

Group Pressure Generation of Multi-Agents on Cross-cultural Simulation Game

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Abstract—In this paper, we pay attention to strong atmosphere of a group momentarily constructed by a place because the agent who expresses gesture and face expression gathers plurals. We called the atmosphere socially constructed as group pressure of agents. The purpose of the paper is to develop a group pressure and investigate the influence to human. We verify if the group pressure made by multiple life-like agents exert an influence on the judgment of player by using the cross-cultural simulation game we developed before.

Keywords- group pressure; cross-cultural simulation game; human-agent interaction; barnnga

I. INTRODUCTION

In the world of human coexistence, social adaptability should be regarded as significant in order for machines to realize flexible communication with humans. However, no essential approach for social adaptability has been shown by the current research regarding Human-Agent Interaction (HAI). Conversely, this issue about social adaptability can be expected to become an important technology to develop a robot that can communicate well with a variety of people as well as to develop such characteristic robots.

There is a cross-cultural simulation game *BARNGA* [1] which is available to experience rules on group society as based on non-verbal interaction. *BARNGA* is an easy-to-use cards game for education. This game has been adopted in a training course of company, the field of education and so on all over the world. The authors have been developed *online BARNGA* [2, 3] which can provide not only human-to-human but also human-agent cross-cultural communication on online environment based on original *BARNGA*. We have been studied and learnt many findings in the adaptability of group on the human-agent cross-cultural environment. For example, we investigated action sequential data, electroencephalography (EEG) of human by fNIRS, impression evaluation by questionnaire by using *online BARNGA* [3]. However, it has never been figured out how construct a social pressure which subjects feel subjectively in the society group on the human-agent cross-cultural environment.

In this paper, we pay attention to strong atmosphere of a group momentarily constructed by a place because the agent who expresses gesture and face expression gathers plurals. We called the atmosphere socially constructed as group pressure of agents. The purpose of the paper is to develop a group pressure and investigate the influence to human. We verify if the group pressure made by multiple life-like agents exert an influence on the judgment of player by using the cross-cultural simulation game we developed before.

II. GROUP PRESSURE GENERATION BASED ON LIFE LIKE AGENTS

A. Communication with Life Like Agents

Realization of human-artifact communication is closely-related to the recognition of human intent and the function of expression. Development of life-like artifact have been performed by using the elements like line of sight, language, gesture, posture, appearance, tactile sense, sound and motion. Generally, the communication of meaning is performed by language as typified by utterance between humans communication. Meanwhile, the importance of non-verbal information like facial expression, line of sight, gesture [4]. Moreover, Mehrabian et. al. reported that language information like contents of utterances gives 7%, hearing sense like tone or speed of talk gives 38% and visual sense like appearance gives 55% influence to a conversational partner, in the experiment of normal reaction of the partner when an utterer talks a conflicted message to emotion and attitude.

This experiment indicates that the taker of the message tends to focus non-verbal information like tone of talk and body language than contents of utterance [5]. Ito et. al. proposed the way to adjust non-verbal information like line of sight and facial expression to realize the atmosphere the user specified by using life-like agent [6]. These researches indicate the designing non-verbal interaction nicely in order to realize smooth communication between human and artifact.

However, above experiments were conducted with pair of human and a life-like agent or human and human or two life-like agents. This paper will treat plural agents to communicate with a society.

B. Group Pressure

Generally, a person becomes a member of a group with newcomer in the real social life. There is already in being a unique basis of the group at the times like this. The members keep the basis as if it were common sense. If the opinions or perspectives of the newcomer disagree with the basis, the person will get confused. In this case, the person have to judge between following behaviors [7].

- 1) The person accepts and agrees with the basis.
- 2) The person ignores the basis and behaves absolutely.
- 3) The person promotes the change of the basis.
- 4) The person leaves the group.

When a newcomer noticed that all members have same perspective without oneself in a group, the person feels a stress and pressure. This triggers a change of the opinion. We call this stress or pressure as a “group pressure”. Following this pressure is the psychology of conformity.

Ash [8] investigated what condition will generate the conformity in the group in the creative experimental way.

