Experimental Verification of Mental Influence by Double-Bind Theoretic Software Agents

Kazuo Ohnishi[1] and Tatsuya Nomura[2]

[1]Graduate School of Corporate Information, Hannan University

5-4-33, AmamiHigashi, Matsubara, Osaka 580-8502, Japan

[2]Department of Media Informatics, Faculty of Science and Technology, Ryukoku University

1-5, Yokotani, Setaohe-cho, Otsu, Shiga 520-2194, Japan

E-mail: [1]mc03003@hannan-u.ac.jp, [2]nomura@rins.ryukoku.ac.jp

Abstract: If machines have emotions and they influence to communication to users, possibility of mental burden to users should be considered from several perspectives. Our research focuses on this problem and aims to providing with some evidences for negative influence of artificial emotions to human mental states, based on psychological experiments.

For this aim, we conducted a psychological experiment, where the subjects interacted with some software agents consisting of simple animations. After interaction between the subjects and agents as games of quiz, the subjects evaluated their impression for the agents along questionnaires. This paper reports and discusses the result of statistical analysis for this data.

I. Introduction

Personal computers and robots have recently become familiar to us by improvement of their operationality by GUI and development of pet type robots, such as AIBO. In addition, research on artificial intelligence aiming to smoothing interaction between users and machines, in particular introduction of affective systems to robots and software agents has been encouraging it. These software agents have many application areas such as business like attendants in virtual space, education, psychotherapy, and so on [10]. On whether affective systems actually make interaction with users smooth and what influence these systems have to users, however, sufficient discussion has not done yet. On the other hand, there is a research result showing that users easily change their feelings in interaction with machines having a simple interface, from the viewpoint of social psychology [9]. Therefore, a possibility that affective systems may give mental burden to users should be considered.

This research aims to investigating empirical evidences showing mental burden to users by artificial affective systems based on psychological experiments. As a concrete technique, we focus on double bind theory [1] proposed as a cause of psychopathology by inconsistency in human communication and impossibility of evacuation from it. In the previous experiment, we suggested a possibility of the existence of this mental burden in interaction between human subjects and a software agent [8]. In this paper, we report a new experimental simulation environment where a pseudo double bind situation in interaction between software agents and subjects is realized. We conducted a psychological experiment using a new system and questionnaires on computer anxiety, and then performed statistical analysis. We discuss about the result of the experiment.

II. Double Bind Theory and Interactive Systems

A. Double Bind Theory

Double bind theory was proposed as a cause of schizophrenia, by G. Bateson [1]. Double bind situation is a state where patients are caught in paradoxical communication based on power relations. It is formalized as follows:

1. The existence of more than two persons (one victim and

some assailants).

2. The repeated experiences.

3. The first prohibition message.

4. The second prohibition message inconsistent to the first message.

5. The third prohibition message which prohibits evacuation from the inconsistent situation.

According to Bateson, human communication is performed across various logical types. Although normal people can classify messages from the others to the appropriate modes, persons in double bind situations are unable to do it because they are always given inconsistent message and prohibited from running away from this inconsistency. This state is shown as follow:

1. In order to perform a suitable response, it is a life-or-death problem to classify a message correctly.

2. The message from the others is inconsistent in the higher and lower levels.

3. They cannot communicate about communication itself at a meta-level.

The factor of double bind is a gap between symbols and meanings caused by inconsistency in communication. As a result, persons caught in double bind situations acquire unconventional and morbid communication customs which are a kind of defensive responses.

B. A Simulation Model of Double Bind

As mentioned the above, double bind is originally the theory in human communication. Our research aims at realizing it in interaction between software agents and users. As a concrete model for this aim we apply the theory of feeling rules and focus our attention on evacuation impossibility from inconsistent situations [4, 5].

Feeling rules are tacit social rules directing what emotion is expected and forced in a certain situation. Human has various emotions in various situations and they are severally different between individuals. A feeling rule requires or forces people to have a particular emotion and denies all the other emotions.

On relations of feeling rules and double bind, Yamada argued that the concept of double bind is related with the gap between "what is felt" and "the thing which must be felt", and the difference happening between feeling oneself and being made feel under a rule is equal to the inconsistency in double bind [11]. Based on this suggestion by Yamada, we assume inconsistent situations in interaction between a software agent and user to be those where the user is given questions on feeling rules and inconsistent answers for any of the user's replies by the agent.

On the other hand, Hase regarded double bind as one system as follows: Although the system is trying to change by a positive feedback to withdraw from an inconsistent situation, it is stabilized due to a negative feedback of prohibition of this withdraw at the higher level [2]. That is, important is evacuation impossibility. Based on this model by Hase, we regard double bind situations as the above inconsistent situations and prohibition of evacuation from these situations, and realize this evacuation prohibition by using messages of prohibition from the software agent. In the model by Hase, however, it is required for assailants and a victim to have an intimate relation like a child and parents, and realization of this type of relations between software agents and users is hard. Thus, it should be noted that double bind situations in our model are pseudo ones.

