

Estimation of Mental Time by Analysis of Tense During Conversation

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Abstract

The increase of dementia patients is one of the problems caused by aged population not only in Japan but in many developed countries. As cognitive enhancement method for prevention of dementia, coimagination method is proposed: designed group conversation whose themes are selected from recent topics for training of recent episodic memory functions, since recent episodic memory functions decline before the onset of dementia. It is known that people who are disuse particular cognitive functions have higher risk of losing the functions. However, the participants of the conversations supported by coimagination method sometimes refer to past topics rather than recent topics. The method is required for analyzing whether the topics deal with recent or past for effective intervention, which has not been established. Purpose of this study is to propose method for analyzing the temporal characteristics of the topics during conversation. Mental time travel, or chronesthesia, is the ability to be aware of one's present, past or future which has been evolved in humans in particular. In order to estimate the mental time of the speaker from topics during conversation supported by coimagination method, we propose mental time estimation method by analyzing tenses and senses. We applied the method to the scripts of conversation supported by coimagination method. The result suggests that it's possible to estimate mental time from analysis of the topics in conversation. The ratio of the reference of past, present and future of each speaker was enumerated. The individual differences of the tendencies were demonstrated as the ratios.

1. Introduction

Prevention of dementia is a crucial issue in this aged society. Number of dementia patients in Japan was about 2.05 million people in 2005, in 2015 number of patients reaches 3.02 million and is estimated to be sharply increases then there will be about 4.45 million patients in 2035, which is 2.2 times larger than the number in 2005[Honma 08]. For prevention, some researches indicated that elderly

who has many social interaction, has low possibility to become dementia [Green 08, Laura 04]. Also some researches takes place in order to use group conversation to prevention of dementia [Otake 09, Butler 63]. Considering these researches, use of artificial intelligence to support human recognition is considerable as a theme. This is because, until now, researches about artificial intelligences are focused on making mechanical system to be able to do some of the human functions. On the other hands, as the medical treatment develops, there are increase in needs for use artificial intelligence to complement human defection. However, to support human, it is required to find human defection. Therefore the hypothesis arose that it is possible to estimate mental time from conversation, by analysis of tenses and senses.

In order to state the difference between previously researched conversation analysis and analysis method used in this paper, cite research in sociology. In sociology, the study of conversation analysis is called ethnomethodology. Ethnomethodology is a method for understanding the social orders people use to make sense of the world through analyzing their accounts and descriptions of their day-to-day experiences [Karamjit 96]. In other words, every person born under an individual culture is one of the members to form the culture, and has appropriate ability to understand society through other members of culture. According to Garfinkel, ability is defined by the operational capabilities of the natural language and field of research that tries to figure out about culture by analyzing the language [Yamada 04]. In this paper, the conversation is macro factor and through the research, explore the micro factor that time speaker of mind. In ethnomethodology, the culture is macro factor and differs from this paper; conversation is set to micro factor.

In addition the field of natural language processing, there is a study of system automatically summarize the necessary information from the sentences consist from a large amount of information. After 3.11, there are needs for system, which can extract necessary information from

huge amount of data, as an example of figure out situation of the disaster stricken area through tweet [Yanai 12]. To summarize the text, select the necessary part of the text, and then create a summary by removing rest of the parts. In this method, it was necessary to create a summarizing rules created manually. However, rapid increase in processing speed and memory capacity of the computer, and a large amount of Machine-Readable text become available, the use of statistical methods has drawn attention [Masuyama 02]. As described above, we classify the utterances in a group conversation to present, past and future to estimate mental time of the speakers.

2. Related Research

2.1 Mental Time

The field of mental time is to study the origin of the ability to recognize the time. The mental time is a cognitive function that has been evolved in humans in particular. 1) A person asked what date it is today in diagnosing dementia. The awareness of the date is essential for humans, but not for other animals. 2) Most languages have exact tenses. This provides another clear evidence for our being always aware of the past, present, and future. 3) Humans are afraid of the death, the end of the future. Even a chimpanzee, on the other hand, showed no sign of fear into the future, even when the animal was severely disabled. In this field, study is collaborated across neuroscientists, psychologists, clinical neurologists, linguists, philosophers, and comparative ethnologists [Iida 14].

