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Development of an Agent System for Conversing with Individuals with Dementia

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An agent system was developed to serve as a conversation partner for individuals with dementia. The computer screens showed an animated face which resembled "a five-year-old grandchild." We prepared 180 reminiscent questions. The system could automatically detect the end of an individual's reply to a question and began asking the next question. Eight subjects with mild Alzheimer disease participated in this evaluation experiment. They replied to the agent (agent condition) and a human partner (human condition), each of whom asked the same 15 questions. To estimate the utterance length, we calculated the syllable number in the subjects' replies for the two abovementioned conditions. All the subjects uttered 5494 (74%) syllables in the agent condition compared with 7406 (100%) syllables in the human condition. Although the number of syllables was fewer in the agent condition, this system was considered to be useful under quiet circumstances.

1. Introduction

The progression of dementia usually starts with amnesia and often involves behavioural disturbances such as illusions and incontinence [Davis 2001]. To reduce the stress of individuals with dementia and the burden on their caregivers, various therapeutic approaches have been proposed such as validation, music therapy, and etc [De Vreese 2001, Gra¨sel 2003]. Reminiscence intervention aims to increase self-esteem and psychosocial well-being [Lai 2004] and to decrease behavioural disturbances [Finnema 2000, Gra¨sel 2003].

A conversation is a common and enjoyable activity for most people [Yasuda 2009]. Individuals with dementia, however, tend to be isolated with few opportunities to converse, particularly for individuals living alone at home [Yasuda 2009]. Therefore, one of the most important interventions for them is to provide them with opportunities to converse with people.

However, provision of such conversation opportunities requires human resources. As one of the interventions to resolve this problem, a remote conversation have been proposed, which connect an individual with dementia and a conversation partner by using a telephone or a video phone [Sa''venstedt 2003]. Furthermore, Kuwahara et al. [2010] suggested that a combination of video phones and reminiscence interventions would be more effective for psychological stability. They have developed a remote reminiscence conversation system that incorporated a video phone and reminiscence photo sharing. In this system, individuals with dementia can remotely talk with conversation partners while they are looking the individual's reminiscent photos shown on the monitor. This system was effective for individuals with dementia in terms of psychological stability. Interestingly, one patient remained stable for more than three hours after the conversation session ended.

Since the number of individuals with dementia is rapidly

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increasing, it is getting difficult to find enough conversation partners, even with remote conversations. In the last decades, many talking dolls and toys for the elderly have been available in markets. However, the number of categories and topics to be spoken by dolls and toys are narrow and limited. The conversation with them is simple and fragmentary so that a reminiscent or theme-oriented conversation such as life review [Butler 1974] is difficult to perform. This limitation may frustrate individuals, especially with mild and moderate dementia. Recently, several talking robots have been developed. Although the elderly showed positive reactions to the robot, the interaction between the elderly and the robot was seldom observed [Kanoh 2011].

One of the alternative interventions is the conversation with agents on the computer screen. The previous studies investigated the acceptance of such agents by the elderly. They reported that it was important for the agents to display social signals like smiling and head nods [Heerink 2006, Cassell 2000, Smith 2010]. Sakai et al. [2012] developed a computer agent system that could serve as a conversation partner for patients with dementia in clinical setting. The agent resembled an orthopedist man in a hospital. In order to elicit the speech response from the patients with bone fracture, a set of questions about physical condition were spoken automatically by the agent. The system could detect the end of speech sound of their replies to a question, and then began asking the next question. The results revealed that all the patients replied and were satisfied with the conversation with the agent. However, when the agent's questions overlapped with the patient's speech, they quitted their utterance. Therefore, the waiting time between the end of speech and the agent's next question was found to be very important.

At any rate, above agent systems cannot perform the long conversations such as 30 minutes reminiscence talk or life review [Butler 1974]. The short conversation is not enough to satisfy with and stabilize individuals with dementia. In order to perform the long conversation, we have developed another computer agent system for individuals with dementia which shows an animated face of a child. 120 reminiscent questions were prepared for general settings such as homes and institutions, not limited to hospitals. The system can also automatically detect the

end of an individual's reply to a question. We investigated the effectiveness of this agent conversation system.