C. Design of Group Pressure Generation

We develop a simulation system of a group pressure by using plural life-like agents and realize various group pressures. And then, we validate the constructed atmosphere by the evaluation experiment. Life-like agent as a CG character represented human body is used as an interface which can be reduced human’s cognitive load on the various tasks. So far, Galatea and TVML [9] are proposed as tools which can be develop a life-like agent relatively-easy. We use TVML for the construction of a group pressure of multiple agents. Figure 1 shows the developed agents. We prepared 4 agents, and set up the environment with interaction between 5 characters including one human person (Figure 2).

III. ONLINE BARNGA WITH GROUP PRESSURE

A. Cross-Cultural Simulation Game BARNGA

The authors have been developed *online BARNGA* which can provide not only human-to-human but also human-agent cross-cultural communication on online environment based on original *BARNGA*.

We used *online BARNGA* in this research in order to investigate an influence of the group pressure made by multiple life-like agents. In the following sections, we first explain about a trick-taking game conducted in *BARNGA* and then that is followed by an explanation about *BARNGA* itself. Afterward, *online BARNGA* is explained.

A trick-taking game is a card game. In general card games, the mark of each card, Spade, Heart, Club, and Diamond, is called a suite. The figures of each of face cards, Jack, Queen,

King, and Ace, are called ranks. In this game, each player receives the same number of cards and the game is continued repeatedly until each person has used on the cards in their hand. In a trick, the dealer leads and other players do the same in order one by one. After all the players have played a card, the player who led the strongest card in that round wins the trick. Then the winner takes all the cards played in that trick. This is referred to as taking the trick and this is repeated until all the cards have been played and all the tricks taken. The player who obtains the largest number of cards becomes the winner of the trick-taking game.

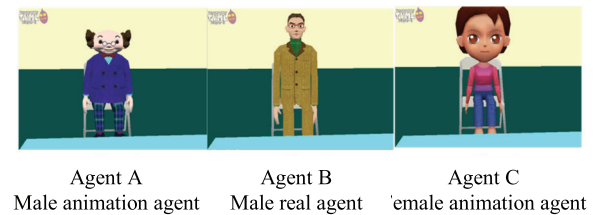


Figure 1. Life-like Agents based on TVML



Figure 2. Group Pressure based on Life-like Agents

The ranking of cards in trick-taking games varies depending on the game variation. Some trick-taking games contain trumps. A trump is a special suit of card set in advance, which is stronger than any other suits.

BARNGA is a simulation game, aiming at realizing a virtual cross-cultural experience. In this game, the rules of a card game are used to resemble a culture, and players can be surprised when they notice the differences in rules so as to experience culture shock.

The rules of *BARNGA* are simple and small in size compared to general social norms, and they are inadequate for recreating a society. However, this game contains coping problem in group society on which this research puts its focus. For this reason, we adopted this game since the acquisition of adaptability of group by players can be adequately observed.

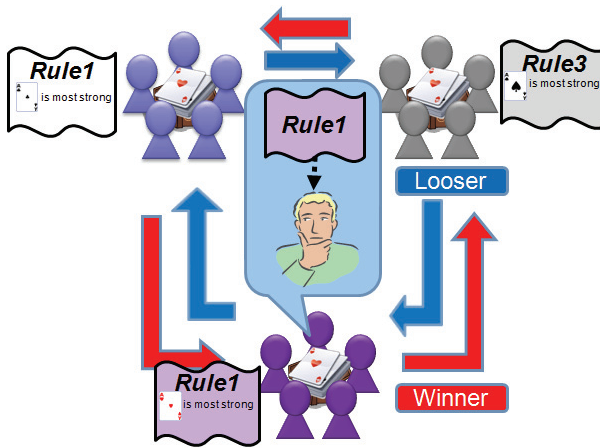


Figure 3. How a trade is done

The following explains the game content. During the game, players cannot converse. Therefore, players need to use nonverbal information such as physical gestures in order to convey their thoughts. Multiple tables are set in this game with four or five players at each table. An information sheet that contains the rules of this card game (initial rules) is distributed to each player when all the players have been seated. What is important in this game is that the game rules distributed to the players at this point vary slightly depending on each table. The differences in rules are simple regarding the types of trumps and rankings of strong cards. However, the players do not know that the rules vary slightly depending on each table. When all the players have finished reading the rules, the rule sheets are collected before the game is started. This means that the players cannot refer to the rules during the game. In this research, these small differences of the rules shows tacit rule. The players should acquire these rules actively. On the other hand, the common rules show regulations. All players acquired these rules passively in advance.

