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# Effects of Sensory Stimulation Type on Learning in Elderly People

The purpose of this study was to examine the effects of sensory stimulation type on the learning of the elderly. The study implemented elderly verbal learning test by evenly dividing a total of 40 elderly people into auditory stimulation followed by visual stimulation group(AVG), visual stimulation followed by auditory stimulation group(VAG), simultaneous visual and auditory stimulation group(SG), and auditory stimulation group(AG). The result are as follows. SSG showed highest results in most of the test, followed by AVG, VAG, and AG. In particular, SG showed a statistically significant difference in immediate recall total score and short delay free recall score($p<.05$). In the post-hoc test results of immediate recall total score, SG showed highest score with a statistical significance. AVG showed the second highest score, followed by VAG and AG and all showed a statistic significance($p<.05$).In the post-hoc test results of short delay free recall score, SG and AVG showed a statistically significantly higher score than AG($p<.05$). The results suggest that simultaneous stimulation of visual and auditory sense is more effective for improving the learning of the elderly people than visual stimulation followed by auditory stimulation or auditory stimulation followed by visual stimulation.

Key words: *Old, Learning, Sensory Stimulation, Recall, Recognition*

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## INTRODUCTION

Cognitive function begins to slowly decrease when one reaches old age. Mild cognitive impairment refers to a pre-dementia syndrome where cognitive function diminishes to an extent that does not disrupt daily life(1,2). The decline of cognitive function due to aging could cause not only reduction of individual adaptation ability as well as emotional problems such as depression or anxiety but also difficult social relationship thereby degrading life quality of elderly persons significantly(3). Symptoms of mild cognitive impairment include memory and attentiveness that are weaker than normal people and stronger than patients with Alzheimer's disease(4). Those with mild cognitive impairment also experience significant decrease of linguistic learning and time and visual spatial ability(5). Learning refers to relatively permanent change of responding ability as a result of practice or experience. Motor learning refers to a series of procedure that causes relatively permanent change of responding ability by acquiring motor techniques through repeated practice and experience. Multiple domains of brain are involved in such procedure. Motor learning consists of cognitive phase, associative phase, and autonomous phase. In cognitive phase, a performer who first encounters a task pays attention to decide what to do and how to try and his/her cognitive activity is animated to find an appropriate strategic scheme(6). In this phase, a lot of learning takes place involving language and cognitive attribute(7).

Studies that aim at enhancing learning ability of the elderly by improving their diminished memory function have been mainly focused on theoretical education regarding cognitive function and training

of strategies for efficient information process(8). However, there is scarce study that examines the effects of the type of sensory stimulation on learning. Hence, further studies are required that can examine the effects of the difference of sensory stimulation type on the learning ability among the elderly people.

## METHODS

### Subjects

This study was conducted with elderly persons using a retirement community located in Youngdeok-gun, Gyungbuk from October 18, 2015 to October 25, 2015. Among them, 40 elderly persons over 65 year's old who can understand the study objective and gave consent to the study participation.. General characteristics of the subjects are as follows(Table 1).

#### Experimental Procedure

For the selection of research subject, cognitive test and one on one interview were conducted as fundamental investigation following the initial interview. Among the subjects, those who agreed on participating in the study were randomly allocated to the following four groups each with ten members: visual stimulation followed by auditory stimulation group, auditory stimulation followed by visual stimulation group, simultaneous visual and auditory stimulation group, and auditory stimulation group. Elderly verbal learning test was implemented after the sensory stimulation.

### Measurement scale

#### Elderly verbal learning Test

Elderly memory disorder scale is a test that was developed to intensively assess the memory function of cognitive domain among the elderly people(9). Elderly memory disorder scale test consists of elderly verbal learning test, story recall test, simple rey figure test, digit span test, spatial span test, clock drawing test, and Korean-Boston naming test. This study used Elderly Verbal Learning Test among the subtests of the elderly memory disorder scale. Elderly verbal learning test is capable of evaluating not only the learning ability and learning strategy, short term memory and long-term memory, and recognition ability, but also the interaction between linguistic memory and conceptual ability. Considering the nature of elderly people's cognitive function that diminishes following the normal aging process, the difficulty level of test was defined such that it can be appropriate for the elderly. This is a linguistic memory test where three words are chosen from each of three semantic categories and the subjects memorize the words after listening to the list that is composed of a total of nine words. As for the

