A CASE STUDY OF CUSTOMIZED COGNITIVE INTERVENTION FOR AN ELDERLY PERSON WITH COGNITIVE IMPAIRMENT AND EARLY DEMENTIA

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Abstract

Cognitive impairment of the elderly due to aging generates difficulties in daily life caused by memory loss. The purpose of this study was to analyze changes in the memorization abilities of an elderly person suffering from cognitive impairment and early dementia during a cognitive intervention, which involved recalling the contents after reading a story. The 94-year-old subject has cognitive impairment due to aging, as well as decreased vision and hearing loss. Customized cognitive intervention ended with a total of 35 sessions by saying the contents remembered after reading a storybook in words and sentences. With a view to analyzing the subject's performance ability during the intervention session, the number of total words and different words that are remembered from reading 5 paragraphs, the appearance rate of each part of speech in the number of different words, the number of synonyms, and the number of sentences from the storytelling tasks were calculated respectively. First, the number of total words, different words, synonyms, and sentences tended to increase compared to that of the baseline, but the performance of remembering was found to be greatly affected by changes in the subject's physical and mental condition. Second, as for appearance rates in different words, nouns (54.9%), verbs (32.3%), adverbs (4.7%), adjectives (4.1%), determinatives (2.5%), and pronouns (1.6%) are followed. Particularly, nouns and verbs were found to be remembered the most. The results of this study are anticipated to provide basic data for devising customized intervention programs for the elderly suffering from cognitive impairment or dementia.

Key Words: cognitive intervention, cognitive impairment, dementia, the elderly

I. INTRODUCTION

In Korea, the elderly population has rapidly increased as the average life expectancy has been extended due to the development and national prevalence of medical technology. Statistics Korea (2023)[1] predicted that Korea will enter a super-aged society in 2025. As most of the elderly suffer from degenerative diseases induced by aging, especially cognitive problems, they have challenges in terms of physical, mental, and social interpersonal relationships along with gradual isolation from cultural life and community activities.

Therefore, appropriate interventional assistance is required to solve various difficulties in daily life caused by cognitive problems (Cho, S. H., 2022)[2]. Despite old age, the development of customized cognitive rehabilitation programs is demanded to prevent social isolation in the daily life of the elderly and at the same time, to maintain communication skills in social relationships.

Mild cognitive impairment is very likely to worsen into dementia with an 80% chance within 10 years. As a result, anxiety about cognitive decline(Petersen et al., 2001)[3] such as cognitive impairment and Alzheimer's disease is also increasing due to the overall cognitive decline (Lee, S. J., 2009)[4]. At this point, when research on pharmacological treatment is being accelerated to prevent dementia, but the effect is not yet proven, attention is being focused on nonpharmacological treatment to slow the progress of dementia. Cognitive intervention treatment as a nonpharmacological treatment can improve cognitive function by activating neural networks through repetitive learning based on neuroplasticity.

Previous studies on cognitive impairment mainly focused on memory and executive functions to select early cognitive impairments (Headley et al., 2018)[5], and in the language area, reports of defects in word finding are mainly carried out (Choi, S., 2020; Mueller et al., 2018)[6,7]. This emphasizes the importance of cognitive intervention to identify the decline in language ability and improve cognitive function concerning memory.

There is no cure for dementia yet, moreover, prevention is more paramount than any other disease due to the nature of the disease. Accordingly, it is recently recommended to perform cognitive intervention along with pharmaceutical treatment at the national level to reduce the risk of developing dementia as much as possible and delay its progression. In addition, in the case of the elderly at home suffering from cognitive impairment or dementia, physical changes and complicated health issues caused by aging further deteriorate cognitive function, consequently, it is indispensable to formulate a practical apparatus to detect physical and mental changes in the early stage.

Therefore, the purpose of this study was to investigate whether a customized cognitive intervention in a storytelling task, namely, speaking through reading tasks improves memory skills for the elderly who are at the border between cognitive impairment and early dementia. Through this study, we tried to

deliver basic data in order to supply customized interventions for the elderly.

II. Materials and Methods
1. Procedures

Customized cognitive interventions (from 28 April 2023 to 31 July 2023) were conducted 3 times a week for 3 months, a total of 35 sessions. From the 1st session to the 5th session, the baseline phase was set, and the 6th-35th session ended with an intervention phase and the 36th session ended with a maintenance session. Maintenance was performed two months after the end of the intervention, but only one session was conducted on account of vision problems. Sessions 1-5 were conducted in the morning, and after that, the subject wanted to do it in the afternoon, so it was operated in the afternoon until the last session.