The game is played by the players on the same table. When the game advances to a certain degree, the game is stopped and those players winning and losing the most are moved to other tables by trading (Figure 3). After players have been traded, the game is restarted at each table. At this time, the traded players should experience discomfort because at the new tables, the game advances based on the different rules from the tables where they were previously seated. Similarly, those players that are not traded also feel something strange toward behavior of the new players that join in their table. *BARNGA* prohibits any conversations among players during the game. To ease this feeling of strangeness, the players need to observe the behavior and movements of the other players around them and use nonverbal information such as gestures in order to advance the game. In *BARNGA*, this feeling of strangeness is regarded as a cross-cultural experience.

The tacit rules we defined before [2] in *BARNGA* can be

considered to be differences in rules. Given that, observing behavior of the players in this game serves to monitor the acquisition of tacit rules. *BARNGA* has also been utilized for agent research of group adaptability. However, interactions between players in this game are ambiguous, which makes it difficult for us to obtain and secure behavioral data from players during the game.

For this reason, we have developed *online BARNGA* in order to record behavioral data of players and clarify the interactions between players.

B. Online BARNGA

Going online with *BARNGA* has introduced the determination methods of winners and the scoring system into *BARNGA*, in order to realize clear interactions between players and to record the behavioral data of players. This adjustment for scoring can generate not only tacit rules as regulations, but also tacit rules as morality. In *online BARNGA*, each player joins in the game by connecting their individual computers to the server online. The gaming interface as shown in Figure 4 is displayed on each individual computer, and each player participates in the game on this interface. On the server side, the state of each player (hand, stock, and ranking) and player behavior (card led, and winner determination) are recorded as log data. Moreover, the introduction of clear determination methods for winners can offer social behavior of players as data. To realize this function, a scoring system has been introduced. The procedures of determining the winners and the flow of scoring transitions are shown as follows:

- 1) The dealer is selected from the table.
- 2) The dealer leads and the other players also play in order.
- 3) The dealer determines the winner.
- 4) The winner can get the Winner Point.
- 5) Non-dealers decide if they follow the decision or make complaints against the decision.
- 6) A non-dealer that made a complaint is given a deduction of Expense Points as a complaint cost.
- 7) The dealer and the winner are given a deduction in their Penalty Points on which the percentage of complaints is weighed.
- 8) A player that makes a complaint is given an increase in Bonus Points on which the percentage of complaints is weighed.

In *online BARNGA*, the parameters design in which the value of each score can be changed allows game designers to create group conditions. In the experiment we conducted, three kinds of group conditions were configured.

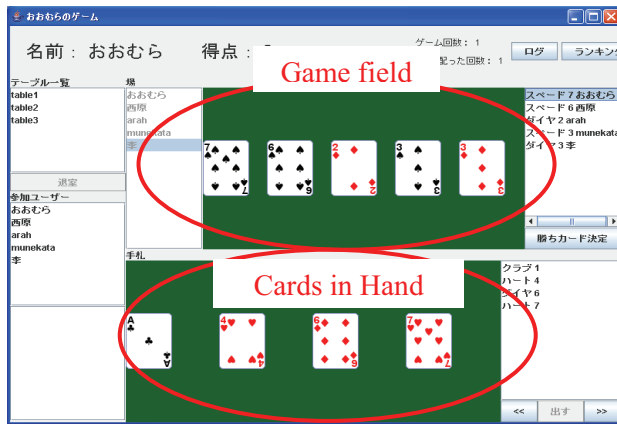


Figure 4. Online BARNGA Interface

C. Setting of Social Group Situation on Game

As to group conditions in the game, the following three settings which previous research [10] adopted were prepared. Standing on the viewpoint of group adaptability, we were able to examine the differences in player behavior under these conditions.

(1) Ordered condition:

This is a usual game condition before trades are conducted. Players can earn their scores by accumulating their Winner Points if they obediently follow the initial rules when leading by drawing a card necessary for winning the game. No penalty is charged by the group, there is no need to make complaints. The players almost never need to worry during the game.

(2) Cross-cultural condition:

Under this condition, only one player joins in the table traded from another table. The remaining four players on this table follow the same rules, so that there should be a variance due to the differences in initial rules. Observing behavior of other players, the traded player needs to learn the differences in the rules quickly, as well as to understand the rules commonly followed among other players at this table. The traded player needs to be free from the initial rules and take actions to learn the new rules. This should be the key to increase his score. The game result significantly varies depending on the level of player's group adaptability.