Hypothesis that cognitive function can be diagnosed by use of tense is based on the idea of mental time, which mental time is explicitly embodied in the form of a language. Therefore, that is verbalization, diversity and regularity of the particular tense representation, it is assumed to become an element to elucidate the mental time.

2.2 Coimagination Method

Coimagination method is named after that share (co-) imagination through interactive communication with images. This 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 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 method and reminiscence. [Otake 09, Otake 11, Otake 11b, Otake 12b]

To summarize, definition and typical coimagination method as follows:

Coimagination method supports interactive communication through bringing feeling with images according to the theme, allocated tie 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.

2.3 Reminiscence

In this paper, we analyze the conversation of coimagination method. However, there is similar group conversational method call reminiscence.

Reminiscence is often used with older people and respects the life and experiences of the individual with the aim to help the patient maintain good mental health and prevent from symptoms of dementia since more than 50 years ago [Lewis 74, Haight 93, Yasuda 09]. Coimagination method and reminiscence are common at the point that determine the theme, but in reminiscence, the theme is set in the past, that it does not limit the time in theme is coimagination method. This experiment requires obtaining the speaker's mental time; therefore coimagination method is more appropriate because of variety of theme available.

3. Procedure of Group Conversational Experiment

3.1 Conversational Experiment by Coimagination Method

At group conversation of coimagination method, it is required to determine the theme that induces a person's mental time effectively. From practical experiments, it has been found that theme related about a person's favorable things are appropriate; therefore theme in Group.1 was favorite hobby and favorite food in Group 2. Two photos per person, 5 minutes of topic provides and 5 minutes of Questions and answers time was given to each speaker. Group 1 consists of 5 participants; A1, B1, C1, D1 and E1. Group 2 consists of 6 participants; A2, B2, C2, D2, E2 and F2. All participants positioned around the screen, which photos that participants brought are shown, and shoot the video while the experiment.

3.2 Analysis Procedure

Transcribe conversation from the video of coimagination method. Based on transcribed texts, tagged each speak to 10 categories by the grammar type, whether talks about event in past, present or future and its happened (past), its happening (present) or will be happen (future). The lists of classification in this experiment and example sentences of

each categories are shown in Table.1. 9 Categories are, FF (future from a point in the future: 1), FN (present at a point in the future: 2), FP (past from a point in the future: 3), NF (future from the present: 4), NN (present: 5), NP (past from the present: 6), PF (future from a point the past: 7), PN (present at a point in the past: 8), PP (past from a point in the past: 9) and N/A (unclassifiable) [Mellor 02]. However, we ignored utterances classified as N/A. This is because laughing, nodding, interjection and filler are categorized as N/A. These utterances are not suitable to estimate the mental time, so ignore N/A from the result to simplify.

Table.1 List of 10 Categories and Example sentences

Categories	Grammar Type	Example
FF(1)	Future Perfect Continuous	He will have been playing the piano.
FN(2)	Future Present	He will play the piano.
FP(3)	Future Past	He will have played the piano.
NF(4)	Present Future	He is playing the piano.
NN(5)	Simple Present	He plays the piano.
NP(6)	Present Past	He has played the piano.
PF(7)	Past Perfect Continuous	He had been playing the piano.
PN(8)	Past Present	He played the piano.
PP(9)	Past Perfect	He had played the piano.

4. Analytical Results

4.1 Analytical results of Group conversation by Coimagination Method as a Group

Firstly, plot graphs of mental time transition within each group conversations at Figure 1 and 2. Note that we use only topic providing session of coimagination method. This is because mental times of the speakers are more at natural situation at topic provide session while in Q&A session, possibilities to be affected by the other speakers. Both figures show that during conversation, past and present tenses are frequently used and future tense is not frequently used.

