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Memory Classes and Group Working Memory Span Tasks Change Memory Self-efficacy of Older Adults

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Memory self-efficacy (MSE) of older adults was investigated by examining short-term and working memory span scores in addition to relations among memory self-efficacy, short-term memory span, working memory span, and memory aids used in everyday life. After older adults (n = 148) responded to a pre-MSE questionnaire, they performed word span tasks, position span tasks, and symmetry span tasks. Later, they completed a post-MSE questionnaire and reported the daily life memory aids they use. The mean post-MSE score was found to be significantly lower than the mean pre-MSE score. Significant positive correlation was found only between the post-MSE score and the number of daily life memory aids, short-term memory span, and working memory span. These results suggest that performing short-term and working memory tasks in a group changes older adult memory self-efficacy from irrelevant to relevant.

Key words : Memory self-efficacy, Older adult, Working memory, External Memory aid

1. INTRODUCTION

Decline in cognitive function and the advance of dementia receive much attention in our aging society. Many community classes are offered by administrative bodies or colleges to support human memory and cognition, with emphasis on cognitive aging. This study investigated memory self-efficacy (MSE) changes and MSE, short-term memory, working memory, and compensatory external memory aids used in real life by older attendees of such human-memory related classes. MSE is an index of one's own cognition and one's own appraisal of memory capabilities (Berry 1999). In fact, MSE is a part of metacognition, which includes evaluations and knowledge about our memory, memory strategies, memory monitoring, and executive functions related to memory.

Whether MSE is correlated to actual memory task performance and to memory failure remains controversial. One earlier meta-analysis examining the relation between MSE and memory tasks from 107 studies of 24,897 individuals between 16 and 103 years of age (mean age = 50 years) found a slight but positive correlation (r = .15) (Beaudoin and Desrichard 2011). Factors affecting MSE are reported as implementation timing for memory tasks and MSE questionnaires, memory task variety, and MSE scale variety (Crumley *et al.* 2014).

By contrast, Kawano (1999) reported that elderly people who scored themselves higher at high MSE at pre-memory task actually had lower real memory task scores. That study found a significant and negative correlation coefficient (r = -.36) between MSE in a pre-memory task situation and memory task (free recall tasks) results in older adult participants.

As described above, significant correlation was found between MSE and memory task results, but inconsistent findings were obtained between younger adults and older adults. Negative or no correlation was found between MSE and memory task results, suggesting that MSE does not match everyday memory task performance. These mismatches represent a lack of appropriate metacognition about memory. They might in fact cause cognitive errors in everyday life.

Especially, MSE is related to older adult memory difficulties in that numerous cognitive tasks in the everyday life of aged people require memory resources and functions (Kinjo and Shimizu 2018). Overestimation of MSE by older adults probably engenders severe cognitive slips such as forgetting to take medication or mistaking meeting times. However, underestimation of MSE might make older adults inactive in everyday life.

Ide *et al.* (2006) reported that older adults MSE (N = 16) showed significantly higher scores after memory strategy instruction classes, which were two hours each, for a total of five times. Their results suggest that classes which affect MSE in older adults are important for care prevention.

Gilewski *et al.* (1990) reported that MSE assessment promotes reflection about cognitive functions in older adults and that it engenders the early detection of dementia. Proper assessments of MSE are necessary with cognitive aging to decrease memory failures of older adults in everyday life.

Recently, many classes are offered to older adults for care prevention or prevention of dementia. Students can try memory tasks or memory strategy training in such classes. Community General Support Center or Social Welfare Councils of Municipalities in prefectures provide these classes to support older adults' healthy life in their community (IDE *et al.* 2006). These classes are useful for older adults to reflect their memory function and memory capacity (Verhaeghen *et al.* 1993). The process by which older adults change MSE through memory tasks implemented in these classes is assessed to evaluate these classes' effectiveness for older adults.

For this study, we held classes on the subject of human memory for older adults in a course for dissemination and for raising awareness of dementia. We also assessed MSE, short-term and working memory, and the participants' use of external memory aids in real life. The participants completed subjective MSE questionnaires twice, before and after the class, including memory assessment tasks, which were done in a group. This study was designed to assess changes in MSE of older adults after doing short-term and working memory assessments in the class, as well as relations among MSE, short-term and working memory, and the number of memory aids used in everyday life. The results indicate MSE class effects on older adults.