(3) Chaotic condition:

Under this condition, including the player, two other players also move in to a new table because of being traded. Three initial rules are now mixed together at this table, and high penalties also exist. At the same time, it is very hard to obtain Winner Points in a strategic sense. On the other hand, making complaints becomes a tacit rule since many complaints come to be made by players in this condition. It makes it possible for players to earn better scores by accumulating Bonus Points; however, this tacit rule is regarded as a new group rule.

D. Making Profiles based on Behavioral Logs

Behavioral logs of players obtained in online BARNGA consist of complaint rate, initial rule dependency rate, and acquired points. These logs can be recorded according to each social group condition. Examining these logs allow us to measure the group adaptability of players.

(1) Complaint rate (CR):

This rate indicates the probability of whether to make a complaint or not where the winner determination made by other players differs from the player's own win-loss standard. The greater this rate becomes, the more complaints the players make.

(2) Initial rule dependency rate (IR):

This rate indicates the probability of whether the complaint made by a player is dependent on the initial rules that the player follows. In the ordered condition, the greater this rate becomes, the more likely the player's behavior follows the initial rules. In the cross-cultural condition or the chaotic condition, however, the greater this rate becomes, the more the player is bound by the initial rules. This means that the player does not deal with social changes in a flexible way and continues to have headstrong attitudes.

(3) Thinking time (TT):

This is a time spent by a player in deciding whether to make a complaint or not. In the ordered condition, this time shows the discretion of individuals in thinking, that is how carefully one makes a usual decision. However, in the cross-cultural or the chaotic conditions, the longer this time is taken, the more the player thinks of dealing with a new condition in some way, thus learning the differences in the rules. This time is categorized into Total Thinking Time (TTT) and Total Thinking of Complaints (TTC).

(4) Acquired point (AP):

This indicates the points acquired by a player during the game. In the ordered condition, the player can acquire points by obediently following the rules. However, in the cross-cultural condition, the player is able to come to acquire points if he learns the differences in the rules, by demonstrating behavior that follows the new rules under the new situation and stops making complaints. On the other hand, in the chaotic condition, since there are three initial rules existing, it is difficult to learn and follow the new rules under the new situation. This is because all the players seating at the same table need to understand their initial tables (before trades are conducted twice) at the onset of the game, learning that the rules vary depending on each table. For this reason, strategic acquisition of Winner Points is difficult. However, the number of complaints made by other players naturally increases. If players can notice that Bonus Points for complaints are given every time, they can learn the tacit rule to make complaints. As a result, they can increase their scores.

IV. EXPERIMENTS

The purpose of the experiments is to investigate an influence of the group pressure made by multiple life-like agents by using *online BARNGA*.

A. Setting of Experiments

The procedures of the experiment are as follows. Three tables were prepared with 5 players at each table, a total of 15 players were allocated. Of the 15 players, one player was the test subject. The four life-like agents based on TVML works on the table with a subject and express gestures according to behavior of the player.

In the experiments, we compare between the results with group pressure by life-like agents (experimental group) and without group pressure (control group). The expressed gesture is anger face to subject when an agent player claims to judgment of dealer. If four life-like agents claimed to a player then the agents glare at the player with scary eyes.

During one turn, each player had a hand of five cards and did the trick-taking game for five sessions. Each test subject followed the following procedures to participate in the game.

- 1) The player does the game two sessions in the ordered condition.
- 2) Trades are made, and three members including the test player moves to other tables.
- 3) The player does the game two sessions in the cross-cultural condition.
- 4) Trades are made, and nine members including the test player move to other tables.
- 5) The player does the game two sessions in the chaotic condition.

The test subjects were 10 graduate students. TABLE I and TABLE II show the scoring settings and initial rules, respectively. All the test subjects answer questionnaires after the game has finished. Figure 5 shows the appearances of the experiments.

B. Hypothesis

In the experiments, we validate following hypothesis.

- 1) *Experimental group tends to group adaptation.*
- 2) *Experimental group tends to behave carefully with time and care compared with control group.*
- 3) *Experimental group tends to acquire game points compared with control group.*

C. Experimental Results

Figure 6, 7, 8 and 9 show the experimental results. In the Figure 6, total thinking time (TTT) and thiking time of the claim (TTC) are not significantly different between groups. However, experimental group in both of time shows less 30 seconds on an average.