Next, gives tables to show results of utterance analysis. Table 2 and 3 show the results of categorization. These tables show that NN has highest frequency in both groups, 38% in Group 1 and 40% in Group 2. Then followed by PN, 25% in Group 1 and 17% in Group 2. Note that FF, FP and NF has used in Group 1. Table 4 to 5 show the results

for percentage calculation of tenses. As Table. 4 shows, past tenses and senses are most frequently used in conversation and more than half of utterances are in past tenses, 40 % of utterances is in present tenses and senses. Then only 5% is future tense in topic providing session of Group.1. As Table.5 shows, present tense is most frequently used in conversation with 53%, 43% of utterances is in past tense and only 4% is future tense in conversation of Group 2 at topic providing session in coimagination method.

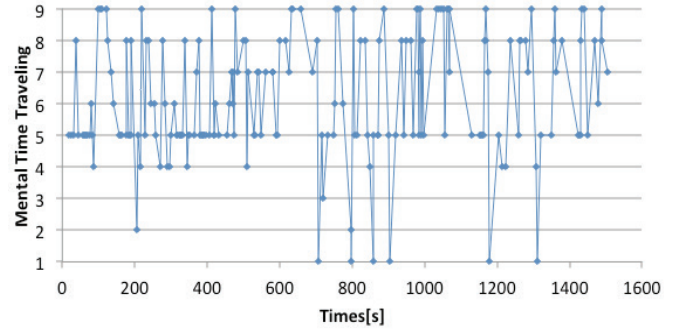


Figure 1: Transition of Mental Time in Group 1 at topic providing session. Note that mental time is transitioned frequently between past and present. However, there weren't any correlation to trend in transition.

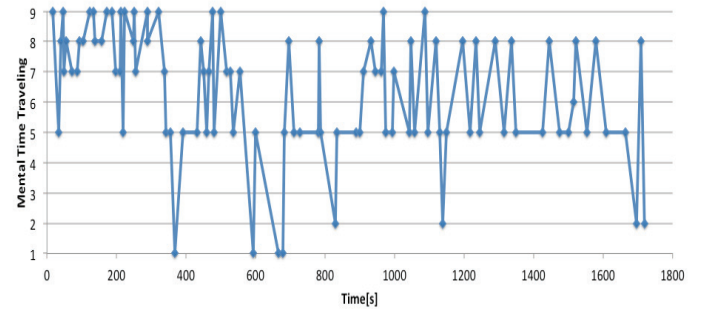


Figure 2: Transition of Mental Time in Group.2. Note that mental time is transitioned frequently between past and present. Correlation couldn't find in traverse.

Table. 2 Results of 9 Categories at the Topic Providing Session of Group.1

Categories	Number of utterances	%
FF	0	0
FN	4	5
FP	0	0
NF	0	0
NN	31	38
NP	1	1
PF	12	15
PN	20	25
PP	13	16

N=81

Table. 3 Results of 9 Categories in topic providing session of Group.2

Categories	Number of utterances	%
FF	5	3
FN	2	1
FP	1	1
NF	12	6
NN	77	40
NP	12	6
PF	20	10
PN	32	17
PP	30	16

N=191

Table 4 Percentage of Present, Past and Future tenses in Group 1 at Topic Providing Session

Tense	Number of utterances	%
Future	4	5
Present	32	40
Past	45	55

Table 5 Percentage of Present, Past and Future tenses in Group 2 at Topic Providing Session

Tense	Number of utterances	%
Future	8	4
Present	101	53
Past	82	43

4.2 Analytical results of Group conversation by Coimagination Method as a Individual Speaker

We analyzed conversation of coimagination method by each speaker. Figure 4 to 6 show the results of percentage analysis of 9 categories at topic providing session of 3 different participants.