Table 1. General characteristics of the subjects

| | | AVG | VAG | SG | AG | Total | P |
|---|---|---|---|---|---|---|---|
| Sex | M | 2 | 2 | 2 | 2 | 8 | |
| | F | 8 | 8 | 8 | 8 | 32 | |
| Age(years) | | 74.30±3.30 | 74.20±4.13 | 73.80±3.85 | 73.90±4.65 | 74.05±3.86 | .991 |
| Height(cm) | | 159.00±4.59 | 158.40±4.77 | 160.70±5.60 | 158.80±6.34 | 159.23±5.24 | .784 |
| Weight(kg) | | 56.10±3.78 | 56.80±4.34 | 57.00±4.50 | 56.40±4.93 | 56.58±4.25 | .968 |
| BMI | | 22.24±1.95 | 22.69±2.09 | 22.09±1.70 | 22.42±2.20 | 22.36±1.93 | .920 |
| MMSE-K score | | 21.50±1.51 | 21.20±1.135 | 21.60±1.51 | 21.20±1.32 | 21.38±1.33 | .879 |
| Education years | | 4.30±1.89 | 6.40±2.59 | 5.20±1.75 | 6.30±.95 | 5.55±2.01 | .055 |

Values are mean±standard deviation, AVG : auditory stimulation followed by visual stimulation group, VAG : visual stimulation followed by auditory stimulation group, SG : simultaneous visual and auditory stimulation group, AG : auditory stimulation group

words list, there are learning list and interference list where the words that contain minor impact from an aspect of education, gender and social class were selected. After repeated learning of the list, short delay recall, long delay recall, and recognition tasks were implemented. Immediate recall of the interference list is implemented as an interference task between the implementation of the learning list (first to fifth implementation of immediate recall) and short delay recall, through which the interference effects of the memory can be examined(9).

### Data analysis

In the present study, the statistical program SPSS 18.0 was used for data analysis. General characteristics of the study subjects were produced as frequency analysis, means and standard deviations. In order to verify the difference of elderly verbal learning ability according to sensory stimulation type, one-way ANOVA was employed and Scheffe was conducted for the post-hoc test. The statistical significance level was set as $\alpha$=.05.

## RESULTS

### Comparison of the elderly verbal learning scores according to sensory stimulation type

Most of the verbal learning scores according to the sensory stimulation type were highest in simultaneous visual and auditory stimulation group, followed by auditory stimulation followed by visual stimulation group, visual stimulation followed by auditory stimulation group , and auditory stimulation group. In particular, immediate recall total score and short delay free recall score showed a statistically significant difference($p<.05$)〈Table 2〉. There was a statistically significant difference in immediate recall total score. In the post-hoc test results, simultaneous visual and auditory stimulation group showed highest score with a statistical significance. Auditory stimulation followed by visual stimulation group showed the second highest score, followed by visual stimulation followed by auditory stimulation group and auditory stimulation group and all showed a statistic significance($p<.05$)〈Table 2〉. There was a statistically significant difference in short delay free recall score. In the post-hoc test results, simultaneous visual and auditory stimulation group and auditory stimulation followed by visual stimulation group showed a statistically significantly higher score than auditory stimulation group($p<.05$)〈Table 2〉.

## DISCUSSION

Prevalence rate of mild cognitive impairment is reported to be 3% among the population over the age of 60 and 15% among those over the age of 75(10). Specific symptoms of mild cognitive impairment include memory and attentiveness that are lower than normal people and higher than