Professionals in Japan use MSE questionnaires of two types (Kawano and Ohta 2000, Ide and Mori 2004). The Ide and Mori (2004) MSE questionnaire version includes more prospective memory question items than the Kawano and Ohta (2000) version. The latter version includes question items specifically examining older adults' memory ability. Participants in this study do not implement prospective memory but short-term and working memory tasks. Therefore, the present study uses the MSE questionnaire version of Kawano and Ohta (2000), which uses one-factor construct. We assessed its reliability and validity.

Memory tasks used for this study were completed in a class about human memory for older adults to become cognizant of their memory span. They were run with a group situation, not individually. Memory tasks for older adults generally require assessment of the older adult participants' cognitive ability through completion of dementia scales such as the Mini Mental State Examination (MMSE). However, because this study was completed as a part of a class for older adults about memory, the participants were not screened for dementia.

In general, memory spans are measured individually to control confounding factors and enhance reliability. However, memory tasks in a group have been developed to save measurement time and to facilitate testing of more participants (De Neys *et al.* 2002). Especially, working memory span tasks for groups in classrooms have been developed to use the results because working memory span shows significant correlation with intelligence or school achievements (Osaka 2002).

The following working memory span tasks in a group have been developed: group reading and listening span test for children (Higuchi *et al.* 2001), group-format reading span tests of English for high school students (Shibasaki *et al.* 2015), group listening span test for college students (Sasaki 2006), group operation span test for adults (De Neys *et al.* 2002). These group-administrable working memory span tasks are presumed not to be implemented under controlled conditions such as a laboratory, but to be implemented in classroom situations. Earlier studies show that working memory span tasks in a group have internal consistency, test retest reliability, and validity (De Neys *et al.* 2002, Shibasaki *et al.* 2015).

We must test short-term and working memory spans in classes for older adult because it was difficult for us to use individualized working memory span tasks in these situations. Therefore, we develop and utilize short-term and working memory span tasks in a group for older adults.

Memory tasks used in an earlier study of relations between MSE and results of memory tasks were of various patterns. These tasks were free word recall, serial word recall, and serial recognition task procedures. The stimuli were verbal and visuospatial. Similarly to earlier studies, we use serial recognition tasks as short-term

memory span tasks and working memory span tasks, the stimuli of which are verbal and visuospatial.

Working memory serves temporary information storage functions for ongoing tasks. It contrasts to information storage functions of short-term memory (Otsuka and Miyatani 2018). Working memory is a central memory function. It simultaneously executes both processing and storage in daily cognitive performance (Kane *et al.* 2007). Individual differences of working memory are measured by working memory span tasks that require participants to complete processing and storage tasks simultaneously. The decline of working memory function influences older adults' daily life more strongly than mere short-term memory function (Osaka 2002, Salthouse and Pink 2008). Therefore, not only short-term memory span tasks are used to infer older adult memory resources better, working memory span tasks are also used.

External memory aids to compensate working or short-term memory capacity constraint are crucially important in everyday life (Otsuka 2003), especially for older adults. We asked older adults about external memory types such as notebooks and wall calendars. Proper external memory use as distributed resources out of our memory resources is a standard strategy for preventing memory failure. Proper MSE is probably related to compensatory external memory use.

This study examines older adults MSE before and after short-term and working memory tasks performed in a class, with examination of relations among pre-MSE, post-MSE, short-term memory, working memory, and external memory aid of participants. Effects of such memory span tasks in a group on the MSE of older adults are discussed.

Beaudoin *et al.* (2008) showed no significant correlation between MSE and word span, position span, or symmetry span in older adults aged between 55 and 88 years old, but they independently conducted MSE questionnaires from these memory span tasks. As described above, Kawano (1999) measured MSE for older adults, the mean age of whom was 73.3 years old, in two situations: an ordinary situation without memory tests, and specific situations with memory tests that were implemented immediately after MSE. That study found significant negative correlation (r = −.36) only between MSE of the specific situations and memory span. This result of Kawano (1999) indicates that older adults overestimate their own memory span.

