

Detection of dementia from responses to atypical questions asked by embodied conversational agents

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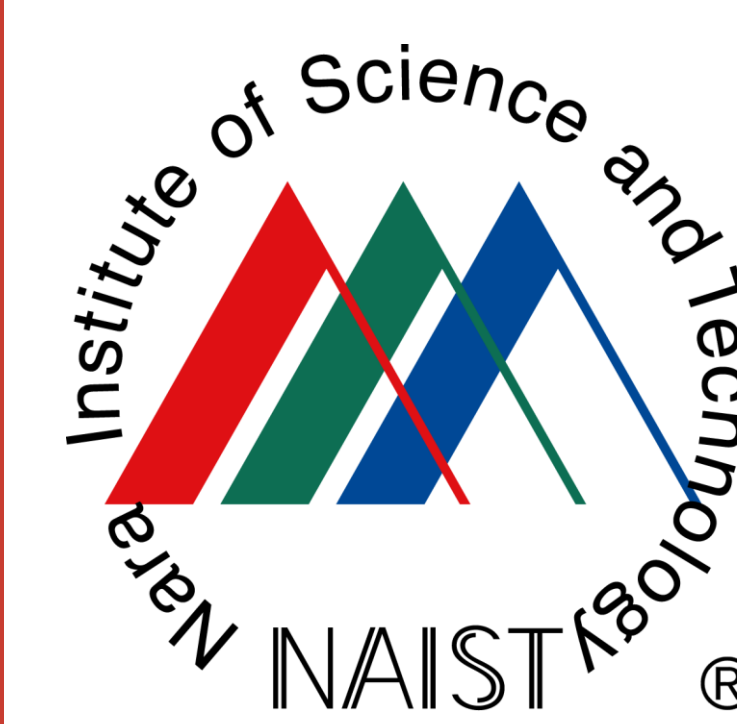
