

# Development of Coimagination Method towards Cognitive Enhancement via Image based Interactive Communication

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**Abstract**—Prevention of dementia is a crucial issue in this aged society. We propose coimagination method for prevention of dementia through supporting interactive communication with images. Coimagination method aims to activate three cognitive functions: episode memory, division of attention, and planning function, which decline at mild cognitive impairment (MCI). Participants of the coimagination program bring images according to the theme and communicate with them. The objective of the program is to make participants to focus on present and future rather than past, which is major difference between coimagination and reminiscence. We measure frequency of comments by others for each participant in order to evaluate interactivity of conversation. They take memory task whether they remember the owner or theme of images after the series of sessions. We held coimagination program successfully at the welfare institution for elderly people in Kashiwa city, Japan. Each session was held one hour per week for five times. The result of the task indicates that the participants showed empathy with each other. The effectiveness of the proposed method was validated through the experiment.

## I. INTRODUCTION

The number of people suffering from dementia is expected to quadruple by the year 2050. Prevention and suppression of the progress of dementia are crucial issues in this century. More than eighty percent of patients with dementia are with Alzheimer's disease or cerebral vascular disease. Therefore, the major strategy for prevention of dementia is to reduce risk factors for these two diseases (Fig. 1). There are two approaches for prevention of dementia. One is physiological approach and another is cognitive approach. Former approach includes improving dietary habits and physical activities. It is based on the fact that use of nonsteroidal anti-inflammatory drugs, wine consumption, coffee consumption, and regular physical activity were associated with a reduced risk of Alzheimer's disease [1]. Latter approach includes intellectual activities and development of social network. There is an evidence that a long-term cognitive-motor intervention in cholinesterase inhibitor-treated early Alzheimer disease patients produced additional mood and cognitive benefits [2], and an extensive social network seems to protect against dementia [3]. The effectiveness and durability of the cognitive training interventions were validated in improving targeted

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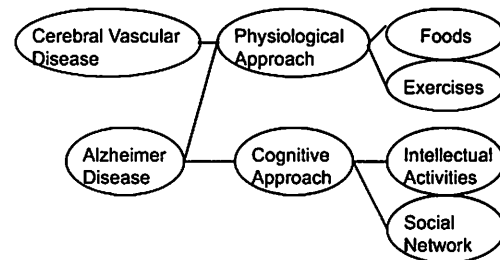


Fig. 1. Classification of Major Diseases causing Dementia with Associated Risk Factors and Effective Approaches

cognitive abilities [4]. There is a hypothesis that activation of three cognitive functions which decline at mild cognitive impairment (MCI) is effective for prevention of dementia [5], [6]. The cognitive functions include episode memory, division of attention, and planning function. Interactive communication activates above three functions. Reminiscence therapy is known as effective methods for the enhancement of psychological well-being in older adults [7]. However, its focus is not on activation of cognitive functions although it is based on communication. A replication of effectiveness studies of the well-defined protocols is warranted. This study proposes novel method with a measure, supporting interactive communication for activating three cognitive functions.

## II. COIMAGINATION METHOD

In this study, we propose coimagination method towards prevention of dementia through supporting interactive communication with images. The method is named after that we can share (co-) imagination through interactive communication with images. The basic concept of the method is listed below.

- 1) Communication is one of the typical intellectual activities. The method should support interactive communication so that three cognitive functions of participants including episodic memory, division of attention, and planning function are activated as a whole.
- 2) Communication is a foundation for social network. The method should contribute to generate social network among the participants through communication. Social network provides opportunity for sustainable communication among the participants.
- 3) The method should have measures for effectiveness. It requires both long term and short term measures. Short term measure should evaluate whether the activities required three cognitive functions.

