Developing Positive Attitudes Towards Cooperative Problem Solving by Linking Socio-emotional and Cognitive Intentions

Kyoto University
Masato Kuno
kuno@ii.ist.i.kyoto-u.ac.jp

京都大学 大学院情報学研究科
Graduate School of Informatics, Kyoto University

IARIA

a short resume of the presenter

- Masato Kuno
  - Student of Graduate School of Informatics, Kyoto University
  - Nakazawa Laboratory (former Nishida Laboratory)
  - Specialty: Conversational Informatics

1. Introduction

・Today, agents are developed to cooperate for solving problems.

－if people think alone, their view is narrow

－others opinions are inspiring

・situation in which self-disclosure and intimacy with collaborators

→precondition for a sense of community (Kwon 2014)

Final Goal：

good, satisfactory problem solving

－through a process in which people recognize agents as effective partners and actively cooperate with them

1. Introduction

・We focus on social interaction in collaborative learning situations

・**Cognitive interaction…**

Discussions related to the task itself or the metacognition of the collaborators

→positive impressions about the **competence** of the other learner

・**Socio-emotional interaction…**

Shared emotions about the task and pronounced expressions of positive and negative emotions

→ positive impressions about the **familiarity** of the other learner

→ induce smooth and low-resistance interaction

1. Introduction

・In the case of people, it is obvious that they have emotions in addition to their abilities
→not for agent

・**”intentional stance” (Dennett 1989)**
– the idea that agents have intentions when people interact with them
– people do not usually think that agents have intentions

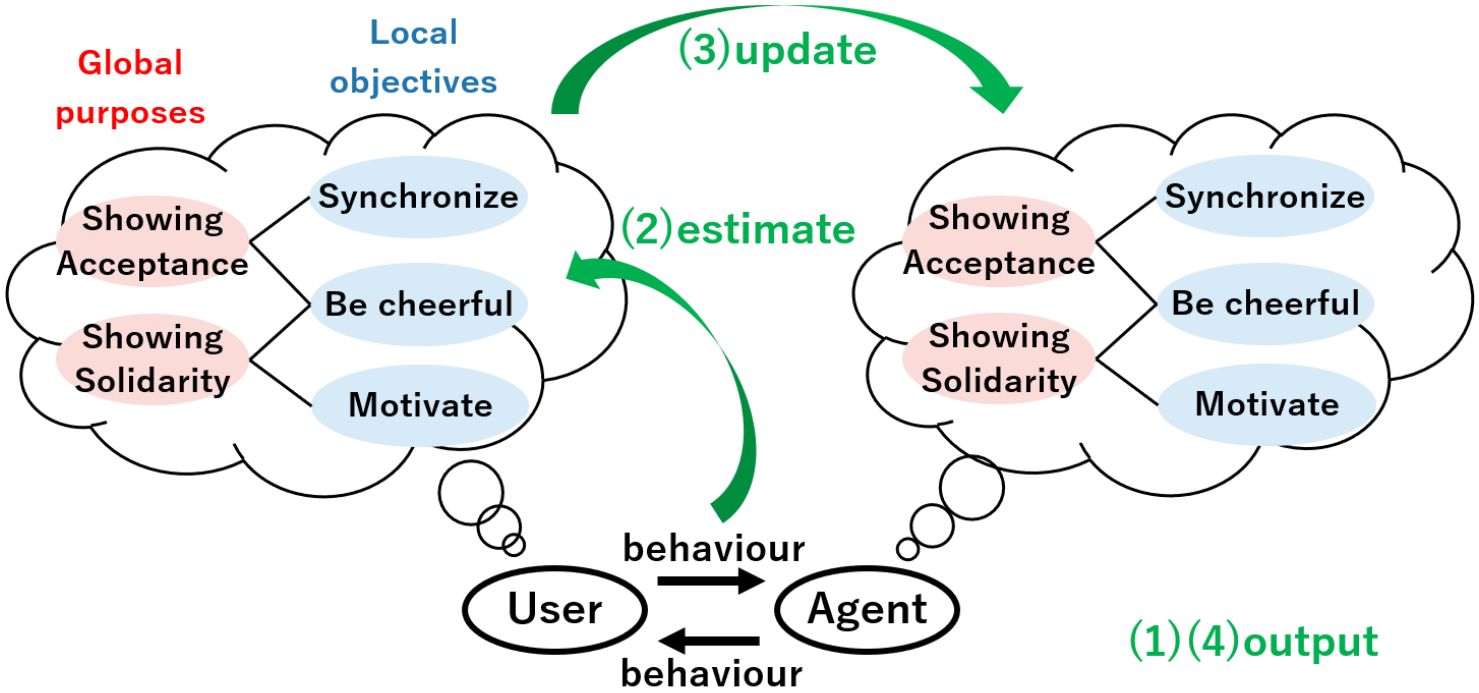
・emotions and abilities of an agent are often understood by people separately
→people cannot perceive an agent’s intention consistently