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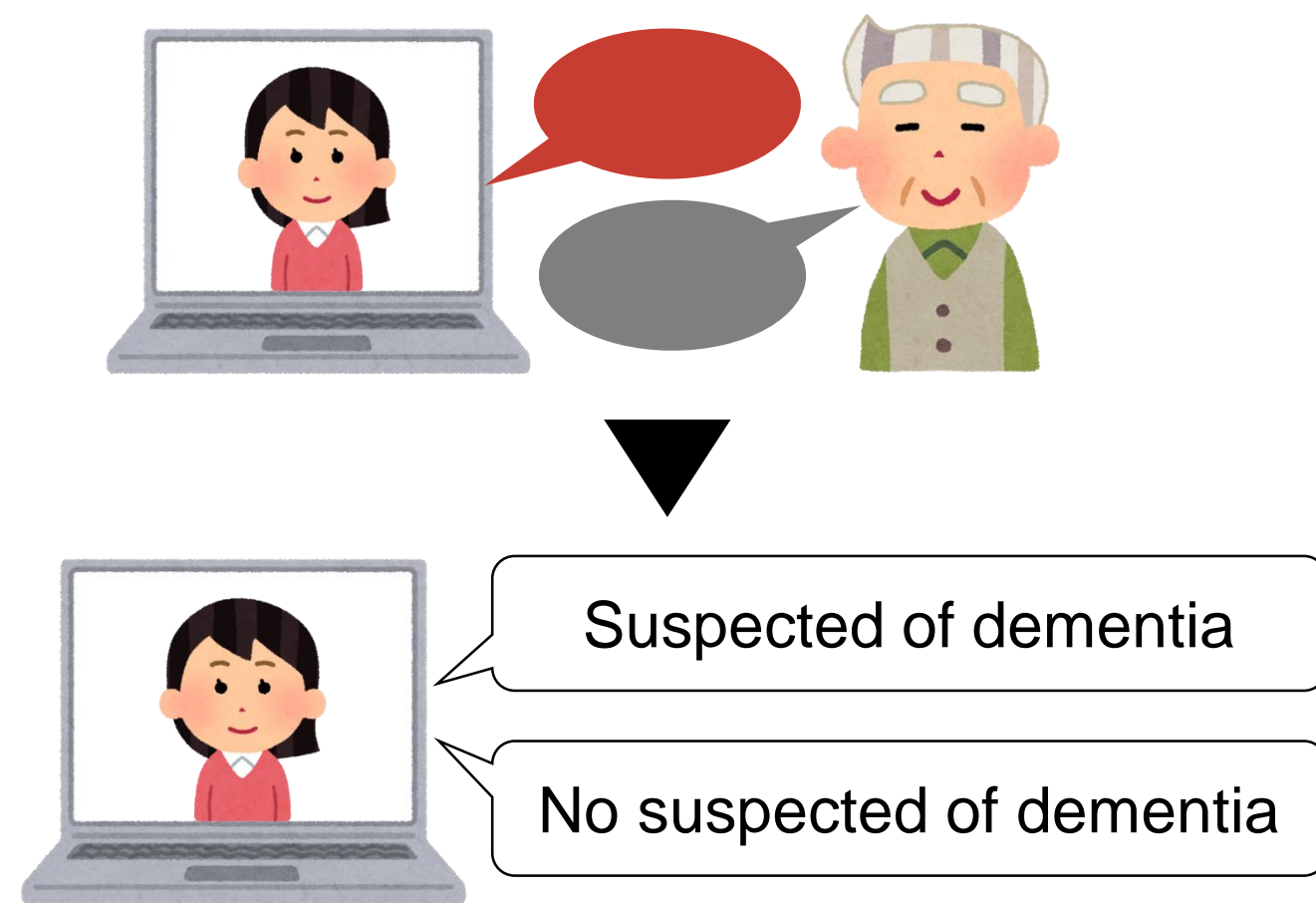
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Introduction