The researcher of this study supervised this task at the subject's house to maintain the most comfortable and stable atmosphere for the subject. The customized cognitive intervention was processed as the subject spoke the contents what he remembered after reading aloud the paragraphs of the novel. The intervention was tailored to the subject's needs since the subject wanted to maintain reading ability as far as he could.

After reading each paragraph consisting of about 4-6 sentences, the process of what he remembers was conducted 5 times, and the first session ended with a task of organizing the contents of the 5 paragraphs read as he remembered and telling them again. The total time required for this process was about 20 minutes. The number of sentences in one paragraph was divided into smaller sections of 4-6 sentences so that the subject did not have much difficulty in understanding the whole content.

While the subject performed remembering and talking about what he read in the intervention session, the reseacher wrote down everything the subject said. The researcher counted the number of total words (NTW) and the number of different words (NDW) for the words remembered by the subject immediately after each intervention session, whereas different words were analyzed by part of speech. In addition, the number of synonyms was counted when the words remembered by the subject were replaced with words that were not mentioned in the text but had a similar meaning.

In the storytelling task of remembering and speaking the contents of all five paragraphs, the sentences spoken by the subject were counted in a unit of simple sentence (subject + object + verb). In addition, the researcher observed changes related to the subject's performance in each session and wrote them from the researcher's viewpoint. Simultaneously, the researcher asked the subject whether any physical or mental factors influenced the performance of the task and summarized the answers.

Other than that, the intervention was terminated with 35 sessions since the subject reached a stage where he could no longer continue reading the book due to deterioration of sight. After completing the intervention, one session of the intervention was administered in the same manner to identify the degree of maintenance in the second month, however, the additional maintenance session was not operated in so much as the subject's health issues serving as intraocular pressure increased. On top of that, during the baseline period, the subject conducted tasks to remember the content by simply listening to one paragraph. Notwithstanding, since the subject recalled only one word intermittently, it was decided not to proceed with the listening task anymore. The subject struggled, saying that the very moment he listened to the content of the story while performing the task, the content came to his mind or became understood vaguely, but once he tried to utter the words he had reminded about the content, he had a hard time that he just couldn't think of anything at all, and nothing came up.

2. Subject

The subject was a 94-year-old male who was diagnosed with mild cognitive impairment at the age of 84 and had been taking choline alfoscerate for about 10 years. The subject is staying at home with his family but gradually his daily life activities at home as well as social activities were lessened, and at the same time he continuously appealed about his cognitive function decline.

Following the problem of memory on account of the subject's cognitive impairment, the family also gradually appealed to difficulties in communicating with the subject. Later, at the age of 92, he was diagnosed with an average of 42 dB HL moderate hearing loss in both ears. After diagnosis, according to the doctor's prescription, CIC-type hearing aids were used in both ears. At the age of 92, on the K-MMSE (Korean-version of Mini-Mental State Examination, Kang, Y. W., 2006)[8], he scored 21 points. Since then, the subject complained of degenerated vision at the age of 93, and at this time, he was diagnosed with right eye blindness as well as progressive vision loss brought forth by macular degeneration and glaucoma.

Because of these conditions, the subject was receiving medication to maintain a certain intraocular pressure. In the left eye, it was possible to distinguish between objects and colors by using glasses (corrected vision 0.7), but there was a challenge in accurately determining the distance or height, and as a result, the subject appealed to numerous types of discomfort in daily life. To make it worse, in the process of blindness in the left eye, even including the subject himself, none of the family members was aware of the deterioration of his vision until the subject's right eye turned out to be blindness. Through this previous background, the whole family was afraid that even the left eye of the subject would become blind. As such, in that both hearing loss and vision impairment occurred simultaneously, the subject complained of continuous memory decline. The subject felt the difficulty of long-term memory more than short-term memory in their daily lives, and both episodic memory related to events they experienced and semantic memory related to information such as facts learned from specific words or books were complicated, but the subject complained of more difficulty in semantic memory than episodic memory. For example, the subject had read newspapers throughout his life, but at the age of 88, he stopped as he moved to a new place. However, two years later, he tried to read newspapers again, but at that time, he realized that he could hardly recall the contents of the newspaper at all even if he read the newspaper and accordingly, he gave up reading newspapers in the end. Since then, the subject had watched the news on TV, but still it was a tough challenge for him to remember what he saw and heard on screen.