Our Purpose:
・**We represent the cognitive and socio-emotional intentions of the agents**
・**We update both intentions with consistency**
→facilitate people to feel that it is easy to talk to and be familiar with the agents.

3. Proposed Model

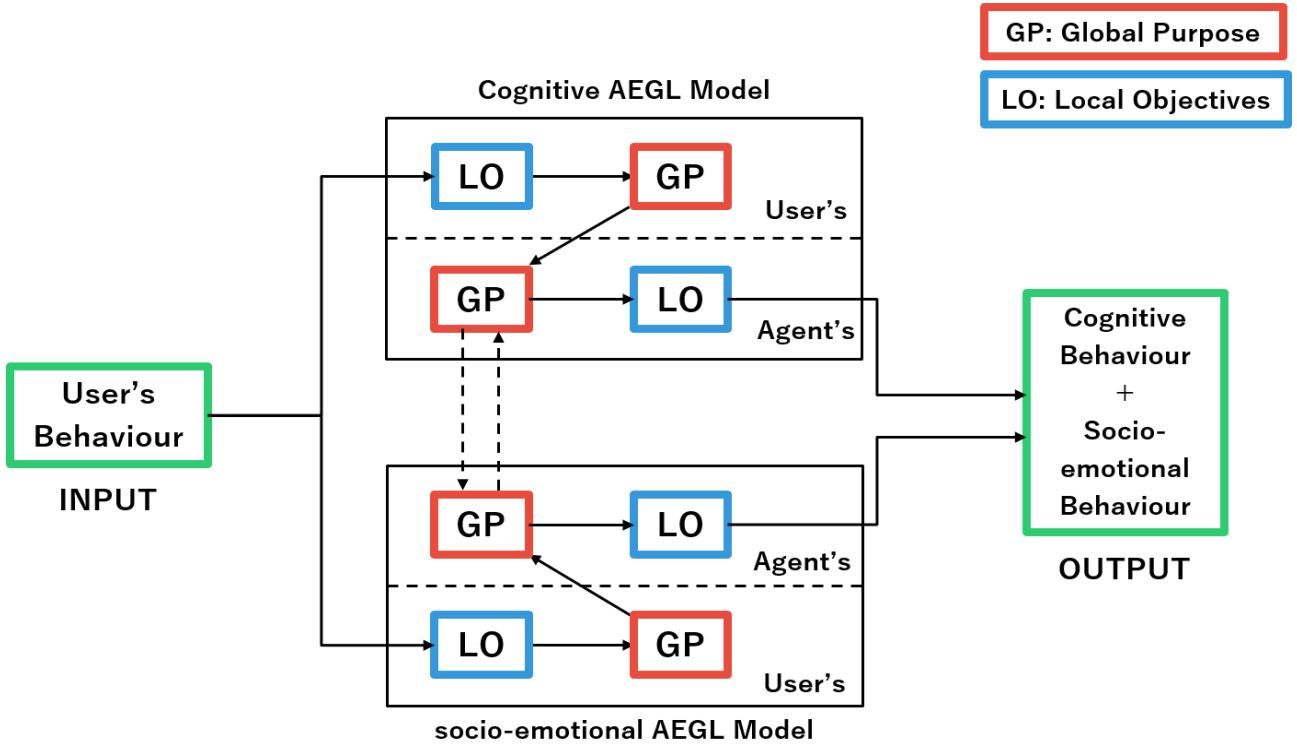
・We use **AEGL Model (Ohmoto 2018)** for agent's cognitive, socio-emotional behaviors

– the intention of the people is inferred from their verbal and nonverbal behaviors.