TABLE I.		SCORING SETTINGS
Point	Description	Score
Winner Points	Winner's point	300
Penalty Points for the Winner	Penalty point against the dealer	100
Penalty Points for the Dealer	Penalty point against the winner	50
Bonus Points	Bonus point obtained in accordance with complaints	160
Expense Points	Point consumed every time a complaint is made	20

TABLE II.		DIFFERENCES IN THE INITIAL RULES
	Trump	Ranking
Table 1	Heart	7>6>5>4>3>2>A
Table 2	Spade	A>7>6>5>4>3>2
Table 3	Club	2>A>7>6>5>4>3

In Figure 7, experimental group in Game 1 (*Ordered condition*) shows less 50 seconds in TTT. Game 1 is significantly different between groups. In Figure 8, Game 1 shows more 5 seconds, Game 2 (*Cross-cultural condition*) and Game 3 (*Chaotic condition*) shows less 22 seconds and less 17 seconds respectively in TTC. In Figure 9, experimental group acquired 275 AP.

As a result, hypothesis 1) and 3) are supported and hypothesis 2) is not supported. In consideration of the results of hypothesis 2), we prospected experimental group spend much time in order to recognize emotional information of the agent players tuitively. In reverse the group can be available to cope with judgement of behavior with less time, because the group can observe and acquire the atmosphere as emotional information of a group.

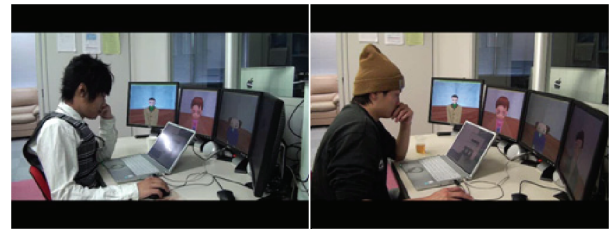


Figure 5. Appearances of The Experiments

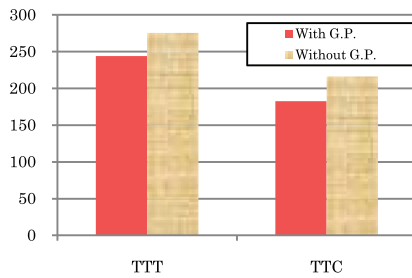


Figure 6. Thinking Time (TT) [sec]

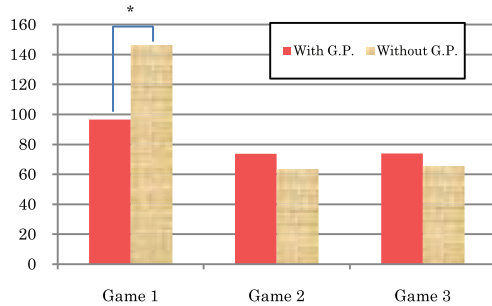


Figure 7. Total Thinking Time (TTT) [sec]

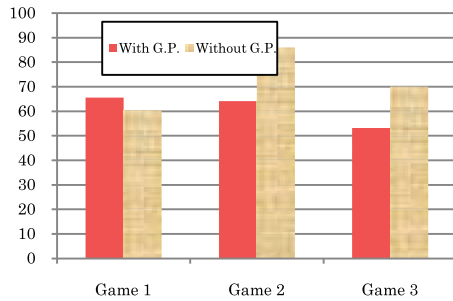


Figure 8. Thinking Time of Claim (TTC) [sec]

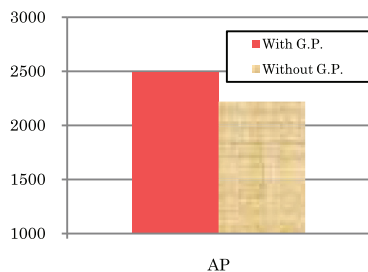


Figure 9. Acquired Points (AP)

V. CONCLUSION

We developed a virtual group pressure by using multiple life-like agents and investigate the influence to human. We verify if the group pressure made by multiple life-like agents exert an influence on the judgment of player by using the cross-cultural simulation game we developed before.

In near future, we will create a model of the mechanism of the group pressure constructed by the combination of the expressions of life-like agents.

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