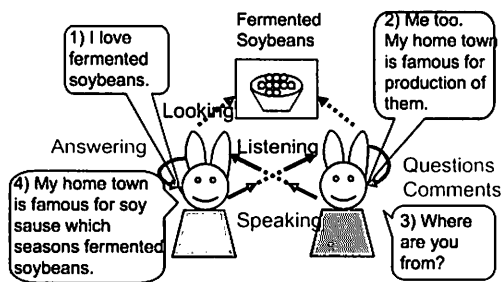


Fig. 2. Interactive Communication with Images

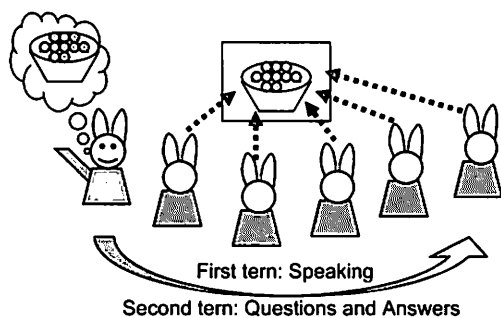


Fig. 3. Explicit Term Taking of Speakers and Listeners

The first strategy comes from the fact that interactive communication requires division of attention to listening, understanding, estimating intentions, asking questions, making comments. If the allocated time is fixed, division of attention to keep time is also required. Planning function is required if the theme of the communication is determined beforehand. The participants have to prepare topics of conversation according to the theme. We made two rules. One rule is to bring images according to the theme for communication so that division of attention, episodic memory and planning functions are activated. The participants have to look at images in addition to listening, speaking, asking questions and comments, answering to the questions (Fig. 2). They also have to remember which images they have and to plan which images they bring. Another rule is to make time limit of speaking and discussions for each participant. There are two terms: first term for speaking and second term for questions and answers (Fig. 3). Each participant has same period for both terms. Without this rule, role of speakers or listeners tends to be fixed during conversation. This is very important rule to achieve bidirectional communication. Each participant has equal period and opportunity for listening, speaking and discussions. Term taking between listeners and speakers is explicit and well organized.

In order to achieve second strategy, we extended theme of communication. Theme of communication of reminiscence has been past while theme of communication of coimagination is past, present, and future. The participants bring feelings rather than memories, which is a major difference between the coimagination method and the reminiscence

method, so that participants who don't want to remember anything from the past can participate. The objective of the method is to make participants to focus on present and future rather than past, since forward-looking thinking towards future is better than backward-looking one towards past for sustainable communication.

The third strategy is based on the fact that activation of cognitive functions leads to enhance the cognitive functions, although it takes time to alter cognitive functions. Activation of cognitive functions is measured by memory task and frequency of comments. We make rule for participants to take memory task in order to make clear whether communications themselves form episodic memory. Participants guess the owner and the theme of the collected images after a series of communications. Division of attentions and episodic memories are assumed to be activated when the topics of surrounding participants are remembered by each participant. In the same way, planning is successful when the topics of each participant are remembered by surrounding participants. Participants are also asked to make efforts towards listening carefully and giving comments or to asking questions to the speaker when they are listeners, and to make efforts towards giving interesting stories which can receive many comments and questions when they are speakers. We measured frequency of comments in order to evaluate interactivity of communication. We can evaluate who made many comments to other speakers or who received many comments during each participants' term, since the role of speakers and listeners are determined beforehand. Division of attentions are assumed to be activated when frequency of comments is high for both participants giving and receiving comments. Planning is successful when frequency of receiving comments is high.

To summarize, we define coimagination method and typical coimagination program as follows:

- Coimagination method supports interactive communication through bringing feelings with images according to the theme. Allocated time for each participant is predetermined. Participants take turns so as to play both roles of speakers and listeners. The themes of communication are examined considering the effects for social networking. Cognitive activities which require episodic memory, division of attention, and planning are measured by memory task and frequency of comments.
- We designed typical coimagination program which could be acceptable at welfare institutions. The program includes five series of sessions. Each session is held for an hour per week. Theme of each session is different. Average number of participants is six. Average number of images for each participant is three. Average allocated time is five minutes for each participant and round during first four weeks where frequency of comments are measured. On the fifth week, the session for memory task is held. Images of the series of four sessions are displayed one after the other. Participants guess the owner and the theme of the collected images.