Overview



Aim

Early detection of dementia (Don't need to go to hospital!)

Proposal

- During interaction with agents
- Tools that can be used repeatedly for daily use
- ▶▶▶ Detection of dementia from responses to **atypical questions**

Typical question: Based on neuropsychological tests (e.g. MMSE; What's the date today?)

Atypical question: Not based on neuropsychological test

Neuropsychological tests

Frequently used screening for dementia (e.g. MMSE [Folstein et al. 1975], WMS-R [Wechsler 1997])

Experts are necessary for these tests

▶▶▶ Need to go to hospital

Related work

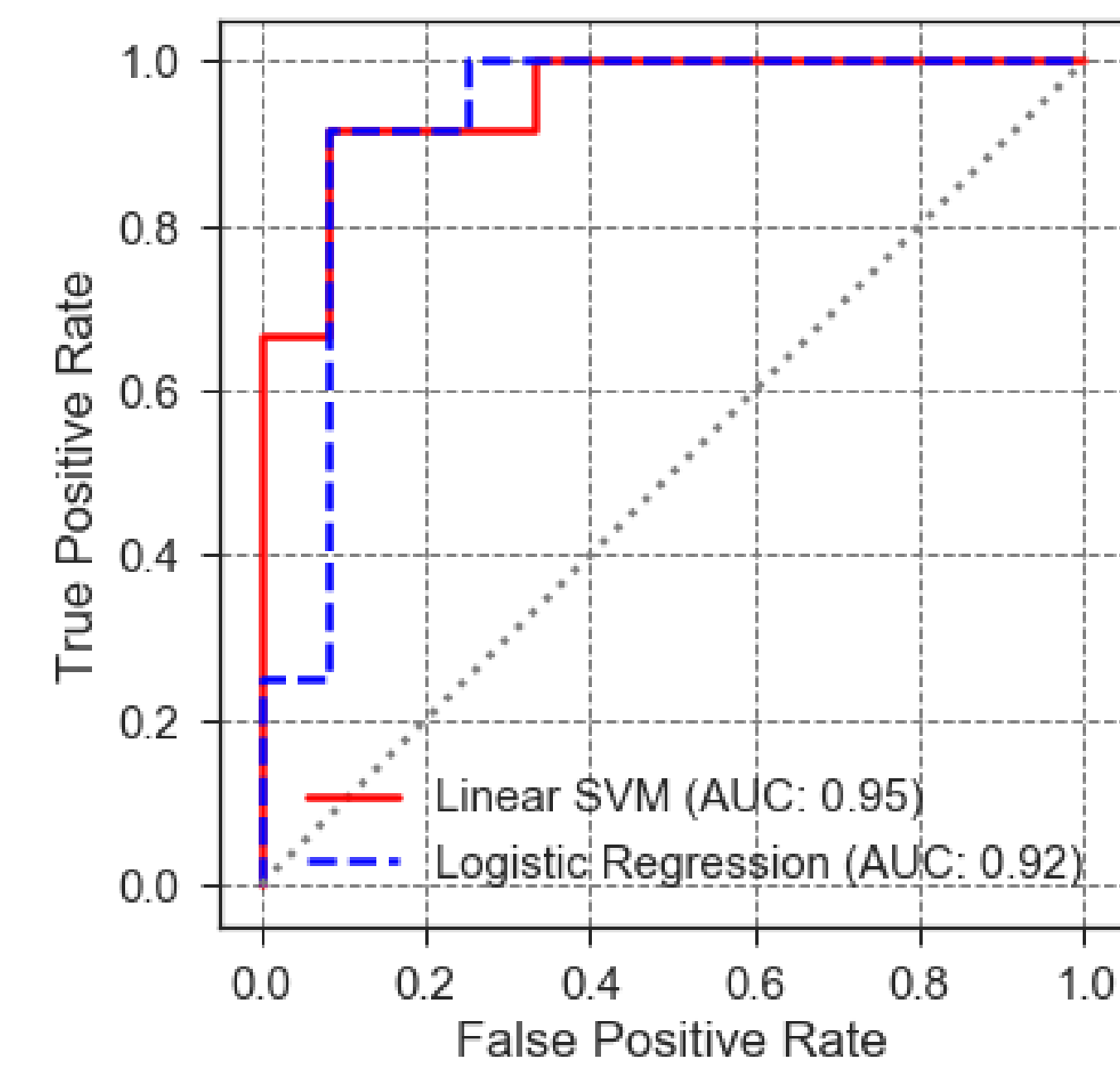
[Roark et al. 2011], [Aramaki et al. 2016], [Tanaka et al. 2017]
Some previous studies show possibilities of detecting dementia from speech features and language features

Same interaction patterns and questions

▶▶▶ These studies are not suitable for daily use

Result

High detection performance



Input (classification model)	AUC	Accuracy
Gap only (SVM)	0.69	0.63
MMSE (SVM)	0.85	0.83
Speech features (SVM)	0.85	0.83
Speech features (LR)	0.90	0.83
Speech and language features (LR)	0.92	0.92
Speech, language and image features (SVM)	0.93	0.83
Speech and language features (SVM)	0.95	0.92

Normalized the features (Mean: 0, SD: 1)
Model evaluation: Leave-one-participant-out, ROC Curve

Analysis of feature weight in the logistic regression

TOP5

1	Gap
2	f0 range
3	f0 max
4	mean value of Pause
5	Verbs

Analysis of "Gap"

