported (Table 5).

Table 4. Homogeneity Test of Outcome Variables Between Groups at Baseline (*N*=62)

Outcome variables	Group	M±SD	Min.~Max. or Median (IQR)	t or Z	*p*
Memory self-efficacy	Exp.	352.00±160.99	120.00~820.00	-1.59	.115
	Cont.	424.38±193.02	40.00~860.00		
Memory	Exp.	19.53±5.48	20.50 (14.75~24.00)	-0.15	.882†
	Cont.	19.81±6.35	21.00 (14.00~24.75)		
Visual-motor Integration	Exp.	18.27±3.49	18.00 (16.75~20.00)	-1.45	.147†
	Cont.	19.00±2.62	19.00 (17.25~20.75)		
Depression	Exp.	6.70±3.60	6.00 (4.00~10.00)	-1.30	.193†
	Cont.	5.66±4.14	5.00 (2.00~9.00)		

Cont.=Control group (n=32); Exp.=Experimental group (n=30); IQR=Inter Quartile Range; Max.=Maximum; Min.=Minimum.
†Mann-Whitney U test.

Table 5. Effects of MVPS on Memory Self-Efficacy, Memory, Visual-Motor Integration, and Depression (*N*=62)

Outcome variables	Group	Post-test		Differences (Post - Pre)		t or Z	*p*
		M±SD	Min. ~ Max. or Median (IQR)	M±SD	Min. ~ Max. or Median (IQR)		
Memory self-efficacy	Exp.	470.67±150.19	120.00~820.00	118.66±180.41	-180.00~580.00	2.20	.031
	Cont.	440.63±149.96	80.00~740.00	16.25±184.38	-400.00~380.00		
Memory	Exp.	23.67±6.81	20.50 (14.75~24.00)	4.13±4.49	4.00 (0.75~7.25)	-2.92	.004†
	Cont.	20.63±8.43	21.00 (14.00~24.75)	0.81±4.36	0.00 (-2.00~5.00)		
Visual-motor Integration	Exp.	19.27±3.75	19.00 (17.00~20.25)	1.00±2.08	1.00 (-0.25~2.00)	-2.49	.013†
	Cont.	18.88±2.72	19.00 (17.25~21.00)	-0.12±1.03	0.00 (-1.00~1.00)		
Depression	Exp.	5.50±3.79	5.00 (2.75~9.00)	-1.20±2.99	-1.00 (-3.00~1.00)	-0.90	.367†
	Cont.	5.06±3.64	4.50 (2.00~7.75)	-0.59±3.01	0.00 (-2.00~1.00)		

Cont.=Control group (n=32); Exp.=Experimental group (n=30); IQR=Inter Quartile Range; Max.=Maximum; Min.=Minimum; MVPS=Memory and Visual-motor integration Program based on self-efficacy theory.
†Mann-Whitney U test.

4) Hypothesis 4

Depression did not decrease significantly in the experimental group post intervention as compared with that in the control group ($Z=-0.90$, $p=.367$). Hypothesis 4 was therefore rejected (Table 5).

DISCUSSION

This study investigated if a memory and visual-motor integration program for older adults based on self-efficacy theory was effective in improving memory self-efficacy, memory, visual-motor integration, and depression.

Memory self-efficacy increased significantly in the experimental group as compared to the control group, and the effect of this program on memory self-efficacy was verified. West et al. [6] emphasized that those specific strategies for sources of self-efficacy must be well unified into the program to increase its effectiveness. This result for memory self-efficacy indicates that the present program very well integrated the four sources of self-efficacy suggested by Bandura [11]. Actually, this program included many specific strategies for self-efficacy, such as giving assignment tasks that gradually increased in difficulty considering the personal levels of the participants, peer modeling, emphasizing on cognitive improvement in any age by fostering neuroplasticity, recreational activities, and supportive atmosphere. Even though self-efficacy based memory training was more effective than traditional memory training [6], few studies have attempted memory training by applying self-efficacy theory of Bandura [11]. Kim [18] implemented a memory training program using the efficacy sources for 102 older adults aged over 60 years for 2 weeks. Similarly, West et al. [6] implemented a memory intervention based on self-efficacy for 84 people over the age of 50 years for 6 weeks. Each group was composed of 9~18 [6] or 10~15 [18] people. Similar to the present results, these previous studies [6,12,18] consistently demonstrated that memory training applying self-efficacy theory was effective in increasing memory self-efficacy and memory despite variations in the participants' age, program duration, and group size in the program. These findings may be explained by the fact that people with high self-efficacy tend to be motivated to engage in desirable behavior, they do not give up easily, and make constant efforts to achieve the expected goals [11]. On the contrary, people with low self-efficacy rapidly abandon desirable behavior if they find it bothersome or if they fail to achieve quickly [10]. It is difficult to lead older adults toward desirable behaviors because they have low memory self-confidence [7]. Therefore, the specific self-efficacy strategies in this program can be used to increase the memory self-efficacy of older adults, especially for those with low self-efficacy.

Memory increased significantly in the experimental group as compared to that in the control group, and the effect of this program on memory was verified. This resulted from the increased memory self-efficacy that the program caused, which led the participants to be immersed in the tasks and to do their best to improve their memory performance. Similarly, previous studies affirmed that memory training based on self-efficacy theory was effective in increasing memory performance [6,12,18] and that memory self-efficacy is the most significant predictor of memory performance [12]. Conversely, several memory training programs based on self-efficacy theory did not show a significant effect on memory after the intervention [14,19]. In the study by McDougall [14], a 4-week memory training based on self-efficacy theory was provided for older adults in nursing homes. The program increased memory self-efficacy but did not significantly increase memory performance because many participants had declined cognitive function and depression. In the study by Rapp et al. [19], a 6-week multi-factorial memory training including memory beliefs was provided for community-dwelling older adults with mild cognitive impairment. The program increased perceived memory ability but did not significantly increase memory performance because its implementation did not consider the characteristics of participants with cognitive impairment. Evidently, it is important to consider the characteristics of participants, such as cognitive impairment and depression, and to modify the duration, task difficulty, and emotional approaches of the program when planning an intervention to improve the memory of older adults.