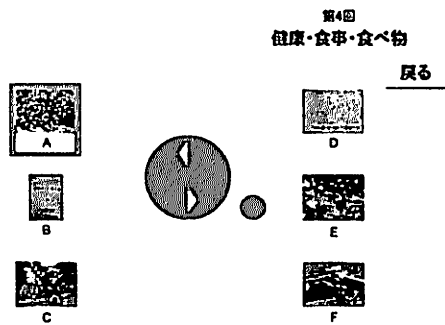


Fig. 4. Displayed Images for the Group of Participants

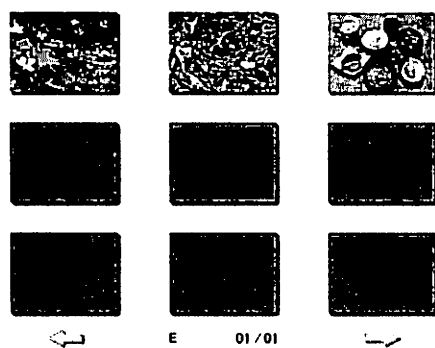


Fig. 5. Displayed Images for One Participant

### III. COIMAGINATION SUPPORT SYSTEM

There are three requirements for coimagination support system.

- 1) The system dynamically displays the images corresponding to the stories of participants.
- 2) Users of the system easily register the images. The registered images are accumulated for each participant.
- 3) Operations of the system are logged so as to be analyzed afterwards. Questions for the memory task are generated from the registered data for display.

We developed coimagination support system which meets the above requirements. The system consists of a laptop computer for the chair of the session, a projector for displaying the images, and a screen.

Before starting the session, the chair of the session scans pictures into the computer and registers them for each participant. Once the session starts, the chair selects the images of the speaker. The initial window is shown in Fig. 4. Images for the group of participants are arranged according to the seating order. The number of participants is six. Allotted time for each speaker is five minutes. When one participant is a speaker, other five participants are listener. The chair of the session selects images considering the elapsed time. When participant E is a speaker, the chair clicks on the image of participant E of Fig. 4. The images brought by the participant E are displayed, which is shown in Fig. 5. The speaker selects



(a)



(b)



(c)

Fig. 6. Enlarged Image of Korean houttuynia

the image to talk about, and ask the chair to click on the image to enlarge. The image is enlarged after one of the three images in Fig. 5 is clicked, which is shown in Fig. 6. The next speaker is participant F after five minutes has passed for participant E. Then, the chair operates the system so as to go back to the initial window, and clicks on the image of participant F of Fig. 4.

About a hundred of images are collected after the series of four sessions in four weeks. On the fifth week, the fifth session for memory task is held. The window for memory task is shown in Fig. 7. It is operated by each participant rather than the chair of the session. The collected images are displayed randomly one after the other. participants select the owner and the theme of the displayed image. The participant clicks on the "next" button after click on the buttons of the owner and the theme. Different images randomly appear until the all images are displayed. The scores of the memory task are recorded so as to be analyzed after the session.

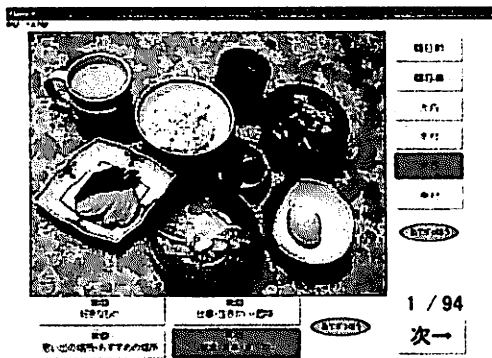


Fig. 7. Displayed Image for Memory Task

TABLE I  
THEMES FOR EACH SESSION

First Session	Favorite Things
Second Session	Work, Purpose of Life, and Hobbies
Third Session	Memorable or Recommended Places
Fourth Session	Health, Meals, and Foods
Fifth Session	Memory Task