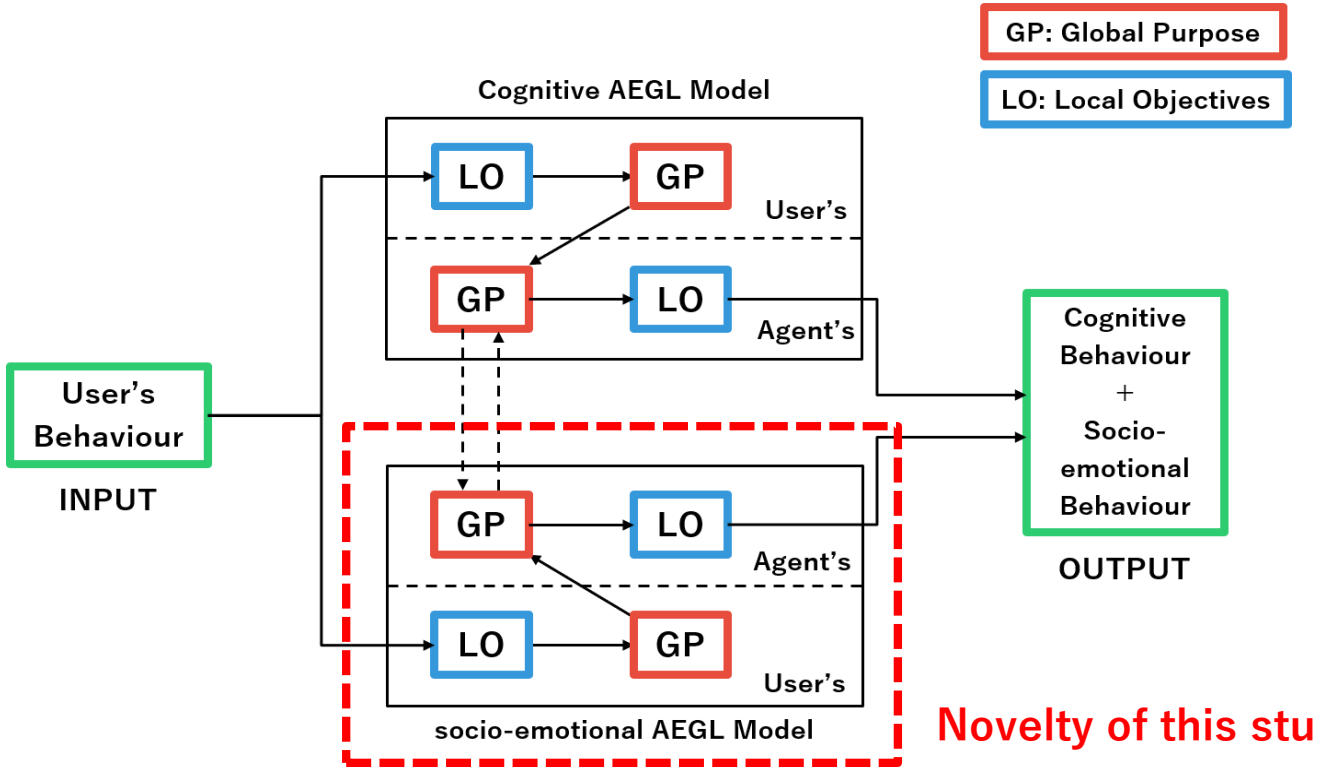


3. Proposed Model

- **Agent model in this study**
  - agents infer people's intentions, and determine next cognitive and socio-emotional behaviour in parallel