Figure 4 shows that participant A1 use 70% of present tenses, and only 28% of past tenses. This ratio is relatively inclined towards present tenses compare with results in Group analysis as 4.1. Figure 5 show that participant D1 has 43% of present tenses, 42% of past tenses and 15% of future tenses. This result is well-balanced comparison to Group analysis, in term of high percentages in future tenses. Figure 6 shows that participant B2 is inclined to past tenses, 88% of utterances are in past tenses, only 12% is in present tenses and 0% of future tenses. Figure 7 is the result of analysis at Q&A session. Figure 7 show that participant C1 has 84% of present tenses, 14% of past tenses and 2% of future tenses.

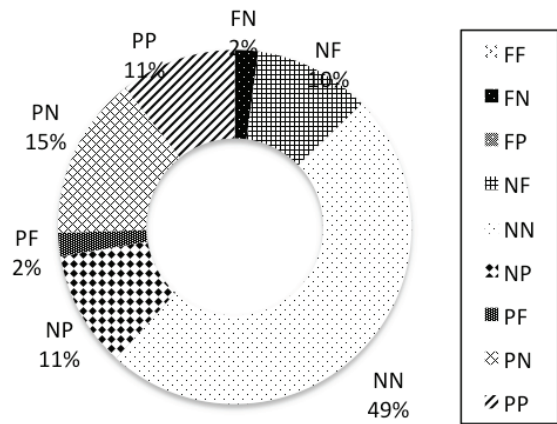


Figure 4 Percentages of 9 Categories at Topic Provide of participant A1

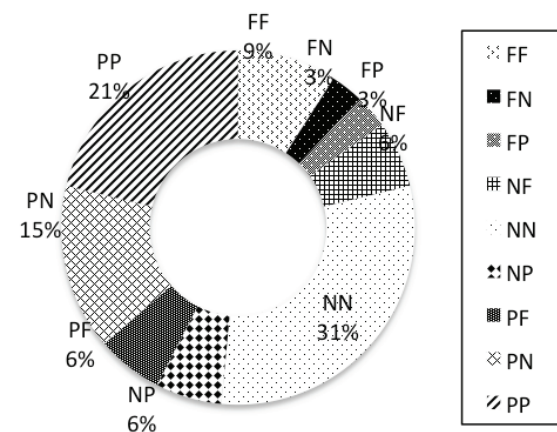


Figure 5 Percentages of 9 Categories at Topic Provide of Participant D1

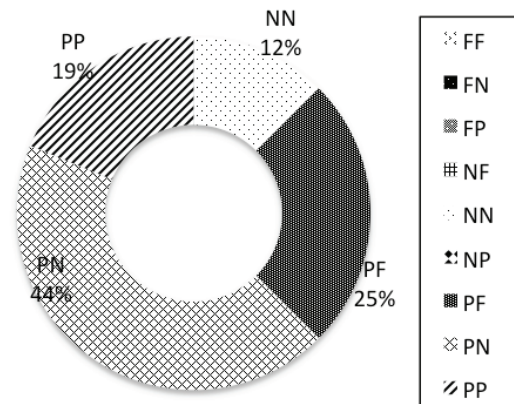


Figure 6 Percentages of 9 Categories at Topic Provide of Participant B2

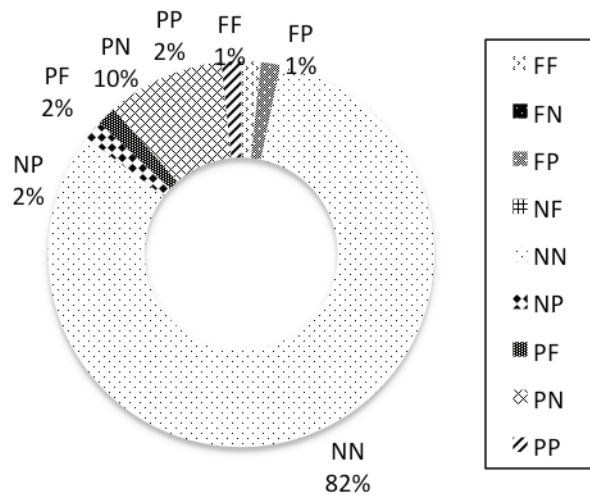


Figure 7 Percentages of 9 Categories at Q&A of Participant C1

5. Discussion

The goal was to estimate mental time from conversation by the analysis of percentage and transition of tenses in utterances into categories of present, past and future. The results show that it is frequently traverses the present and past. However, there isn't any specific feature in traverse at Group analysis. The results of percentage analysis show that Group 1 has used more of present tenses while Group 2 used more of past tenses. Despite that both Groups contains about 5% of future tenses.

Then takes look at the detail of the results of analysis by individual speakers. From the graph of the analysis results in 4.2, participant A1 has the high tendency to use present tenses. This result indicates that participant A1 has mental time, which is inclined towards present. Then, participant D1 has higher ratio of future tense than the results of Group analysis. This result refers to participant D1 has mental time, which is inclined towards future. However, participant B2 has high tendency to use past tenses. These results are necessary to find out who needs to shift towards use more of present tenses at coimagination method.

In this study, we obtained the result which against to our hypothesis; there is correlation in mental time and recognition ability. The result from participant C1 has high tendency of use in present tenses, while participant C1 has MoCA score of 22. MoCA is stand for Montreal cognitive assessment and assesses several cognitive domains [Fujiiwara 10]. MoCA score of 22 is in range of mild cognitive impairment. Thus MoCA score and tendency of use in past tenses are contrary.

6. Conclusion and Future Research

6.1 Conclusion

In this paper, analyzed percentage and transition of utterances by categorize to present, past and future tenses and senses. The results of transition analysis show that during conversation, speaker's mental time traveled frequently between present and past, however correlation couldn't found.