#### IV. COIMAGINATION PROGRAMS AT WELFARE INSTITUTION

Coimagination programs for elderly people have been provided at welfare institution in Kashiwa city, Japan (Fig. 8). In this section, we analyze two programs which were held for the first and the second time. Both programs include series of five sessions. Each session was held one hour per week. The last session provided memory task while other four were conversation sessions. The themes of each session are shown in Table I. The theme of the first session was "favorite things", that of the second session was "work, purpose of life, and hobbies", that of the third session was "memorable or recommended places", and that of the fourth session was "health, dishes and foods". The last session was for memory task. Six normal participants (3 men and 3 women; mean age= 74 years) for the first program and six normal participants (3 men and 3 women; mean age= 70 years) participated in the second program. In total, twelve participants participated in the two programs.

#### V. COLLECTED IMAGES AND STORIES IN COIMAGINATION PROGRAMS

Through coimagination programs, images and stories which represent the viewpoints of participants were collected. In this section, we show some of the interesting stories with images. Three images in Fig. 6 were brought by participant E. They describe the tips for health and well-being. Fig. 6 (a) is the flowers and leaves of Korean houttuynia. Korean houttuynia is one of the typical weeds in the garden. She used to remove the glass because it is not supposed to be in the garden. One day, she got to know that the glasses are materials for herb tea made from the glass. Then, she decided to make tea from the glass in the garden. Fig. 6 (b) is the dried glasses. The leaves of the

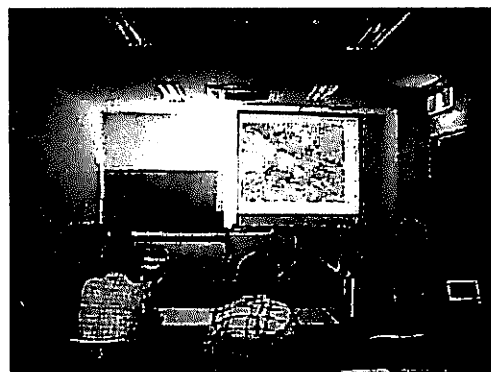


Fig. 8. Participants Surrounding the Image on the Screen during Coimagination Program

TABLE II  
NUMBER OF IMAGES FOR THE FIRST COIMAGINATION PROGRAM

Participants	A	B	C	D	E	F	Total
First Session	1	2	4	5	1	6	18
Second Session	4	9	2	5	5	4	29
Third Session	3	4	6	3	2	5	23
Fourth Session	1	3	3	3	3	3	16
Total	9	18	15	16	11	17	86

TABLE III  
NUMBER OF IMAGES FOR THE SECOND COIMAGINATION PROGRAM

Participants	A	B	C	D	E	F	Total
First Session	4	3	3	3	6	4	23
Second Session	2	6	3	6	2	3	22
Third Session	5	5	7	4	7	1	29
Fourth Session	3	4	3	4	2	4	20
Total	14	18	16	17	17	12	94

glasses were pulled out and dried under the sun. The leaves were boiled with the hot water and Korean houttuynia tea was poured. The fresh Korean houttuynia tea were served with breakfast, which is shown in Fig. 6 (c). She and her husband became healthy more than before with handmade tea. Previously weeds became good medicine and now they are grown in the side of the garden without care.