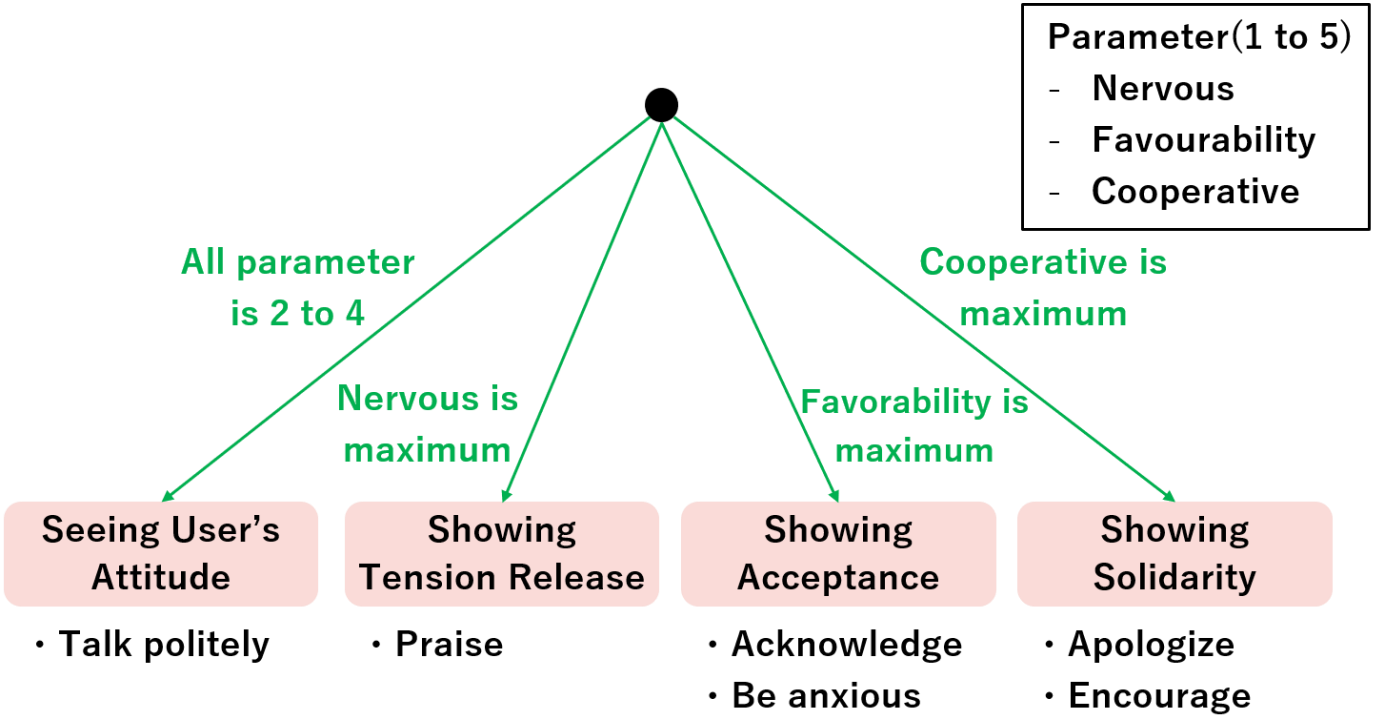


- **Agent model in this study**
  - agents infer people's intentions, and determine next cognitive and socio-emotional behaviour in parallel