Table 2. Comparison of verbal learning score according to sensory stimulation type on each group (unit : score)

| | AVSG | VASG | SSG | AG | F | p | post-hoc |
|---|---|---|---|---|---|---|---|
| immediate recall total | 29.90±1.37 | 27.90±1.10 | 32.10±1.19 | 27.10±1.37 | 31.229 | .000* | c>a>b,d |
| interference recall | 3.30±1.05 | 3.50±.52 | 3.60±1.26 | 2.90±.56 | 1.154 | .341 | ns |
| short delay free recall | 6.30±1.56 | 5.20±1.13 | 6.20±1.22 | 4.70±.82 | 4.090 | .013* | a,c>d |
| short delay cued recall | 6.70±1.05 | 6.40±1.35 | 6.80±1.03 | 6.20±1.22 | .549 | .652 | ns |
| long delay free recall | 6.10±1.10 | 5.70±1.33 | 6.20±.78 | 5.80±1.61 | .363 | .780 | ns |
| long delay cued recall | 6.10±.87 | 5.90±.99 | 6.00±1.05 | 6.00±1.24 | .060 | .980 | ns |
| long delay recognition | 23.60±1.42 | 23.10±.99 | 23.20±.91 | 24.50±1.35 | 2.848 | .051 | ns |

*p<.05

patients with Alzheimer's disease(4). Those with mild cognitive impairment experience significant decrease of linguistic learning and visual-spatial ability(5). Studies on various factors that influence learning and activation in brain regions due to motor learning processes have been one actively(11,12). However, few studies have been done on the effect of sensory stimulation type change on learning difference. Therefore, studies aimed at improving learning ability of the elderly are required. This study used Elderly Verbal Learning Test as a subtest for examining memory impairment of the elderly and investigated their verbal learning ability according to the type of sensory stimulation.

In this study, most of the verbal learning scores were highest in simultaneous visual and auditory stimulation group, followed by auditory stimulation followed by visual stimulation group, visual stimulation followed by auditory stimulation group, and auditory stimulation group. In particular, a statistically significant difference was observed in immediate recall total score and short delay free recall score. Immediate recall total score showed a statistically significant difference where simultaneous visual and auditory stimulation group showed statistically highest results in post-hoc test, followed by auditory stimulation followed by visual stimulation group, visual stimulation followed by auditory stimulation group, and auditory stimulation group all of which had statistical significance. Short delay free recall score showed a statistically significant difference where auditory stimulation followed by visual stimulation group and simultaneous visual and auditory stimulation group showed higher post-hoc test results than auditory stimulation group with a statistical significance. It is conjectured that simultaneous provision of visual and auditory stimulation is helpful for memory, which consequently increases the verbal learning score.

Similar to this study results, Mayer and Anderson reported that ability to understand and memory was stronger when animation that contains visual information and narration that contains auditory information are provided at the same time, rather than providing each separately(13). Mayer and Sim reported that learners' ability to understand learning and memorize was stronger when presenting words and figures on the same page rather than providing each separately(14). These results imply that providing multiple sensory stimulations in a dispersed way is more effective for learning than providing in an integrated way. It is conjectured that presenting a combination of auditory and visual information reduces cognitive load so that more cognitive resources can be used for learning(13,14).

Controversial to the results of this study, Mayer and Moreno reported that presenting either one of visual information or linguistic information causes overload of the channel of the functioning memory, that is, visual channel or auditory channel, and that presenting two types of information separately can diminish the overload(15). It is conjectured that decreased cognitive overload increases cognitive resource, enhancing the ability to understand learning and memorize.

Based on the above results, it is most effective to simultaneously stimulate both of visual and auditory senses for the improvement of verbal learning among the elderly. We also found out that visual stimulation followed by auditory stimulation is more effective than auditory stimulation followed by visual stimulation or auditory stimulation only.

## CONCLUSIONS

This study compared verbal learning score of the elderly by evenly dividing 40 elderly people over 65 into auditory stimulation followed by visual stimulation group, visual stimulation followed by auditory stimulation group, simultaneous stimulation of visual and auditory sense group, and auditory stimulation group for the purpose of examining the effects of sensory stimulation type on the learning of the aged. The verbal learning score was highest in simultaneous visual and auditory stimulation group in most of the cases, followed by auditory stimulation followed by visual stimulation group, visual stimulation followed by auditory stimulation group, and auditory stimulation group. In particular, immediate recall total score and short delay free recall score showed a statistically significant difference. We found out that simultaneous stimulation of visual and auditory sense is most effective for improving verbal learning of the elderly. Additionally, providing auditory stimulation after visual stimulation is more effective than providing auditory stimulation followed by visual stimulation or providing auditory stimulation only.

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