We assess participants' MSE twice before and after short-term and working memory span tasks. Earlier research suggests that MSE changes according to the assessment situation (Kawano 1999, Crumley *et al.* 2014). Therefore, it is possible to establish three hypotheses for the change of participant's MSE between memory tasks. The first is that, if older adults overestimate their memory capacities, then MSE decreases after memory span tasks. The second is that, if they properly estimate their memory capacities, then MSE does not vary after those. The third is that MSE increases after memory span tasks, contrary to the first hypotheses.

Kawano (1999) found that MSE results significantly and negatively correlate in specific situations in which participants face short-term span tasks. Therefore, MSE is assumed to be significantly correlated with short-term memory span in this study. Although no significant correlation was found between MSE and working memory in an earlier study (Beaudoin *et al.* 2008), it is assumed that MSE is significantly correlated with the working memory span because it is assessed in specific situations.

Memory task performance declines with cognitive aging (Salthouse and Pink 2008). Therefore, it is assumed that significant and negative correlation exists between memory spans with age, positive correlation between the number of external memory aids, and age. Presumably, significant and positive correlation exsists between the number of external memory aids and age and working memory span because a cognitive strategy such as the use of external memory aids positively correlates with executive functions (Otsuka 2003).

2. METHOD

2.1. Participants

Ten classes of approximately 60 min were conducted. Older residents of Nagasaki, Japan participated in the classes (N = 304), each of which had 13-44 participants. Data of older adults who completed the short-term memory span tasks and responded to the memory-self efficacy questionnaires were analyzed (n = 148, 75.7% female). Of these, 111 participants completed the working memory span tasks.

2.2. MSE questionnaire

The MSE questionnaire for older adults (Kawano and Ohta 2000) comprises 14 items. Participants

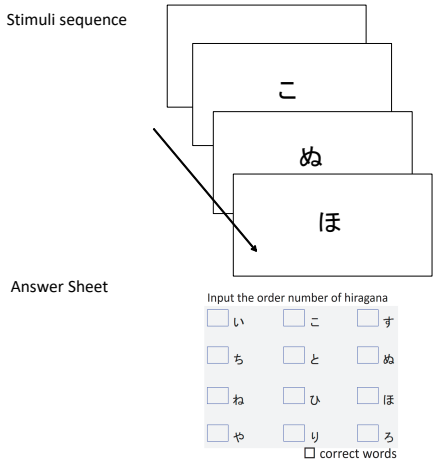

Figure 1. Stimuli and answer sheet for the group version word span task.

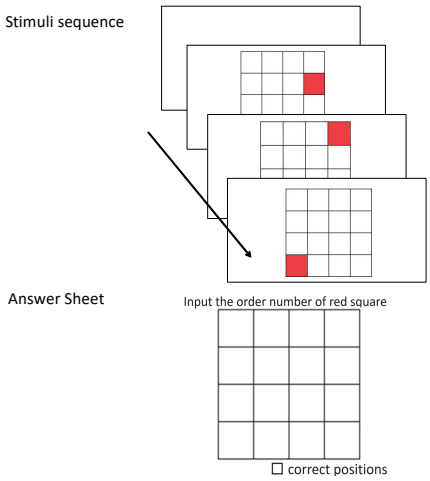

Figure 2. Stimuli and answer sheet for the group version position span task.

rated self-statements on a four-point Likert-type scale: 1 (Strongly disagree), 2 (Disagree), 3 (Agree), and 4 (Strongly agree). Figure 4 shows the MSE and external memory aid questionnaire.

2.3. External memory aid questionnaire

The external memory aid questionnaire consisted of a list of 10 items that are external devices and memory aids. Participants checked the items that they use in daily life. The external memory aid items were a notebook, a wall calendar, a memo pad, the family, a mobile phone, a smartphone, a tablet, a laptop, a desktop computer, and other items.