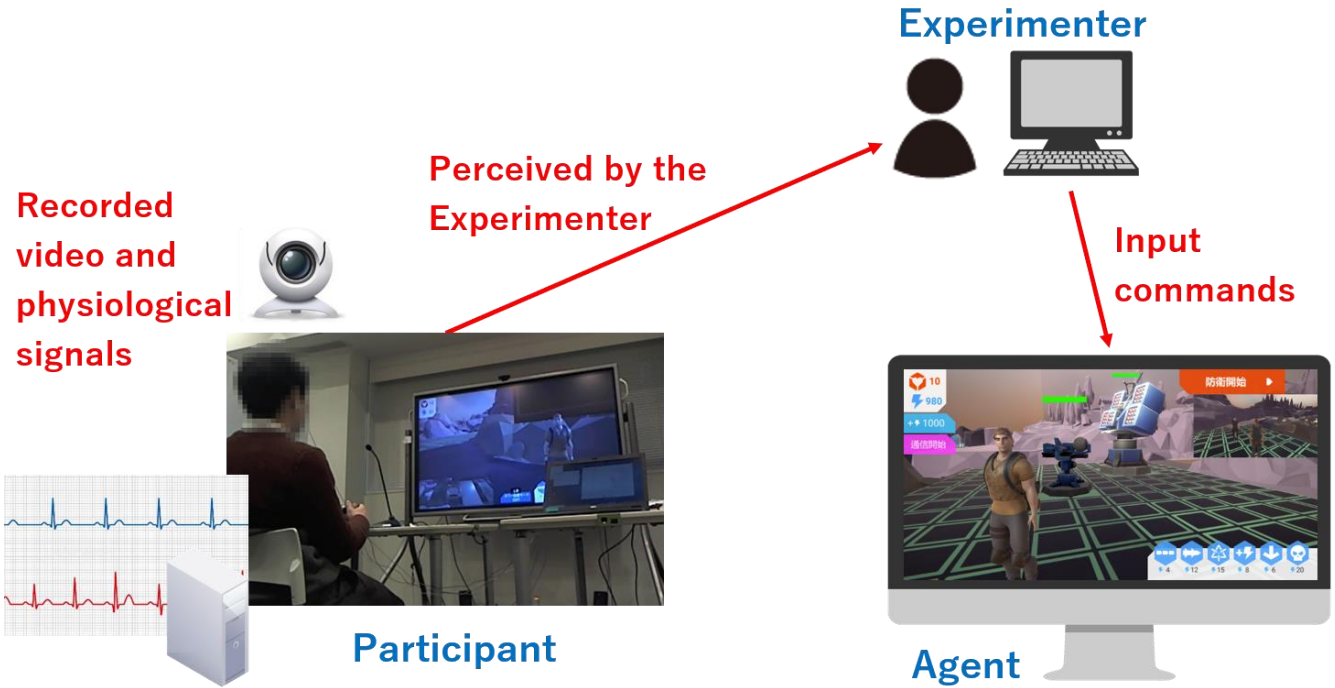


3. Proposed Model

- **Experimental Socio-emotional Behaviour Generation Model**
  - only the agent's intention model is assumed
  - local objective layer does not exist



- **Task：Tower Defense Game**
  - The player and agent communicate with each other to place a tower in position to prevent an enemy attack.



4. Experiment

- **Task：Tower Defense Game**
  - Players need to discuss the placement of towers, considering tradeoffs, such as the tower attack power versus cost.

  - To succeed in this task, the player and agent must work well together

  - When socio-emotional behaviors are displayed (such as **thank**, **praise**, **apologize**), we believe that the player will become
    - more familiar with the agent
    - more willing to interact and cooperate more actively

4. Experiment

- **Task：Tower Defense Game**
  - Experimental group: agent displays socio-emotional behaviors using experimental Socio-emotional Behaviour Generation Model
  - Control group: agent doesn't display socio-emotional behaviors

＜**participants**＞

- 12 males and 3 females
- average age: 22.53 (variance: 10.65)

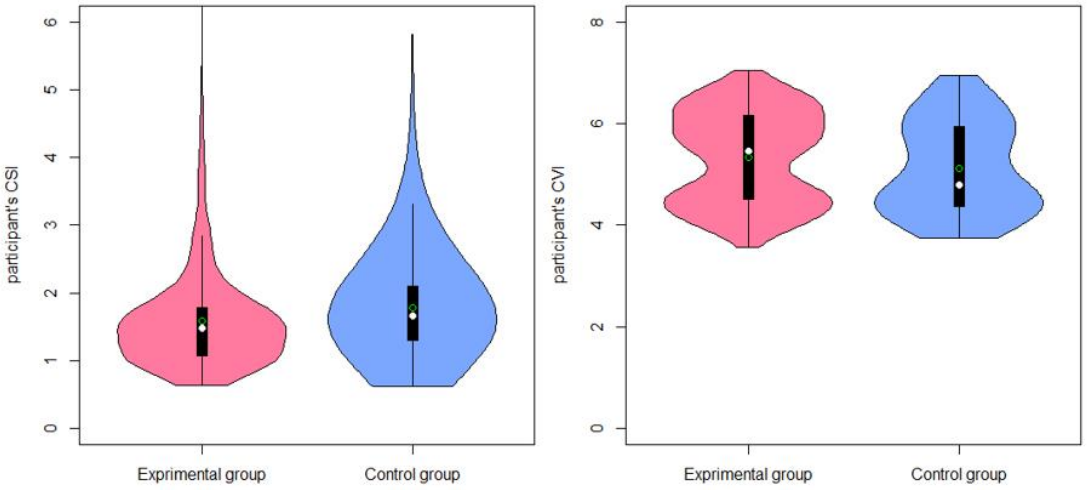
＜**evaluation**＞

- Player's behaviour (number of speech, speech latency)
- Physiological indices (heart rate, skin conductance response)
- Questionnaire