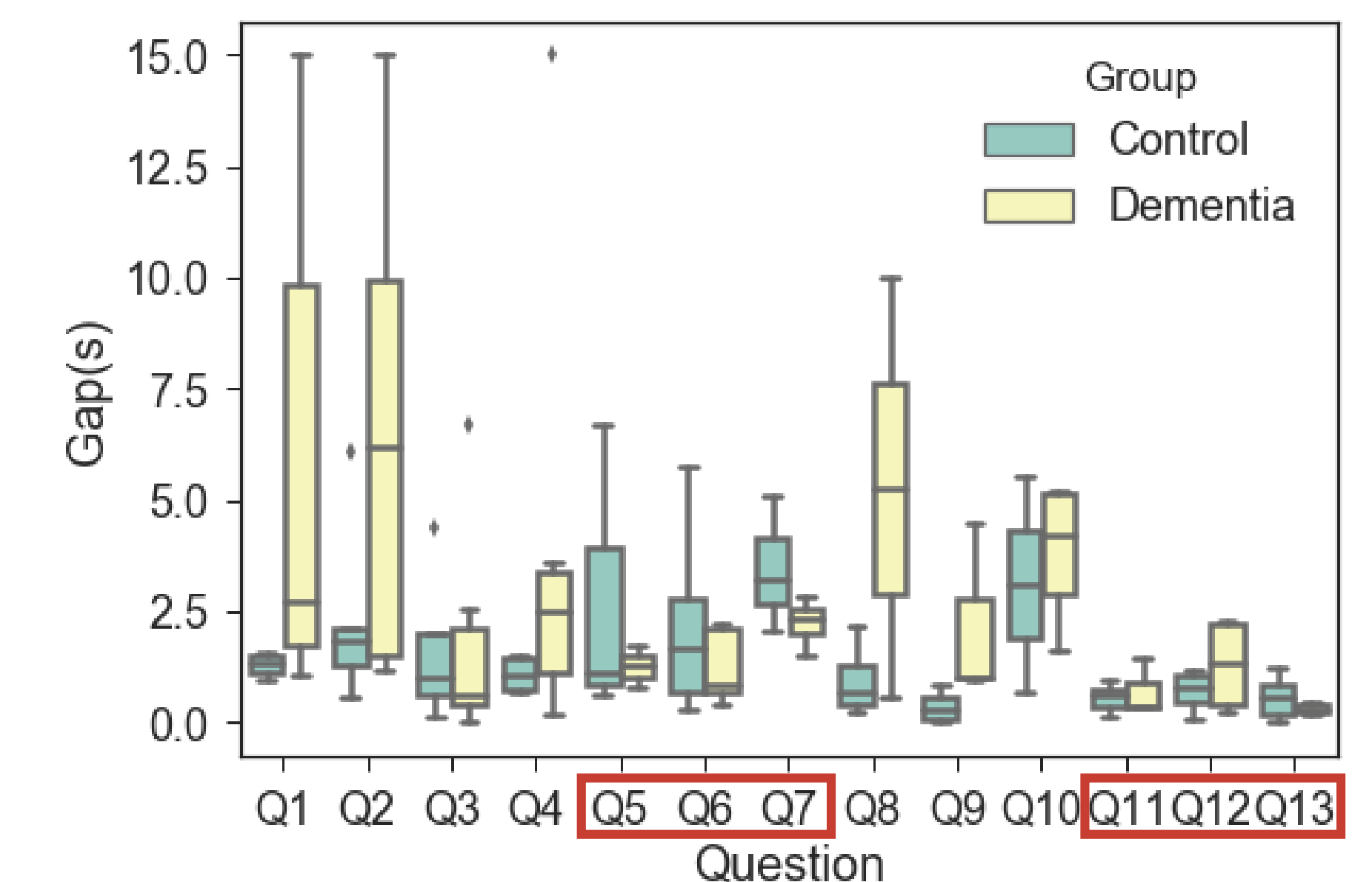
The dementia group is slow to respond to questions than non-dementia group (two-tailed Mann-Whitney U test) $p = 0.04$ ($n = 24$)
(Effect size) *Cohen's d* = 0.98

"Gap" is the time difference from the end of the agent's question to the start of the participant's response