2.4 Word span task

Participants memorized the correct order of recalling a stimulus, which was a hiragana character (う, け, こ, す, ち, ぬ, ひ, ほ, み, や, る, or を) presented on a presentation slide displayed on a screen (PowerPoint; Microsoft Corp.). The experimenter presented a character on a screen in front of the participants for about 1000 ms. Participants responded to two word-span tasks. The experimenter presented six stimuli in the first and seven stimuli in the second task. After the stimuli were presented, the participants recalled the order of the stimuli and wrote it down on the answer sheet provided for each task. Figure 1 presents stimuli and an answer sheet for the group version word span task.

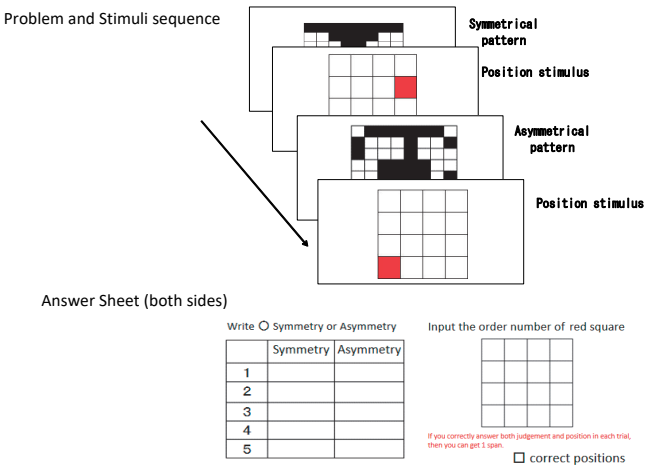

Figure 3. Stimuli and answer sheet for group version symmetry span task.

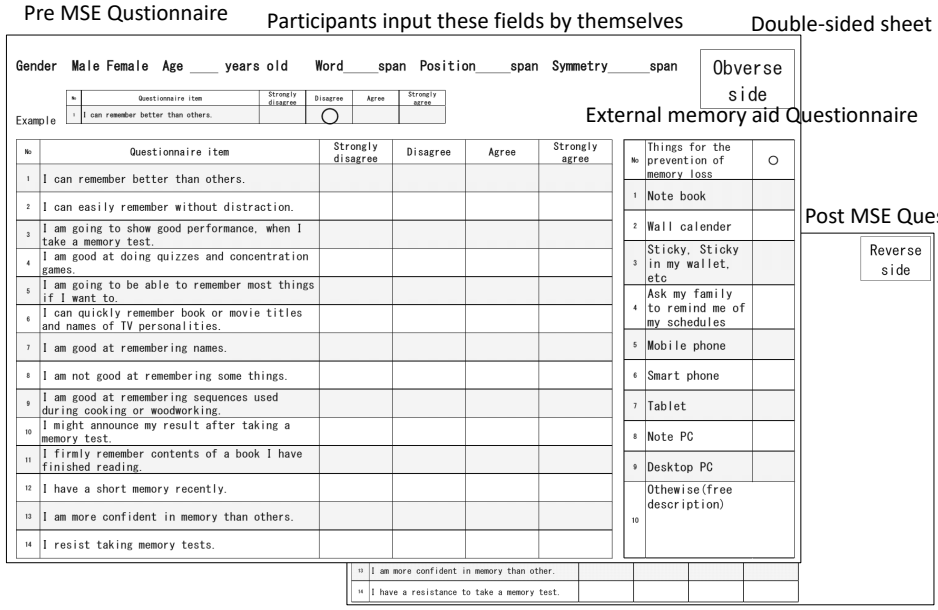

Figure 4. Answer sheet used in classes.

Note: Sheets of this anonymous questionnaire were collected after class.
Because this sheet was double-sided, we were able to identify certain participants.

Having completed the tasks, participants counted their correct answers by checking the slide of correct answers. They wrote the number of correct answers, which meant a word span of each participant, down on the underlined word span part located in the upper part of the pre-MSE questionnaire sheet (Figure 4).

2.5 Position span task

Participants memorized the correct order of the position of a red square in a 4 × 4 matrix presented as a slide (PowerPoint; Microsoft Corp.) for approximately 1000 ms on the same screen as the word span tasks. Participants responded to two position span tasks. The experimenter presented five stimuli in the first task and six stimuli in the second task. Subsequently, they recalled the order of the positions of red squares and wrote it down on the answer sheet provided for each task. Figure 2 shows stimuli and an answer sheet for the group version position span task. After completing the tasks, participants counted their correct answers and wrote down the score on the underlined position span part just as they had done for the word span task.