3. Materials

The cognitive intervention used in this research attempted to improve memory through reading, a method familiar to the subject, in consideration of the subject's daily life habits. Semantic memory contains information about facts shared by the world and the community. Unlike episodic memory related to individual experiences, semantic memory is unrelated to the temporal and spatial context in which information was obtained and instead of it, implicates information or knowledge about general facts. In the research method of this study, 'Memorize a

title', one of the methods introduced in A Smart Newspaper Reading, a method of reading and remembering newspaper topics, was applied. A Smart Newspaper Reading was published as 9988 A Smart Newspaper Reading: Doo-geun Doo-geun Brain Movement (Shin, S. R., Kim, S. Y., Kim, K. W., 2017)[9] by integrating cognitive training methods to improve the memory and language skills of the elderly at the Jung-ang Center for Dementia under the Ministry of Health and Welfare. The 'Memorize a Title' training is an approach of memorizing by heart an interesting news headline and remembering it again after a certain period. Therefore, by this mechanism, the effect of improving memory can be expected to improve through the process of repeated storage and withdrawal of new information. The procedure of the 'Memorize a Title' method follows reading a front-page newspaper article every Friday and subsequently writing the title of the article the subject wants to remember on a blank sheet of paper several times. On the Monday after the weekend, remember the title of the article again and fill out the activity sheet. This drill is a practice to incessantly train diverse cognitive functions, including memory that is susceptible to damage under aging or dementia, while looking at new newspaper articles and photos every day.

In this investigation, however, the subject had difficulty with the terms in the newspaper, so a large-letter book, Bunyan's The Pilgrim's Progress (translated by Cho, E. H., 2023)[10] as reading material instead of the newspaper was selected. A large-letter book refers to a book printed in 16-point font books that can be easily read by the elderly by the Ministry of Culture, Sports and Tourism to distribute. This large-letter book was chosen since the subject with poor eyesight is approachable to read and what's more, the translation was also straightforward for the subject to understand.

As for the intervention method of this research, the subject read one paragraph (about 4-6 sentences) of the contents of this book by himself and then said or wrote the contents he remembered in words or sentences. In this manner, he read and spoke the parts he recalled and finally the task was concluded by speaking the plot of the five paragraphs to the extent he could remember as far as possible. In addition to this, changes in the subject's generic performance ability were observed at each session, and concurrently, the subject's health status and changes were written in the intervention journal.

4. Data analysis

In this study, the researcher first compared the contents of the five paragraphs contained in the book with the contents remembered by the subject and counted the number of total words whose memory exactly matched the original text and the number of different words. At this time, the researcher analyzed the appearance rate of each part of speech for the vocabulary used in the different words from the perspective of examining the list of the subject's vocabulary preferences. Next, the researcher counted the number of synonyms representing the same meaning as the words in the book recalled by the subject. Finally, in the storytelling task of organizing and speaking five paragraphs, the number of sentences spoken by the subject was counted in a unit of simple sentence.

III. Results
1. Number of Total Words and Different Words

Until the 1st-5th (baseline phase) of the entire intervention sessions, the process was unchanged by and large, but from the 6th session, the number of total words and different words increased rapidly, and the performance ability correspondingly

improved (Figure III.1). Excluding after the 33rd session, which was the time when vision was weakened, the number of words in the 8th, 11th, 17th, 19th, and 27th sessions showed performance less than that of the baseline. Among them, the number of words in the 11th, 17th and 19th sessions were low and this was because the subject felt not only very tired but also realized that the story itself was demanding for him to understand. Except for those factors, it is presumed that this is because the story style was written in a literary style rather than a dialogue, and the content also contained religious parts and pieces that the subject was not very familiar with.

The performance of the 22nd and 23rd sessions, where the subject complained of a headache, was maintained at the baseline phase. In addition, the performance of the 17th, 22nd, and 29th sessions, which were conducted by delaying the next intervention session by 4-5 days due to poor health, was much lower than that of the previous regular sessions. What is particularly noteworthy was, that in the 8th session he did not remember the words corresponding to the reading content well, on the other hand, storytelling of the entire content (5 paragraphs) in sentences was better remembered than previous ones.

During the 27th session, the subject could not remember what was read in the 2nd to 4th paragraphs and instead only repeatedly said the content of the first paragraph. At the 33rd session, the subject's eyesight was deteriorated, making reading formidable, and at the 34th session, his eyesight was restored, but at the 35th session, his eyesight deteriorated to the extent that the reading task itself was difficult, forcing him to stop the intervention. Later, in the first session maintenance conducted on the second month after the intervention, the numbers of words except sentences showed higher performance than those of the baseline period.