C. A Simulation Program of Double Bind

Figure.1 shows an overview of the simulation program of double bind in our research. Under this simulation program, a software agent is an assailant and user is a victim. This simulation program is implemented by using Java Applet. In double bind situations of this Java Applet program, users have interaction with the agent through only an easy animation and buttons. Interaction between the agent and user is done as follow:

1. The software agent gives a question on feeling rules to a user.

2. The user answers with either "yes" or "no" for it.

3. The agent gives a negative answer to any of replies of a user.
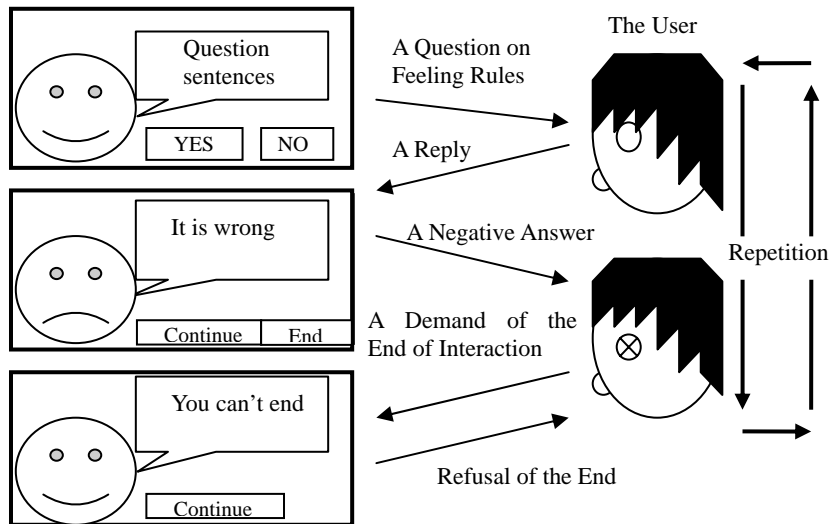
4. 1 to 3 is repeated.

Figure 1: An Overview of the Simulation Program of Double Bind

5. The agent gives a message of evacuation prohibition when the user demands the end of interaction while this repetition.

The interaction in this simulation program is formalized on the surface as a game in which users gain scores for quizzes. These quizzes require answers on emotions "felt" or "not felt" in situations including the user himself or others. (For example, "do you think it strange if you imagine that you did not feel sad in the funeral of your lover?") Moreover, scores of the user are increased when an answer of software agent is affirmative, and they are decreased when it is negative. Under double bind situation, scores are always decreased since all the answers to replies of the user are negative. Furthermore, scores are also decreased when the user demands the end of interaction since evacuation from the game is forbidden.

III. Design and Procedures of the Experiment

In this research, we assume the following two hypotheses:

1. Subjects evoke more negative feelings to double-bind theoretic software agents mentioned in section II, in comparison with software agents not showing inconsistent messages about feeling rules or allowing the users to evacuate from interaction with them.

2. Subjects with higher anxiety toward computers evoke more negative feelings to the double-bind theoretic

agents than users with lower anxiety toward computers.

For investigation of the first hypothesis, we prepared two types of software agents. For investigation of the second hypothesis, we used a psychological scale for measurement of computer anxiety, Aikyodai's Computer Anxiety Scale (ACAS) [3].

A. Procedures for the Experiment

The social rule game corresponds to an experimental condition based on double bind situation mentioned in section II. We prepared another software agent executing a logical game as a controlled condition unrelated to double bind. This agent gives a question on logical thinking [6, 7], correctly replies to users' answers, and permits them to evacuate from the game.

The concrete procedures in the experiment are shown as follows:

1. Subjects were explained that they were asked to evaluate their impression for game programs using artificial intelligence. Their decision on participation for the experiment was arbitrary.

2. First, the subjects replied to the questionnaires of ACAS.

3. Then, the subjects experienced the games in both of conditions. In order to maintain a counter balance, a half of the subjects experienced the double bind theoretic agent (the social rule game) and non double bind theoretic agent (the logical game) in order, and another

Table 1: The Adjectives Used for Impression Evaluation for the Software Agents

1	Pretty	2	Considerate	3	Chatty	4	Unfamiliar	5	Hateful	6	Pleasant
7	Foolish	8	Terrible	9	Clever	10	Full	11	Dark	12	Formal
13	Familiar	14	Selfish	15	Empty	16	Mild	17	Unpleasant	18	Light

half of the subjects experienced them in inverse order.

4. After the end of interaction with the agents, the subjects replied to questionnaires to evaluate their impression for the software agents.

5. Debriefing on the subjects' knowledge on double bind and explanation of the true purpose of the experiment were done.

B. Questionnaires

Computer anxiety is considered as anxiety or apprehension evoked in individuals when they use computers, do things leading them to computers, or think on the meaning of using computers. It is dealt with as one of important problems in education of computer literacy.

In the experiment, we aimed at investigating influence of subjects' computer anxiety to impression for the software agents. For this aim, we used ACAS, one of the psychological scales for measurement of computer anxiety in Japanese [2]. ACAS consists of 21 questionnaires and each questionnaire item has a score with five grades (from 1 to 5). The total of all the item scores (including inversion of some specific item scores) means the degree of computer anxiety in an individual. We administrated this scale to the subjects before the games by the software agents.