2.6 Symmetry span task

The symmetry span tasks are working memory span tasks for a visuospatial domain (Unsworth *et al.* 2009). For the experiment, participants were required to complete memory tasks and to process tasks simultaneously, generally designated as a dual task situation. The original version of the symmetry span tasks, in which the participant performs the tasks individually, was used for older adult participants (Salthouse and Pink 2008). The symmetry span tasks of the group version were revised for the memory classes in this study.

The symmetry span task requires that participants judge whether a stimulus figure is bilaterally symmetrical. After making the judgment, the participants memorized the position of a red square in a 4 × 4 matrix presented on the screen. The experimenter presented four combinations of recall stimulus and judgment task in the first task and five combinations of these in the second task. If participants correctly recalled the order of recall stimulus and judged the stimulus figure at the order, participants counted up their working memory span by checking the slide of correct answer. Then they wrote it down on the underlined symmetry span part just as they did for the other memory span task by themselves. Figure 3 presents stimuli and an answer sheet for the group version symmetry span task.

Table 1 Descriptive statistics for MSE questionnaire and factor loading on a MSE factor

No.	Questionnaire item	Pre		Post		Factor loading	
		Mean	*SD*	*Mean*	*SD*	Pre	Post
1	I can remember better than others.	2.122	0.816	2.014	0.841	0.789	0.754
3	I am going to show good performance, when I take a memory test.	1.892	0.792	1.811	0.777	0.782	0.754
13	I am more confident in memory than others.	1.973	0.773	1.905	0.828	0.725	0.670
5	I am going to be able to remember most things if I want to.	2.142	0.865	2.007	0.877	0.705	0.810
2	I can easily remember without distraction.	2.061	0.851	1.946	0.839	0.702	0.758
6	I can quickly remember book or movie titles and names of TV personalities.	1.797	0.747	1.791	0.740	0.652	0.641
7	I am good at remembering names.	1.845	0.822	1.831	0.860	0.646	0.641
4	I am good at doing quizzes and concentration games.	1.892	0.801	1.865	0.814	0.623	0.731
11	I firmly remember contents of a book I have finished reading.	2.378	0.868	2.115	0.845	0.615	0.658
9	I am good at remembering sequences used during cooking or woodworking.	2.514	0.922	2.331	0.950	0.546	0.691
10	I might announce my result after taking a memory test.	2.101	1.093	2.074	1.101	0.487	0.570
12*	I have a short memory recently.	2.993	0.979	2.899	0.981	0.022	−0.012
8*	I am not good at remembering some things.	2.730	0.945	2.662	0.980	−0.140	−0.203
14*	I resist taking memory tests.	2.399	1.055	2.358	1.088	−0.201	−0.290

n = 148

* Reverse item

Factor contributions pre-MSE 4.954 post-MSE 5.707

2.7 Procedure

Informed consent was obtained from participants before the experiment. The two-sided answer sheets had the MSE questionnaire and an external memory device questionnaire. Memory span record cell sheets were also used for memory span tasks. Figure 4 portrays an answer sheet used in classes. Participants answered a pre-MSE questionnaire and an external memory devices questionnaire. Then they recorded their memory span scores on the obverse side of the sheet. After completing the memory span tasks, they answered post-MSE questionnaire on the reverse side. Although the sheet was unregistered, we were able to identify participants from these sheets. Each participant's unregistered memory span score and the MSE questionnaire sheets were collected after the class.

After participants responded to the pre-MSE and external memory aid questionnaires, they sequentially completed the group versions of word, position, and symmetry span tasks. Finally, they responded to the post-MSE questionnaires. All questionnaires and tasks, which were paper and pencil type, were completed by participants in a group.

3. RESULTS

We conducted a confirmed factor analysis of the 14 scores of pre-MSE and post-MSE items, extracting a MSE factor and applying an oblique rotation. Table 1 presents descriptive statistics and the loadings of the items on the pre-MSE and post-MSE factor in each MSE questionnaire items.