Comprehensively, customized cognitive intervention is judged to have had a positive effect on the subject's memory performance. The subject's overall performance was greatly influenced by his condition on the actual day of the session and the familiarity with the story itself. The subject recalled that if these interventions had started earlier, they would have been very helpful in remembering. Therefore, it is the most critical part that such interventions should be provided at the right time to produce the most effective results for the elderly in need.
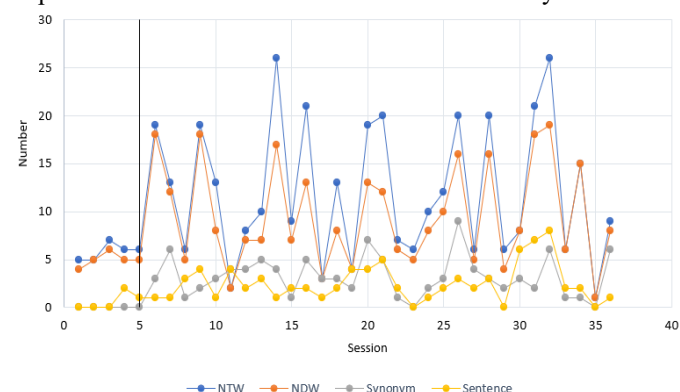

Figure III.1 The number of total words, different words, synonyms, and sentences.

2. Appearance rates of part of speech in different words

As for the number of different words remembered by the subject, only parts of speech were investigated, excluding numerals, exclamations and postposition introduction that serve as grammar morphemes among parts of speech in Korea. The number of different words (NDW) remembered by the subject during the intervention was a total of 319 words. Table III.1

shows the results of investigating the appearance rate by part of the speech.

Among parts of speech, nouns (54.9%) appeared the most and showed a significantly higher appearance rate than other parts of speech. The next was the verb (32.3%), which had a lower appearance rate than that of nouns but a higher appearance rate than others. Adverbs (4.7%), adjectives (4.1%), determinatives (2.5%), and pronouns (1.6%) appeared in order and showed a very low appearance rate compared to nouns or verbs.

Table III.1 Appearance rates of part of speech

Ranking	Number of Different Words	
	Part of speech	Appearance Rate(%)
1	Nouns	54.9
2	Verb	32.3
3	Adverbs	4.7
4	Adjectives	4.1
5	Determinatives	2.5
6	Pronouns	1.6

3. Number of synonyms

Unexpectedly, synonyms did not appear in the baseline phase, but from the 6th session during the intervention period, where the number of total words and different words began to appear, furthermore, when the numbers of total words and different words increased, the number of synonyms tended to increase as well (Figure III.1). As an example of synonyms, the subject expressed the word 'expiration' in the original text as 'death'. The synonyms that the subject produced are not accurate memories of the words corresponding to the contents read, but they can be illustrated to be alternative words that appear in good attempts to remember the contents by connecting the meanings of the entire contents.

4. Number of sentences spoken in the storytelling task

In the storytelling task, it was from the 4th session that the subject expressed in sentences after reading the entire plot of the 5 paragraphs. This is the point in time when the memorable words was connected and spoken in sentences, even if the number of total words or different words did not specifically increase while performing the reading task. What is peculiar about the subject's storytelling was that the number of spoken sentences was higher than that of memorized words in session 11, despite that the numbers of total words and different words were the lowest in the session. This did not mean that the number of sentences increased in a session where the number of total words and the number of different words heightened. This demonstrates that regardless of the number of total words and different words, some of the contents are continuously memorized meaningfully after reading. In the 19th, 20th, and 21st sessions, the number of sentences steadily developed, then decreased from the 22nd, and again, in the 30th, 31st, and 32nd sessions, the number of sentences increased to the maximum. Remarkably, it improved significantly in the 21st session. Meanwhile, in the 23rd, 29th, and 35th sessions, the storytelling tasks were not performed at all and it is supposed that poor health conditions during these periods influenced considerable parts of long-term memory.

IV. Discussions

One of the representative problems of an aging society is the deterioration of physical and mental activity due to aging. It was stated that when cognitive intervention was provided to the elderly with cognitive problems, it enhanced in numerous areas from memory, language ability, space-time ability, etc., to quality of life, self-efficacy, and depression (Kim, E. J. & Gong, E. S., 2014)[11]. The highest deterioration of attention concentration, orientation, and short-term memory was observed in subjects between 20 and 27 points in the MMSE test, and the main factor of the decline in attention concentration, memorization, and cognition was old age, and memory ability issues could predict dementia in MCI (Gomez-Soria, I. et al., 2021)[12].

Most of all, it was reported that the elderly in their 70s and 80s exhibited difficulty in vocabulary production (Kim, H. H., Yoon, J. H., & Kim, J. H., 2020)[13] during the discourse. Looking at the preceding studies on language and communication of the elderly, 'Naming' was used the most in terms of cognitive meaning (Kim, W. S. & Kim, S. H., 2017)[14]. In a study that provided an intervention using noun familiarity to the elderly with dementia, the intervention had a positive effect on the performance of naming (Mo, K. O., Sung, J. E., & Jeong, J. H., 2015)[15]. In this research, it is believed that the memory intervention through reading contributed to partially improving the subject's memory performance.