Visual-motor integration in the experimental group increased significantly as compared to that in the control group, and the effect of this program on visual-motor integration was verified. Yeo [2] proposed that visual-motor integration training exercises should be paper-based, and they should involve the upper extremities and whole body. Therefore, the present program may have been effective, as it comprised tasks such as drawing a line and maze games as a paper-based practice as well as rhythmic hand gestures with a song, breaking balloons, and throwing wood chips as whole-body recreational exercises. In addition, specific sources of self-efficacy may enhance the self-efficacy of participants, which, in turn, may lead them to perform more trained behaviors to increase visual-motor integration. Most studies of cognitive intervention have investigated effects on metamemory, memory performance [6,12,18], cognitive function, depression, or quality of life [16]. It is hardly possible to make direct comparisons with the present results because no study has investigated the effect of cognitive intervention on visual-motor integration. However, there was one similar result indicating that cognitive intervention is more effective if it includes elements such as exercising extremities to enhance visual-motor integration [27]. Contrary to this result, one study revealed no significant effect on visual-motor integration after visual-motor integration training [28]. Poon et al. [28] conducted a computerized visual-motor integration program for 6~7-year-olds with handwriting difficulties. In the program, children had trouble in controlling a small pen since the beginning, and these initial failed experiences decreased their motivation for goal achievement [28]. Unsuccessful experiences decrease self-efficacy, but successful experiences increase it and facilitate expected behaviors [11]. This finding indicates that visual-motor integration training based on self-efficacy theory is more effective than general visual-motor integration training. Therefore, self-efficacy theory should be applied in visual-motor integration training, and the specific strategies to address the sources of self-efficacy used in this program, such as giving personalized appropriate tasks, could also be used.

Depression was alleviated in the experimental group as compared to the control group, but the difference was not statistically significant. This may be because the participants in this study were too old to change their fixed mood (mean age 79.93 years). With aging, older adults experience memory deterioration, which reduces their memory self-efficacy. Older adults with low memory self-efficacy experience anxiety related to their memory loss, which finally makes them more depressed. However, because older adults tend to stick to their style as they are aging, they can hardly change their old ways [29]. The program implemented in the present study was conducted for 6 weeks. Compared with the present findings, Sun [16] also verified the effect of a cognitive intervention based on self-efficacy theory. In the study by Sun [16], a 90-minute program including group and individual activities was provided for female older adults living alone in the community twice a week for 12 weeks. The mean age of the participants was 72.32 years, which was lower than that of participants in the present study. In contrast to the present findings, Sun [16] reported a decrease in depression despite the inclusion of older adults living alone in that study. This indicates that age and program duration can be considered as factors influencing the effectiveness of the program. Therefore, before drawing any conclusion, we must examine whether participant's age and program duration affect program effectiveness because depression in older adults has a significant correlation with self-efficacy and affects the level of engagement in health promotion activities to improve cognitive function [8].

This study was limited in that differences in effects according to area, age, and gender were not analyzed because the participants were mostly female older adults from a particular area. Additionally, participants' characteristics must be considered when these results are generalized to the entire population of older adults. In addition, this study focused on the effectiveness of the program without considering changes over time. Therefore, follow-up studies to verify the effect over time are needed.

This study was the first trial to add elements of memory self-efficacy and visual-motor integration to traditional memory training to maximize the effects of cognitive intervention for older adults. The results showed that the program was effective for improving memory self-efficacy, memory, and visual-motor integration in older adults. These findings may affect future studies of cognitive intervention for older adults. The specific strategies for memory self-efficacy and visual-motor integration included in this program could be applied to enhance cognitive function and prevent dementia in older adults.

CONCLUSION

Traditionally, memory-training programs have tried to enhance cognitive function. However, especially in older adults, subjective memory beliefs and affective factors such as depression have adverse influences on cognitive decline. Additionally, visual–motor integration is the most essential cognitive function for the independent daily living of older adults. Therefore, a new approach involving multifactorial memory training is worth validating.

This study was the first trial to confirm the effect of a memory and visual–motor integration program based on self–efficacy theory of Bandura [11]. The 12–session program was conducted over 6 weeks, and the effects of the program on memory self–efficacy, memory, visual–motor integration, and depression were investigated.

Memory self–efficacy, memory, and visual–motor integration increased significantly in the experimental group as compared to the control group. However, the participants' depression did not decrease significantly. These results demonstrate that a memory and visual–motor integration program based on self–efficacy theory is effective for increasing memory, visual–motor integration and memory self–efficacy in older adults.

These findings signify that the specific strategies addressing the sources of self–efficacy integrated in this program facilitate an increase in memory self–efficacy, motivation, commitment, and continuous effort to perform desirable behaviors, and they affect memory and visual–motor integration as well as memory self–efficacy.

This study confirmed that multifactorial memory training was effective at improving cognition in older adults. The verification of memory self–efficacy and visual–motor integration in cognitive interventions for older adults is particularly valuable because their cognitive decline is more fragile owing to the decrease in memory self–efficacy, and visual–motor integration is the most essential cognitive element for their independent daily living.

CONFLICTS OF INTEREST

The authors declared no conflict of interest.

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