2. Method.

2.1 The agent system for conversation

The computer screen showed an animated face of the child agent which resembled "a five-year-old grandchild." The system can automatically detect the end of speech sound of a subject's reply to a question and begin asking the next question. When the subject speaks, the agent reacts to them with generating nods, mouth movement, and acknowledgement automatically.

A directional pin microphone (Y2 Products S-02) was put in front of a computer for the detection of subject's speech. The distance between the microphone and the subject was about 30 centimeters. Each subject sat in front of a 19 inch display (Dell Studio one 19) where the agent appeared. A subject with hearing problems wore earphones.

2.2 Questions

We prepared 12 sets of 15 (total 180) reminiscent questions such as parents, home town, school life and so on. These were spoken by the synthesized voice of the agent. The continual questioning by the agent may yield an atmosphere like "a police interrogation". In order to improve this atmosphere, each question was composed with two parts. First part was introductory comments by the agent. The agent introduced his own reminiscent experiences. e.g. "I used to eat watermelon in the summer". The second part was the question for subjects. e.g. "what kind fruits do you like?" The pause between the comments and questions was fixed for one second. The introductory comments and questions were also shown in written form at the lower part of the screen for the visual confirmation of questions and compensation for hearing difficulty.

2.3 The waiting time

According to the results of Sakai et al. [2012], the waiting time was very important for the smooth conversation with the agent. In this system, the waiting time before the agent utter next question can easily be adjusted to a subject. However, on the analysis of Sakai et al [2012] and our preliminary trials, the waiting time was fixed to 3.5 second in this investigation. If

following speech sounds were not detected during the 3.5 second's waiting time, the agent moved to the next question, or spoke "do you have any other experiences?"

2.4 Experimental procedure

Eight subjects (two male and six female) with mild Alzheimer disease participated in this evaluation experiment; the average age was 78.5 years old and the mean Mini-Mental State Examination [MMSE; Folstein 1975] score was 22.2.

To evaluate the effectiveness of this system, subjects replied to the questions by the agent (agent condition) and a human conversation partner (human condition). The human partner was a speech therapist whom all subjects were acquainted with. In both conditions, the almost same 15 questions were asked, although some introductory comments were slightly modified in human condition. The waiting time was fixed to 3.5seconds for the agent condition and 3 or 4 seconds for the human condition. The order of these two conditions was randomized. Between the two conditions, 20 minutes' free talking time for the conversation with human partner was inserted. Each conversation took about 20 minutes. The contents of the 15 questions are listed in the appendix. The utterance of the subjects was recorded by Sony IC Recorder UX300F.

Subjects and their families were explained about the purpose and the procedures of the experiment, and signed their names on the agreement sheet. The ethical committee of the Chiba Rosai hospital recognized this experiment.

3. Resuls

All the subjects accepted and replied to the questions asked by the agent. All of the subjects' speeches were transcribed to written texts. If this system were effective to elicit the utterance from the subjects, the length of the utterance may be same for the two conditions. To estimate the utterance length, the syllable number in the subjects' replies was calculated for the two abovementioned conditions. All the subjects uttered 5494 (74%) syllables in the agent condition, compared with 7406 (100%) syllables in the human condition.
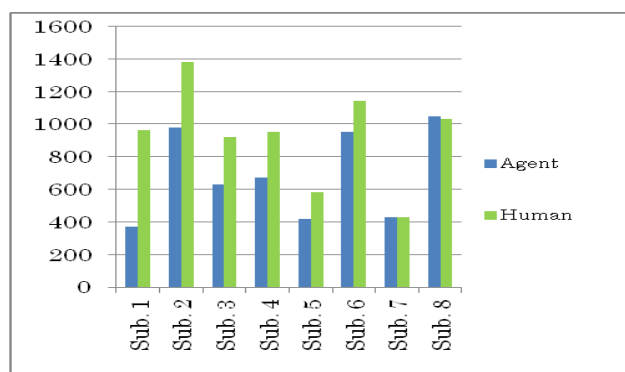
Fig 2 The syllable number in subjects replies

This system was sometimes disturbed smooth transfer to the next question by the agent by picking up non-speech uttering such as, sigh, cough of subjects, and environmental noise(door's closing, footsteps in the corridor and so on). Some subjects replied to the introductory comments before the question was spoken.