Differences of "Gap" at each questions

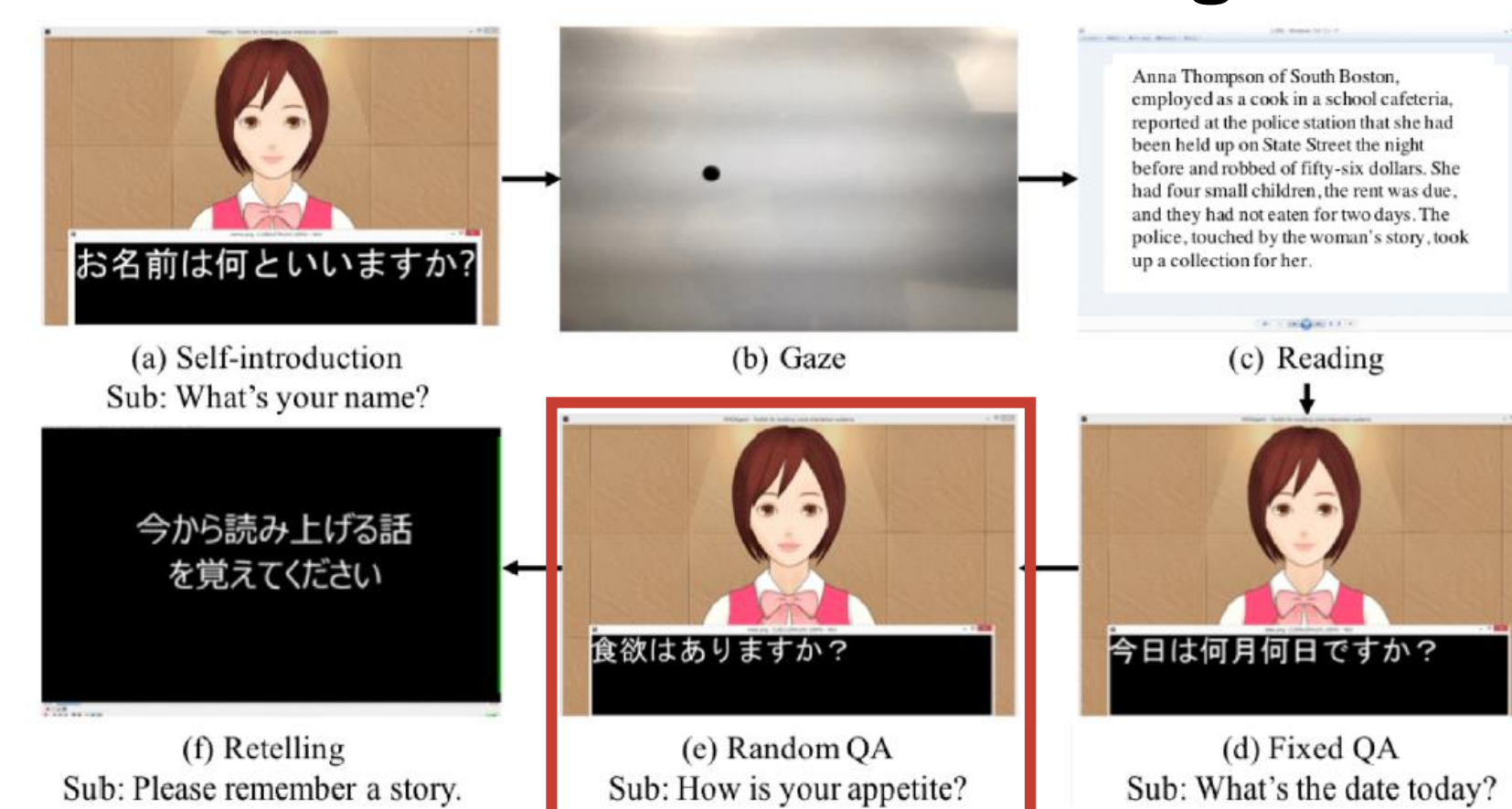
No difference between the two groups

- Q5, Q6, Q7
About the past story unlike other questions
- ▶▶▶ For our participants, memory disorder possibly has not been progressed
- Q11, Q12, Q13
Closed-ended questions are not effective
- ▶▶▶ Easy to answer with short sentences