After the games, we administrated another type of questionnaires to measure the subjects' impression for the software agents. These questionnaires consist of 18 adjectives corresponding to impression and respondents answer which agent is suitable for each adjective. Table 1 shows these adjectives. We prepared them based on the results of the previous experiment [8]. For each adjective, respondents answer which double-bind theoretic agent or the agent of the controlled condition is suitable for the adjective from the perspective of their impression for them.

IV. Results of the Experiments

Based on the procedures mentioned in section III, we executed the experiment for nine subjects in May, 2004. All the subjects were male and university students aged from 18 to 20 (the average: 19.2). Moreover, they also had more than one year of experiences on computer literacy

A. The Result of the Subjects' Impression for the Agents

In order to verify the influence of the double-bind theoretic agent to the subjects' impression by comparison with the agent of the controlled condition, we calculated the rate of selection of the double-bind theoretic agent for each adjective, and then executed interval estimation of this rate. Table 2 shows the number of the subjects who selected the double-bind theoretic agent for each adjective, the rate of selection of the double-bind theoretic agent for each adjective, and the estimated interval of this rate of selection with 95% confidence.

For all the adjectives except for the adjectives "Pleasant", "Clever", "Full", and "Empty", the estimated intervals were either lower than 0.5 or higher than 0.5. More concretely, the subjects showed their impression for the double-bind theoretic agent as "Unfamiliar", "Hateful", "Foolish", "Terrible", "Dark", "Formal", "Selfish", and "Unpleasant", more strongly than that for the agent of the controlled condition. Moreover, they showed their impression for the agent of the controlled condition as "Pretty", "Considerate", "Chatty", "Familiar", "Mild", and "Light", more strongly than that for the double-bind theoretic agent. This result shows that the double-bind theoretic agent affected the subjects' impression, in particular, their negative impression.

B. Influence of Computer Anxiety

The average score of ACAS in the subjects was 46.9, and the standard deviation was 6.2. These values were lower than the values reported in Hirata's original work (the average: 60.6, SD: 9.5) [2]. This fact means that the subjects had lower computer anxiety, and their variance was also lower.

Table 2: The number of the subjects who selected the double-bind theoretic agent for each adjective, the rate of selection of the double-bind theoretic agent for each adjective, and the estimated interval of the rate with 95% confidence

Adjective	Pretty	Considerate	Chatty	Unfamiliar	Hateful	Pleasant
No. the subjects	0	1	0	8	8	3
The rate of selection	0.000	0.111	0.000	0.889	0.889	0.333
The estimated interval	[0.000, 0.283]	[0.003, 0.483]	[0.000, 0.283]	[0.518, 0.980]	[0.518, 0.980]	[0.075, 0.751]
Adjective	Foolish	Terrible	Clever	Full	Dark	Formal
No. the subjects	9	9	6	2	9	9
The rate of selection	1.000	1.000	0.667	0.222	1.000	1.000
The estimated interval	[0.717, 1.000]	[0.717, 1.000]	[0.299, 0.925]	[0.028, 0.600]	[0.717, 1.000]	[0.717, 1.000]
Adjective	Familiar	Selfish	Empty	Mild	Unpleasant	Light
No. the subjects	0	9	7	0	9	0
The rate of selection	0.000	1.000	0.778	0.000	1.000	0.000
The estimated interval	[0.000, 0.283]	[0.717, 1.000]	[0.400, 0.972]	[0.000, 0.283]	[0.717, 1.000]	[0.000, 0.283]

Our original design of the experiment included a procedure to divide the subjects into two groups based on their scores of ACAS (subgroups with higher computer anxiety and lower anxiety), and then statistically test differences between these subgroups on the selection rate of the double-bind theoretic agent for each adjective (for example, by using phi correlation coefficients). In this paper, we could not report this result due to a little number of the subjects and lower computer anxiety.

However, the result of the experiment and the fact that the subjects' computer anxiety was low suggest that double-bind theoretic framework in software agents can affect users' mental states independent on their computer anxiety. Since this suggestion is opposite to our second hypothesis mentioned in section III, it should sufficiently be investigated by assembling more subjects.

V. Conclusion and Discussion

This paper investigated empirical evidences showing mental burden to users in man-machine interaction by psychological experiments based on double bind theory. As a concrete model of double bind situations, we applied the theory of feeling rules and focused on evacuation impossibility from inconsistent situations. These situations were realized by using Java Applet programs, and an experiment in interaction between software agents and users was executed based on these programs. Moreover, the users' mental reactions were measured by using some questionnaires, and analyzed by statistical estimation.

As future problems, we should investigate influence of computer anxiety to impression for the software agents by assembling more subjects in the experiment. Moreover, we should specify which part of the double-bind theoretic framework affects humans' mental states (inconsistency of messages, evacuation impossibility from it, or mutual influence of them), by improving the experimental design in more detail.

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