After the experiment, a simple interview was conducted to ask the impression for this conversation system. Most of subjects had a favorable impression for the agent. A woman was moved to tears while conversing with the agent, because it's too enjoyable. A man with early onset dementia said "When I talk with normal people, I am always worrying about the difficult question which I cannot reply, or the repetition of answers which I already made. But, in this system, I can talk freely with this agent without above hesitation or anxiety.

4. Discussion

Although the number of syllables was fewer in the agent condition, the system could succeed to elicit 74% utterances from the individuals with dementia. This percentage means that this system may be practical and valuable to introduce as an alternative way of a conversation when no human conversation partner exists. With further improvements, this system will be able to elicit more utterance from subjects. Nonetheless, all of subjects could accomplish 20minuute' conversations with the agent. We consider that much longer conversation with this system is easy to perform.

The interview after the experiment was very impressive. A woman was moved to tears while conversing with the agent, because it's too enjoyable. This suggests that the agent was deemed to be a real boy by her. Another man said "In this system, I can talk freely without any hesitation or anxiety". This comment means that the conversations with normal people were stressful to him, due to the difficult questions which he cannot reply. Therefore, we consider that this kind of artificial talking system is needed for such individuals to provide enough talking chances without any hesitation and worries. In future, we will improve our system by incorporating the topic-selection program that the subjects can reply easily and eagerly on the subject's ability, profile, and history of the previous conversation with the agent.

This system can adjust the waiting time for each subject. However, in this study, the waiting time was fixed to 3.5 seconds. Needles to say, the appropriate waiting time is different from the each subjects. The future study will reveal the effectiveness on the elicitation of speeches from subjects when the waiting time is adjusted to the subjects. Furthermore, some subjects replied to the introductory comment by the agents. This was unexpected phenomena for us. But it is natural that we utter something before partners finish their speech. In the next revision, we will also insert the waiting time between the agent's introductory comments and questions.

Recently, several robots and smart phones are installing a speech recognition system to converse with people such as "speaking concierge". However, its robustness for speech recognition is still unstable. Furthermore, the subjects do not always clearly pronounce. Since the robustness is definitely important for the practical use of this system, we employed the sound recognition system as same as Sakai et al. [2012] which was simple but more stable ways.

As might to be expected, this system was forced to pick up non-speech uttering such as sigh, cough of the subjects, and environmental noises. However, this system could work well under quiet circumstances. With the further improvement of the microphone, picking the noise will be reduced.

In this study, we did not evaluate the psychological stability of the subjects. However, the results of the interviews suggest that the conversations with this system may contribute to the psychological stability of individuals with dementia.In future, we will also investigate the psychological effect of conversations with the agent which Kuwahara et al. [1210] have reported previously. Kuwahara et al. [1210] have also developed the remote scheduling assist system by using a video phone. The repetitive questionings by the agent will work for maintaining or reminding various memories of individuals with dementia. It will be a more natural way of measuring the cognitive status, when the agent system can assess the individual's cognitive status through conversations [Wang 2009]. If this system can be integrated with these functions, the agent will become a "remote concierge" system for a subject.

Most of families in advanced nation have computers. We consider this system is easy to be installed in the computer with lowest cost. This system can also be installed in small tablet computers. If these devices are stored in to dolls, and robots, the individuals can converse with the agents through them.

5. Conclusion

Aiming at supporting the psychological stability for individuals with dementia, this study proposed an animated agent that talks to them by asking questions. As the result, they could converse with such conversational agent system, and enjoyed the conversation. Although there are some problems to be resolved for this system, this system is practical and will become one of the important interventions to assist individuals with dementia.

6. Acknowledgements

7． References

[Davis 2001] R.N.Davis, P.J.Massman, & R.S.Doody: Cognitive intervention in Alzheimer disease: A randomised placebo-controlled study. Alzheimer Disease and Associated Disorders, 15, 1-9, 2001.