Method

Embodied conversational agents

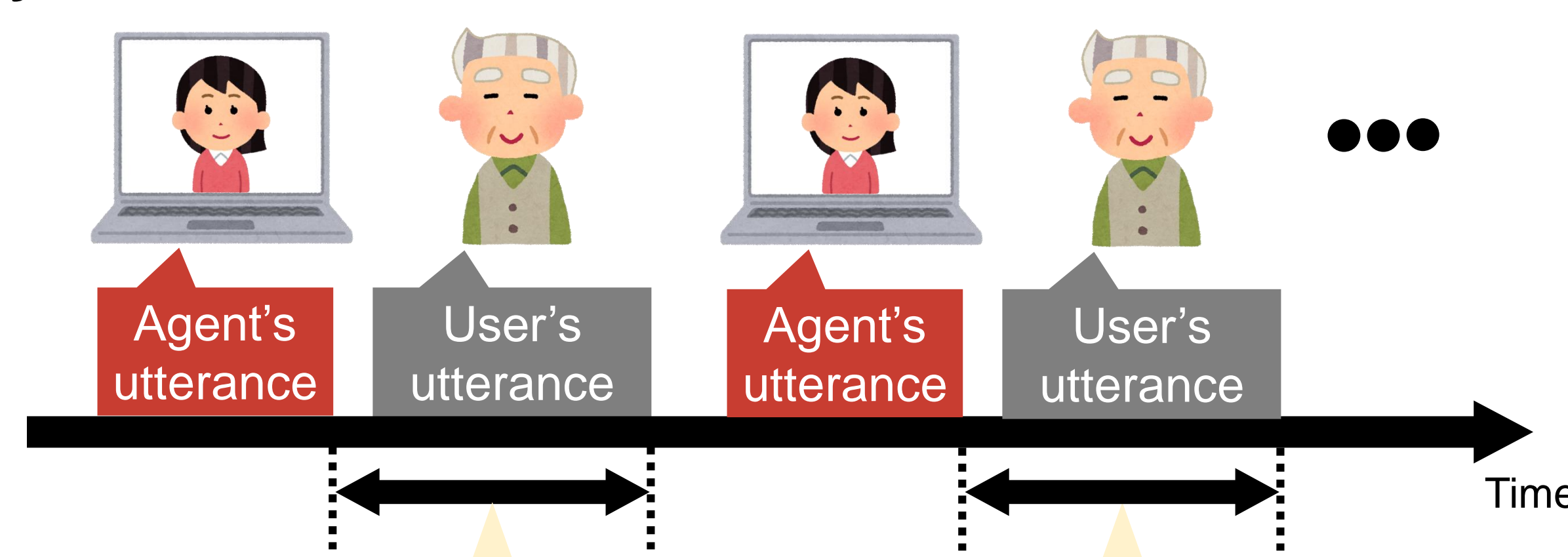


Detail of participants

Group	N	Age	MMSE
		mean (SD)	mean (SD)
Non-dementia	12	74.5 (4.3)	27.5 (1.8)
Dementia	12	75.9 (7.6)	21.2 (5.1)

Diagnosis is based on DSM-IV-TR

System



Feature extraction

Speech features
Answer time, Gap, Power, Pause, f0

Language features
Speech rate, Tokens, Fillers, POS (noun, verb, adjective, adverb)

- The agent randomly asks five questions from question set
- Analyze the user's utterance

Question set

Content
Q1 Please tell me about your family.
Q2 Please tell me something that you feel is stressful in your life.
Q3 What is your hobby?
Q4 What is your favorite song?
Q5 Please tell me about Yujiro Ishihara.
Q6 Please tell me about Shigeo Nagashima.
Q7 Please tell me about Hibari Misora.
Q8 Who is Japan's Prime Minister?
Q9 What season is it now?
Q10 What year is it?
Q11 Are you left-handed or right-handed?
Q12 Do you sleep well?
Q13 How is your appetite?

These questions are based on consultations with neuropsychologists

Conclusion

- Dementia can be detected even when using speech features and language features with atypical questions (AUC: 0.95, Unweighted accuracy: 0.92)
- The result will change depending on question types
- Possibility of measuring the degree of dementia from memory disorder

Future work

- Analyze image features e.g. facial expressions, eye movements
- Confirm the relationship between memory disorder and degree of dementia

References

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