Such story is also available in Fig. 9. Three images in Fig. 9 were brought by participant A, who is a husband of participant E. They also describe the tips for health and well-being. Fig. 9 (a) is the leaves of Korean ginseng. Korean ginseng is famous for food which used to be believed to guarantee the everlasting life without aging in ancient times. One day, he heard that the glass is easy to grow in the garden. Then, he planted the glass. The grown plants were pulled out which is shown in Fig. 9 (b). The roots of the glass were cut and filled in the liquor (Fig. 9 (c)). The color of the liquor became orange, then brown. He succeeded in hand making the special liquor which is good for health. Other participants listened carefully with interest to the stories. After the series of sessions, some of the participants went to the house of participants E and A, and enjoyed drinking Korean houttuynia tea and Korean ginseng liquor. The things which happened after the session also include episodic memory, division

Horizontal axis shows the percentage of memorized images of other participants by self and others for each participant of the first and second program. Numbers of images for the first program are shown in Fig. 10 and 11. Numbers of images for the second program are shown in Fig. 12 and 13.

Vertical axis shows the percentage of memorized images of each participant by other participants. This indicates whether other participants listened carefully and remembered the participant's stories. Planning of stories with images by each participant was successful when the percentage of memorized images by other participants is high, although this depends on the efforts of other participants. Percentage of memorized images by other participants was high for participant A of the first program in Fig. 10, and participant D of the second program in Fig. 11. Their stories were memorable and attracted attentions of other participants.

Frequency of comments by self and others for each participant of the first and fourth week of the first imagination program are shown in Fig. 12 and 13. Horizontal axis shows the frequency of comments during other participants' talk for each participant. The frequency of comments during other subjects' talk indicates whether

VI. QUANTITATIVE EVALUATION OF COIMAGINATION PROGRAMS VIA MEMORY TASK AND FREQUENCY OF COMMENTS

Percentages of memorized images by self and others for each participant of the first and second coimagination programs are shown in Fig. 10 and 11. Numbers of images in total were 86 for the first program and 94 for the second program. Numbers of images for each participant are shown in Table II and III.

Horizontal axis shows the percentage of memorized images of other participants by self and others for each participant of the first and second program in Fig. 10, and participant D of the first program in Fig. 11. They have good memories.

Vertical axis shows the percentage of memorized images of each participant by other participants. This indicates whether other participants listened carefully and remembered the participant's stories. Planning of stories with images by each participant was successful when the percentage of memorized images by other participants is high, although this depends on the efforts of other participants. Percentage of memorized images by other participants was high for participant D of the first program in Fig. 10, and participant C of the second program in Fig. 11. Their stories were memorable and attracted attentions of other participants.

Frequency of comments by self and others for each participant of the first and fourth week of the first imagination program are shown in Fig. 12 and 13. Horizontal axis shows the frequency of comments during other participants' talk for each participant. The frequency of comments during other subjects' talk indicates whether

of attention, and planning. This became another story for the future coimagination sessions. Empirical knowledge for health and well-being were collected and accumulated. The program became a starting point of social network.

Fig. 9. Enlarged Image of Korean ginseng

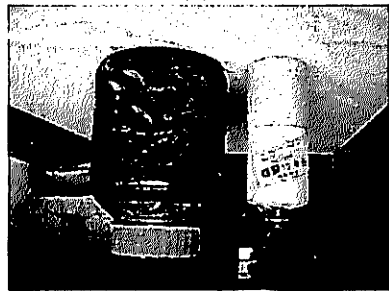


Fig. 11. Percentage of Memorized Images by Self and Others for Each Participants of the Second Coimagination Program

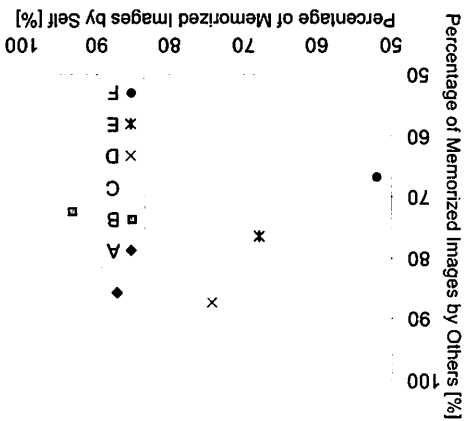
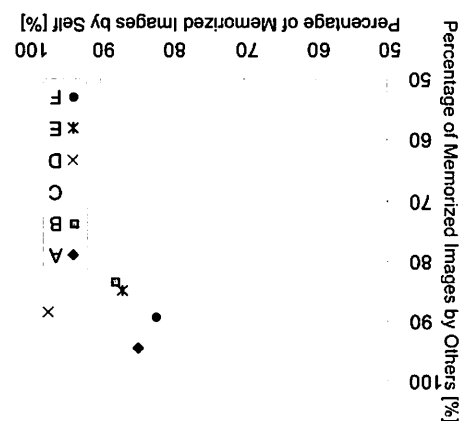