However, previous studies on the elderly (Boschi, V. et al., 2017; Mueller, K. D. et al., 2018) [16 7] ultimately attempted to confirm the deterioration of language function in the context of communication in everyday life. There was no significant difference in lexical and semantic analysis between the MCI group and the normal group in the connected speech of the elderly (Choi, J. S. et al., 2021)[17]. Therefore, in terms of memory shown in this study, the amount and frequency of semantic vocabulary production were compared with the results of the previous study(Jung, S. Y. & Park, H. J., 2022)[18]. In a storytelling task for the elderly in their 70s and 80s, the frequency of use by part of speech was in the order of nouns (38.9%), verbs (22.3%), adverbs (10.6%), postposition introduction (7.4%), and adjectives (5.7%). On the other hand, the frequency of use of nouns and verbs was the highest compared to other parts of speech, and the frequency of use of adjectives was lower than that of adverbs. This not only coincided with the results of the appearance rate of different words by part of this study, but the appearance rate of nouns (54.9%) and verbs (32.3%) was much higher than that of the previous study.

Although synonyms were not the same memory as the words in the original text, attempts to recall them could be regarded as an effort to supplement the whole content without missing any partial pieces in conveying the meaning of the reading. In this regard, it is necessary to analyze in-depth what the synonym means in the task of remembering what is read. It is understood that the subject's ability to tell the entire content of five paragraphs in a storytelling task as a story plot after remembering and speaking the content of each paragraph represented the degree of long-term memory. In addition, it is accepted that the comprehensive speaking ability had improved to some extent by utilizing the meanings partially remaining in long-term memory among the contents read by the subject through the storytelling task repeated in the intervention sessions. The subject's semantic memory was significantly influenced by his background knowledge as well. In the intervention results of this study, it could be speculated that the more familiar the content, the better it was connected to background knowledge, and as a result, it was more likely to promote memory. Since the subject's vision was continuously weakened and blindness was in progress, correspondingly for the subject, a program that

promotes memory by focusing on listening rather than reading is required. The subject said that he thought he could remember when he heard the contents of the book, but unfortunately, on the actual task, he couldn't think of anything at all. Like this, the difficulties in semantic memory of the elderly are called a failure of output (Hultsch, D. F. et al., 1992)[19] and accordingly, cognitive rehabilitation is required to help revitalize cognitive functions. Including memory, some valuable pinpoints such as deterioration of cognitive functions including memory abilities, progression of disabilities, lack of self-esteem, as well as the economic burden and psychological and mental difficulties of the family should be discovered in the early stage, and it should provide a personalized rehabilitation which can be led to a happy and healthy life in old age.

There was a limitation of the study that it was not possible to produce an individual's internal change accurately without bias due to the difference in the difficulty of words and content in the story content for each intervention session. Nevertheless, in the procedure of providing intervention, the subject's performance abilities changed on account of various factors, but while analyzing the change, the problem that appeared in the subject's physical change was detected early and the treatment was immediately started. Considering these backgrounds, it was found that individually tailored cognitive interventions for the elderly should be furnished before the occurrence of degenerative diseases that have a significant influence on cognition. For further research, it is fundamental to expand the number of subjects and develop reading materials that can objectify the results.

V. Conclusion

This study intensively provided interventions of reading and remembering stories to an elderly person who was at the border of cognitive impairment and dementia and analyzed the changes in the subject's memory performance. The outcomes of this study are as follows.

First, the number of total words and different words remembered by the subject during the intervention period increased by leaps and bounds, and the ability to perform the task also improved. However, the subject's memory performance was noticeably influenced by the subject's health status and familiarity with the story content.

Second, in the number of different words remembered by the subject during the intervention, the appearance rate of each part of speech was in the order of noun, verb, adverb, adjective, determinatives, and pronoun, and among them, the appearance rate of nouns and verbs was substantially higher.

Third, synonyms began to emerge in the first session of the intervention period, and the number of synonyms tended to increase when the total number of words and different words elevated.

Fourth, the number of sentences in the storytelling task was steadily increasing, but the performance of this task was also greatly affected by the subject's health condition.

In the future, this study is expected to contribute to basic data in observing physical and mental problems of degenerative diseases caused by aging, detecting them early, and managing them to lead to prompt treatment when constructing a customized program for cognitive intervention for the elderly with cognitive impairment or dementia.

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