[De Vreese 2011] L.P. De Vreese, M.Neri, M.Fioravanti, L.Belloi, & O.Zanetti: Memory rehabilitation in Alzheimer's disease: A review of progress. International Journal of Geriatric Psychiatry, 16, 794-809, 2001.

[Gräsel 2003] E.Gra̎sel, J. Wiltfang, & J.Kornhuber :Non-drug therapies for dementia: An overview of the current situation with regard to proof of effectiveness. Dementia and Geriatric Cognitive Disorders, 15, 115-125, 2003.

[Lai 2004] C.K.Lai, I.Chi, & J.Kayser-Jones, J: A randomised controlled trial of a specific reminiscence approach to promote the well-being of nursing home residents with dementia. International Psychogeriatrics, 16, 33-49, 2004.

[Finnema 2000] E.Finnema, R.M.Droes, M.Ribbe, & W.Van: The effects of emotion-oriented approaches in the care for persons suffering from dementia: A review of the literature. International Journal of Geriatric Psychiatry, 15, 141-161, 2000.

[Yasuda 2009] K.Yasuda, K.Kuwabara, N.Kuwahara, S.Abe,& N.Tetsutani: Effectiveness of personalised reminiscence   photo videos for individuals with dementia. Neuropsychological Rehabilitation, 19(4), 603-619, 2009.

[Sävenstedt 2003] S.Sävenstedt, C.Brulin, P-O.Sandman: Family members' narrated experiences of communicating via video-phone with patients with dementia staying at a nursing home. Journal of Telemedicine and Telecare, 9, 216-220, 2003.

[Kuwahara 2010] N.Kuwahara,K. Yasuda, N.Tetsutani, K.Morimoto: Remote assistance for people with dementia at home using reminiscence systems and a schedule prompter, Int. J. Computers in Healthcare, 1, (2), p126-143, Inderscience Enterprises, 2000.

[Kanoh 2011] M.Kanoh, Y.Oida, Y.Nomura, A.Araki, Y.Konagaya, K.Ihara, K.Kimura: Examination of practicability of communication robot-assisted activity program for elderly people. Journal of Robotics and Mechatronics, 23(1), 3-12, 2011.

[Heerink 2006] M.Heerink, B.Kr̎ose, V.Evers, & B.Wielinga: Studying the acceptance of a robotic agent by elderly users. International Journal of ARM, 7(3), 33-43, 2006.

[Cassll 2000] J.Cassell: Embodied conversational agents. In J. Cassell, J. Sullivan, S. Prevost, & E. Churchill (Eds.), pp. 1-27, The MIT Press, 2000.

[Smith 2010] C.Smith, N.Crook, J.Boye, D.Charlton, S.Dobnik, D.Pizzi, & M.Turunen, M: Interaction strategies for an affective conversational agent. In 10th International Conference on Intelligent Virtual Agents (IVA 2010) (p. 301-314), 2010.

[Sakai 2012] Y.Sakai, Y.Nonaka, K.Yasuda, Y.Nakano: Listener agent for elderly people with dementia. Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction (HRI2012), p199-200, 2012.

[Butler 1974] R.N.Butler: Successful aging and the role of the life review. Journal of the American Geriatrics Society, 22 (12), 529-535, 1974.

[Folstein 1975] M.F.Folstein, S.E.Folstein, & P.R.McHugh: "mini-mental state": A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12(3), 189.198, 1975.

[Wang 2009] Y.Wang: A cognitive informatics reference model of autonomous agent systems (AAS). International Journal of Cognitive Informatics and Natural Intelligence, 3(1), 1-16, 2009.

8． Appendix

Sample of the questions. The underline is the introductory comments.

I was born in 2008. When were you born?

My blood type is A. What is your blood type?

My treasure is a toy car which was given as my birthday present. What is your treasure?

I am 4 years old, so to use kitten knife is dangerous. I sometimes help my mother to wash vegetables.

Did you help some homemaking when you were child?

My elderly sister is eating fruits every day. Are you eating something for health?

I had dreamed about flying in the sky. Are you dreaming sometimes while you are sleeping?

I am too young to understand the feature of my home town. What is your home town like?

I am also too young to understand the special cuisines of my home town.

What kind of special cuisines is in your home town?