The results of the average percentage analysis of group conversation show that 47% of past tense, 49 % of present tense and 4% of future tense are used during conversation. However, the percentage analysis has unique result by each individual speaker. Some participants have higher frequency to use present tenses than past tenses, while some other participants have higher frequency to use past tenses than present tenses. These results suggest that it's possible to estimate mental time from analysis of the topics in conversation. Therefore, to conclude, by the analysis of tenses used in conversation, speaker's mental time can be estimated.

6.2 Future Research

The aim of this study was to establish a system that analyzes whether the topics deal with recent or past for effective intervention. In the future, we want to investigate the correlation of having high tendency to use past tenses and risk of becoming dementia for the change over the decades.

Currently, participant A1 has MoCA score of 27, participant D1 has MoCA score of 30 and B2 has MoCA score of 26, so there isn't clear correlation between MoCA score and percentage of tenses. Thus, future research is required for investigation. Furthermore, we want to develop this study and construct an automatic analysis system of mental time from utterances. Thus, instead of categorizing utterances manually; it is desired to establish a method to analyze automatically.

As trial, set an analysis rude by creating a dictionary with collection of keywords that represent past, present and future. Based on the dictionary, create a system that match the word from utterance with dictionary and classify each utterance. However, Japanese speakers tend to use oxymoron frequently and this makes difficult to classify utterances with just matching keywords. Therefore in the future, using a supervised machine learning, with the aim to build a mechanism that can analyze utterances statistically.

As a candidate option of statistical method, we are planning to use Naive Bayes classifier. Naive Bayes classifier is statistical classification and used for pattern recognition like text categorization. There are other classification methods such as decision tree, Ruche classification, k-nearest neighbor method, Logistic regression, neural network, support vector machine, Boosting

and so on. However, by considering the simplicity to implement system and quick running speed, Naive Bayes classifier has advantage from other options. Also Naive Bayes classifier has two main model, Multinomial and Bernoulli models. From the research about comparison of these two models, multinomial model has higher accuracy to categorize when data contains huge amount of vocabulary. Moreover, bernoulli model required more amount of calculating than multinomial model. Therefore by using Naive Bayes classifier with multinomial model, construct an automatic analysis system.

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