5. Results

- **Cardiac Sympathetic Index(CSI) and Cardiac Vagal Index(CVI)**

＜CSI, CVI average for 30 seconds after cooperative agent's speech for the entire task＞



- CSI…sympathetic nerves (stress state)
- CVI…parasympathetic nerves (relax state)

＜Welch's t-test＞

- CSI between group (p=**1.29e-05*****, t=-4.38)
- CVI between group (p=**0.00025*****, t=3.67)

5. Results

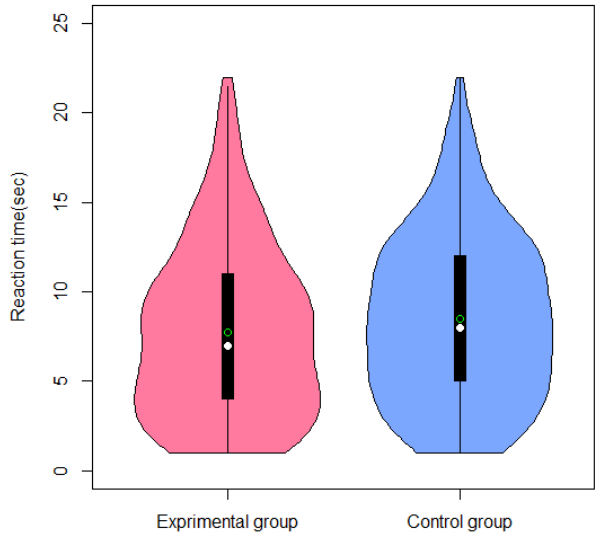
- **participants' Skin Conductance Response**
  - electrical measure of sweating caused by mental tension and excitement
  - rate of SCR values exceeding the threshold within 30 seconds of speech

	positive	negative
Experimental	330	91
Control	364	77

- no significant differences in the response rates

5. Results

- **participants' Skin Conductance Response**
  - focused on the speech with positive SCR response
  - number of seconds that the SCR value exceeded the threshold within 30 seconds after agent's speech



<Welch's t-test>

- control group having a significantly longer time (p=**0.045***, t=-2.01)

- In the control group, participants tend to be overly nervous about the agent's speech

5. Results

- **participants' socio-emotional speech**
  - we measured five types of speech:
    "acknowledge", "apologies", "be anxious", "encourage", "praise"

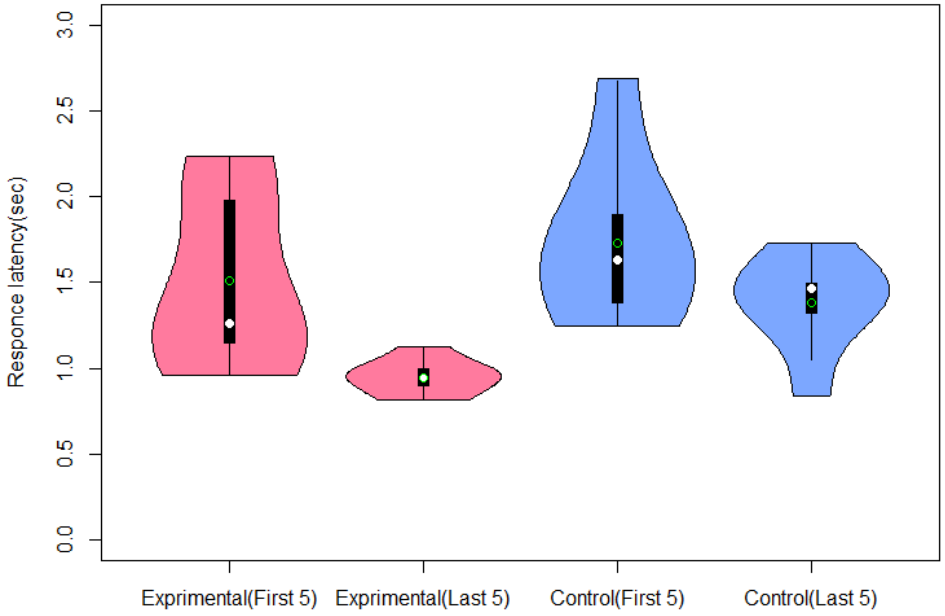
	Socio-emotional	cognitive
Experimental	40	538
Control	7	381