Factor analysis of participant ratings of the MSE questionnaires indicated identical MSE dimensions to those which Kawano and Ohta

Table 2 Descriptive statistics, correlation coefficients (below the diagonal) and partial correlation coefficients after controlling for age (above the diagonal) for the measures

Measure	*Mean*	*SD*	*Min*	*Max*	1	2	3	4	5	6	7
1. Age	75.00	6.34	60.00	92.00	—						
2. Pre-MSE	22.72	6.48	11.00	41.00	.00	—	.63 **	−.02	.10	.11	.03
3. Post-MSE	21.69	6.98	11.00	40.00	−.16 *	.63 **	—	.17 *	.38 **	.47 **	.15 +
4. Word span	5.21	1.44	0.00	7.00	−.22 **	−.02	.20 *	—	.10	.15	.12
5. Position span	4.00	1.15	0.00	6.00	−.10	.10	.39 **	.12	—	.43 **	.15 +
6. Symmetry span	2.94	1.40	0.00	5.00	−.30 **	.11	.49 **	.21 *	.44 **	—	.28 **
7. External memory aid	2.57	1.14	0.00	6.00	−.18 *	.03	.18 *	.15 +	.16 +	.31 **	—

Note. External memory aid means the number of participant's external memory devices.

** $p < .01$, * $p < .05$, + $p < .10$, n = 148 except for Symmetry span, n = 111 for Symmetry span.

(2000) described in a report of an earlier study. The MSE score was formed by combining 11 items with loading of more than .48 of the pre-MSE and over .57 of the post-MSE on the MSE factor. The pre-MSE and post-MSE scores indicated excellent internal consistency (pre, α = .89; post, α = .91). Table 2 shows descriptive statistics and correlation coefficients of the variables used in these analyses. The mean of the post-MSE scores was significantly less than the mean of the pre-MSE scores, t (147) = 2.14, $p < .05$, as shown in Table 2.

4. DISCUSSION

This study assessed the subjective MSE of short-term and working memory before and after older adults attended a class on memory. Relations among pre-MSE and post-MSE scores, age, short-term and working memory span, and the number of external memory aid of participants were all analyzed.

Age was significantly and negatively related to post-MSE scores, word span, symmetry span, and the number of external memory aids. The symmetry span, an index of working memory span, showed moderate correlation. Others showed weak correlation with age. The results and those of an earlier study (Park *et al.* 2002) showed that memory resources of older adults and MSE decline with cognitive aging. Significant and negative correlation was found between age and the number of external memory aids of participants, suggesting that older adults have not come to employ external memory aids in everyday life with cognitive aging. External memory aids are a basic and important memory strategy to expand memory resources. Therefore, training in the use of distributed resources in everyday life is effective for older adults.

The mean of post-MSE scores was significantly lower than that of pre-MSE scores, demonstrating that subjective MSE differed between the assessment of short-term and working memory in the study participants. No significant correlation was found between pre-MSE scores and memory span measures and the external memory aid measure, but post-MSE scores were significantly and positively correlated among all these measures. Positive correlation between post-MSE and short-term and working memory spans suggests that MSE in older adults changed from irrelevant to relevant as a result of group working memory tasks.

The MSE is a concept of our engagement in memorization or positive use of memory strategies. It is assumed to be correlated with real memory task performances in everyday life (Kinjo *et al.* 2018). Although MSE significantly decreased after memory span tasks in this study, the scores of post-MSE significantly and positively correlated with memory spans. Results showed that older adults adjusted their metacognition of their memory spans to appropriate levels.

Kawano and Ohta (2000) demonstrated that older adults lose their MSE when experiencing memory failure or decay. Memory span task results of participants with these failure or decay experiences were found to have MSE shifts. Bandura (1977) proposed that four sources cause self-efficacy shift: performance accomplishment, vicarious experience, verbal persuasion, and emotional arousal. That study emphasized that performance accomplishment including both success and failure of tasks, is a particular factor. It seems reasonable to conclude that a participant's failure experiences of memory span tasks caused the decline in MSE scores found in this study.

This study demonstrated a change in the relevance of MSE in older adults appropriate to their short-term and working memory span. The change was accomplished easily through memory span tasks completed in a group.