Fig. 10. Percentage of Memorized Images by Self and Others for Each Participants of the First Coimagination Program



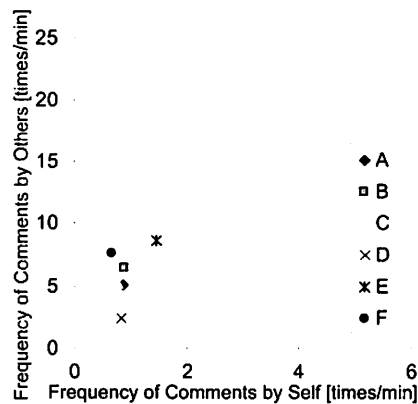


Fig. 12. Frequency of Comments by Self and Others for Each Participant of the First Week of the First Program

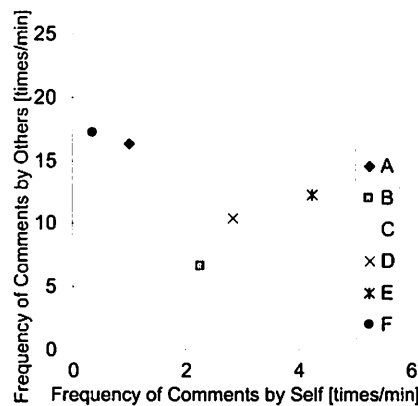


Fig. 13. Frequency of Comments by Self and Others for Each Participant of the Fourth Week of the First Program

the subject listened carefully so as to ask questions and give comments to other subjects. Division of attention functions are assumed to be activated if the frequency of comments during other subjects' talk is high. Frequency of comments to other participants was high for participant D and E of the fourth week of the first program in Fig. 13. They are active listeners.

Vertical axis shows the frequency of comments by other subjects during each subject's talk for each participant. The frequency of comments by other subjects indicates whether the subject provided interesting story so as to make other subjects listen carefully. Planning of stories with images by each subject is successful, and division of attention functions are assumed to be activated if the frequency of comments by other subjects is high. The frequency of comments by other subjects was high for participant A, C and F of the fourth week of the first program in Fig. 13. They are impressive speakers.

Overall, percentage of memorized images by both self and others were high. Frequency of comments to and by other subjects were very high. The results indicate that interactive communications were achieved for both programs, so that cognitive functions including episodic memory, division of attentions and planning were supposed to be activated. The

result indicates that the participants showed empathy with each other. The effectiveness of the proposed method was validated through the experiment.

## VII. CONCLUSION

We have proposed coimagination method towards prevention of dementia through supporting interactive communication with images. Characteristics of the method are described as follows.

- Coimagination method supports interactive communication through bringing feelings with images according to the theme.
- Allocated time for each participant is predetermined. participants take turns so as to play both roles of speakers and listeners. The themes of communication are examined considering the effects for social networking.
- Cognitive activities which require episodic memory, division of attention, and planning are evaluated by memory task and measurement of frequency of comments.

The method was validated through providing programs for elderly people at welfare institution in Kashiwa city, Japan. Percentage of memorized images by both self and others were high. The result indicates that the participants showed empathy with each other. We succeeded in achieving interactive communication during the programs, so that cognitive functions were supposed to be activated. Future work includes evaluation of the method through direct measurement of the cognitive functions, change in size of social network, and longer follow-up to observe effects on everyday function.

## ACKNOWLEDGEMENTS

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