< χ 2 test>

・ significant differences
(p=**0.00052*****, χ 2=12.05)

5. Results

- **participants' speech latency**



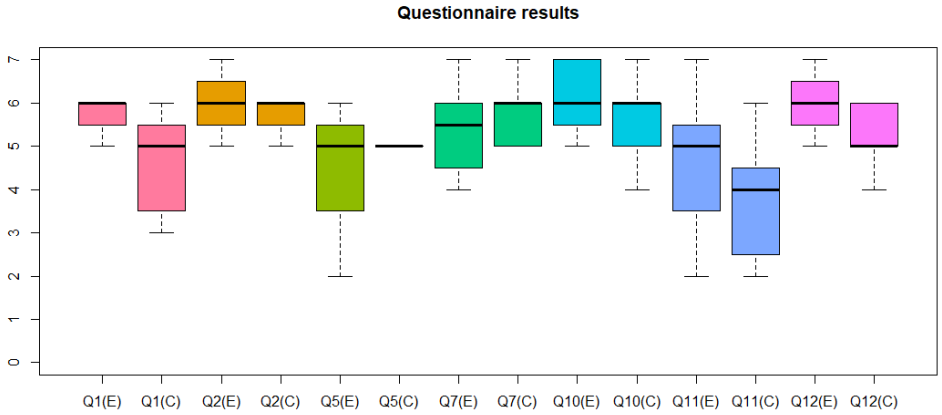
- long speech latency
  →participants found it challenging to communicate with the agent

<two-way ANOVA >

- significant differences
  (p=**0.0498***, F=4.68)
- significant differences between first 5 minutes and last 5 minutes
  (p=**0.0039****, F=12.27)

5. Results

- **Questionnaire**



Q1. I took a liking to the agent.
Q2. The agent was reliable.
Q3. I felt easy to talk with the agent.
Q4. The behavior of the agent was natural.
Q5. I found the agent's behaviour human-like.
Q6. I felt the value of the cooperation with the agent.
Q7. I was willing to the cooperation with the agent.
Q8. I could understand the way of thinking of the agent.
Q9. The agent understands my way of thinking.
Q10. I felt accepted by the agent.
Q11. I felt relieved by the agent.
Q12. I felt solidarity with the agent.

< Mann-Whitney U test>

- significant difference in Q1 (p=**0.046***, W=45)
- The other items are not significantly different.

6. Discussion

- **CSI, CVI, SCR**
  - participants in experimental group tend to be less tense and more relaxed in response to the cooperative agents' speech.
  - no significant difference in physiological indices, between agent's cognitive speech and socio-emotional speech
  - socio-emotional speech of agents did not directly affect participants

➡ agent's cognitive speech based on socio-emotional speech, was effective in reducing the participants' tension.

- **Player's behaviour**
  - Shortening of participants' speech latency, Increase in socio-emotional speech

➡ participants became less stressed when interacting with the cooperative agent

6. Discussion

＜To Construct an Ideal Proposal Model＞

– According to the questionnaire results, the participants in the experimental group more strongly perceived the socio-emotional intentions
(showing tension release, acceptance, and solidarity)

➡ the types of adopted intentions in experimental model were relatively appropriate

– we could not induce the participants' trust in the cooperative agent and strong positive attitudes towards it.

➡ there is room to devise more effective ways to link the cognitive and socio-emotional behaviors of the cooperative agents

7. Conclusion and Future Work

- **This study's goal:**
  facilitate people to feel that it is easy to talk to and be familiar with the agents

- **Proposed method:**
  output cognitive and socio-emotional behaviors in parallel using the AEGL model.

- **Task:**
  Tower defense game

- **Results:**
  people became less nervous and feel more comfortable talking to the agents.

- **Future Work:**
  further consistency between cognitive and socio-emotional intentions in the model