Kawano (1999) reported significant and negative correlation between MSE and memory task performance in older adults. By contrast, the present study showed no correlation between pre-MSE and memory span tasks, but significant positive correlation between post-MSE and memory span tasks. Results further imply that the MSE of older adults is situation-dependent and task-dependent. The *Introduction* describes that proper assessment of MSE in older adults must be done along with cognitive aging to decrease memory failures in the everyday life of older adults. Participants were asked MSE questionnaires before memory task implementation in the earlier Kawano (1999) study. This situation differed from the situation used for our study, which examined participants after memory task implementation. The MSE change found from the present study shows that memory span tasks such as easy and group short-term or working memory span tasks might be effective for adjusting older adult MSE.

With cognitive aging, the decline of working memory resources and functions is more important than that of short-term memory resources

(Salthouse 1993). The working memory span found in this study is moderately correlated with post-MSE, in contrast to the weak correlation found between post-MSE and the short-term memory span. Moderate correlation between the working memory span and post-MSE showed that the working memory span adequately reflects the memory resources of older adults. Results show that working memory span tasks such as those in the group examined in this study are effective to attract attention to their memory resources in older adults.

The numbers of external memory aids of participants were significantly and positively related to post-MSE and working memory span. This correlation suggests that, to compensate for their memory resources, participants with high MSE and working memory capacity use external memory aids more than others do. Otsuka (2003) reported that younger adults with high working memory capacities operate external resources such as computer displays in problem-solving better than those with low working memory capacities. Presumably, appropriate MSE and working memory resources in the older adults examined in this study engender the use of distributed representations such as external memory aids.

Because the participants of the present study were 60- 92 years old, individual differences in cognitive aging of the study participants are expected to be large. However, we did not complete dementia scales and did not check participants' eyesight. We only asked their age and gender for their profile. The questionnaires and memory tasks were administered in silence.

The ratio of the results which were analyzed for working memory span tasks in a group in an earlier study were 98.8% (419/424) (De Neys *et al.* 2002), 100% (30/30) (Sasaki 2006), and 80.8% (97/120) (Shibasaki *et al.* 2015). The ratios of this study were 48.6% (148/304, short term memory span tasks) and 36.5% (111/304, working memory span tasks). As a result, the ratios of analyzed results were fewer than those reported from earlier studies of children, students, and younger adults. Procedures of group administered memory span tasks for older adults must be developed further.

Data used for this study were not collected from experimental or controlled situations. In fact, we only analyzed about half of the participants: those who were able to answer memory span tasks perfectly. Some participants with diseases might have been included. Some environmental difficulties such as screen size or audio visual devices might have affected these results. However, results reported herein suggest that these easy and group versions short-term and working memory span tasks beneficially change older adult MSE. These results underscore that these memory task classes, by virtue of their adjustment of MSE, can be effective for avoiding or mitigating the need for dementia care.

5. SUMMARY

We assessed short-term and working memory from changes in subjective MSE before and after older adults attended a class on memory. We analyzed pre-MSE and post-MSE scores, short-term and working memory spans, and the number of external memory aids of participants.

Older adults (N = 148) responded to pre-MSE questionnaires, short-term memory span tasks, working memory span tasks, and post-MSE questionnaires in a class situation. They also reported the daily life memory aids they use.

The mean post-MSE scores were not correlated with age, memory span, or external memory aids. However, the mean of post-MSE scores was significantly lower than that of pre-MSE scores. Results show negative weak correlation with age, positive weak correlation with short-term memory span and the number of external memory aids, and positive moderate correlation with the working memory span.

Positive correlation found only between post-MSE and short-term memory and working memory spans suggests the occurrence of relevant change of MSE in older adults according to their short-term and working memory span through easy memory span tasks performed in a group. Particularly, the moderate positive correlation between post-MSE and working memory span indicates that the decline of resources and functions in working memory is important for cognitive aging. Classes that include working memory span tasks are effective to address difficulties that arise with cognitive aging and metacognition in older adults.

ADDITIONAL STATEMENT

This is an expanded and revised version of work reported earlier by Otsuka (2018).

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