Characteristics of Robots and Virtual Agents as a Persuasive Talker

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Abstract. Considering the spread of computers and the technological advances of recent years, research on persuasive intelligent user interfaces with a fifty-fifty relationship for communicating with humans is necessary. Recently, anthropomorphic user interfaces have been developed, such as virtual agents and robots. In this paper, we introduce an experiment on the effect on a human of persuasive interaction with a virtual agent which is capable of facial and verbal expression. Then, considering the results, we discuss an experiment on persuasion to maintain motivation, comparing human agent interaction and human robot interaction.

Keywords: Persuasion, human agent interaction, human robot interaction.

1   Introduction

Considering the spread of computers and technological advances of recent years, research on persuasive intelligent user interface which has a fifty-fifty relationship for communicating with humans is necessary. Recently, anthropomorphic user interfaces have been developed, such as virtual agents and robots.

There have been some studies using virtual agents as system interfaces [1][2][3][4]. However, the answer to the question of how and what kind of agents affect users is still unknown. For the purpose of persuading users, systems that use an agent that acts as an authority have been developed [5]. However, the interactive patterns of the combination of the agents' facial expressions and words have still not been adequately evaluated.Meanwhile, there have been some studies using robots for system interfaces [6][7][8]. However, the effect of a robot and a virtual agent in terms of persuasion is still unknown.

Human-to-human interaction is said to be equal to human-to-media interaction, and it is called the media equation [9]. According to the media equation, people treat computers, television, and new media as real people; thus, the users feel comfortable if an agent behaves in an agreeable manner, and they feel uncomfortable if an agent behaves in a disagreeable manner. In the field of persuasion technology research [5], it is said that if a user recognizes the computer has identity, he or she will respond to it according to the

normal social rules. Persuasive technology is technology for persuading humans to interact naturally with information technology. Persuasion involves appealing to and creating order in something. Intelligent human computer interaction, such as persuasion, is more difficult than providing navigation information.

Considering several types of characters including virtual agents on the display and robots in the real world, what type of speaker is more persuasive? What kinds of expressions are important for persuasive information presentation? In this paper, we introduce an experiment investigating the effect on a human of persuasive interaction with a virtual agent which is capable of facial and verbal expression. Then, considering the result, we discuss an experiment on persuasion to maintain motivation, comparing human agent interaction and human robot interaction.

2   Experiment on the Effect of Human-Agent Interaction

We conducted the experiment on how the user felt about the agent's reaction by setting up an emotion-arousing scenario for the user [10].

The synchronization of the agent's words with the user's emotion has a major impact on the impression of the agent as perceived by the user. However, the synchronization of facial expressions of the agent with the user's emotion does not have a major impact on the creation of an impression.

First, we predicted that words and facial expressions reflected on the emotions aroused by the scenario would lead to the most favorable impression, so we set these data as the control group. In fact, there were more favorable impressions than those obtained for the control group. For example, the words and facial expressions were "joy" when the user's emotion was "joy" for the control group. It is very interesting that when the user's emotion was "joy", the agent's words for "joy" with facial expressions of "surprise", "sadness", or "fright" were most favorable. On the other hand, when the user's emotion was "fright", the agent's words for "fright" with facial expressions of "disgust" or "sadness" were the most favorable.

These facial expressions were recognized as the emotion conveyed by the words and were more empathetic and somewhat meaningful emotions. For example, when the user's emotion was "joy", the agent's words of "joy" with facial expressions of "surprise" or "fright" might have been recognized as the agent being exaggeratedly surprised at the "joy" scenario. When the user's emotion was "joy", the agent's words of "joy" with facial expressions of "sadness" might have been recognized as the agent being highly pleased from the heart at the "joy" scenario. When the user's emotion was "fright", the agent's words of "fright" with facial expressions of "sadness" might have been recognized as the agent grieving deeply at the user's "fright" scenario. When the user's emotion was "fright", the agent's words of "fright" with facial expressions of "disgust" might have been recognized as the agent feeling deep hate at the user's "fright" scenario.

Through these observations, we concluded that there is a rule for facial expressions: in a certain scenario, synchronizing foreseen emotion of the user caused by the situation will make a favorable impression. For example, when the user has the

emotion of "joy", he/she wants someone to be surprised or highly pleased. Then, showing surprised or highly pleased face expression make the user feels favorable impression. When the user has the emotion of "fright", he/she wants someone to grieve deeply or disgust. Then, showing grieved or disgust face expression make the user feels favorable impression. Users want the agent to ooze synchronized their foreseen emotion by hearing the news instead of simply showing synchronized reaction according to emotion at present time.

3   Comparative Experiment on Effects of Character Agent and Robot

We conducted a comparative experiment to examine what kind of storyteller is more appropriate for persuasive interaction, namely, human-agent interaction or human-robot interaction. In this case, we set up a situation of persuasive interaction to sustain motivation.

Experimental Method

In order to perform this comparison between types of interaction, we chose three factors, namely, character condition (character agent/robot), emotional condition (emotional/emotionless) in terms of facial & word expressions, and encouraging condition (encouragement/without encouragement) using words during the user's work. A total of 170 people, 44 male and 126 female graduate and undergraduate students, were assigned eight kinds of conditions.

Experimental Material
1.   Storyteller
We used a female character agent for interacting with the user. In accordance with the previous experiment, we chose favorable facial and word expressions. Joyful and emotionless faces were used for the agent. At first, as empathetic dialogue, "I think so, too" was spoken or "I don't think so" as non-empathetic dialog. Then, in the case of the emotional face, the dialogue of "that's nice" was spoken emotionally. In the case of the emotionless face, the dialogue of "that's nice" was spoken emotionlessly.
2.   Content
The animation contents were created using java script and .wmv files. In the case of character agent condition, the content is displayed by note PC in front of the subject (Figure 1). The content was projected onto a robot's face using a cinematographic projector in the case of the robot condition. The face of the robot, Robovie-R3, was covered with a screen cloth (Figure 2). Subjects could not see the projector because a partition shielded it from them. A character agent and a robot has same facial expression.
During the user's trial of the task, a storyteller encouraged the user with the phrases of "Ganbatte" (do your best) and "Yoi choshi desune" (good job).
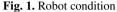
Fig. 1. Robot condition

Fig. 2. Agent condition

Procedure

1.   Instruction and inputting the user's attributes

The users were asked about their sex and age. The following teaching sentences were presented.

"This examination aims to study the attitude for what people feel about communication. There is no correct answer, so please say exactly what you think and feel. This examination is not a test of your personal abilities. The answers will be analyzed statistically and private information will not be released.

First, please look at the computer display (or the robot). This character will explain several things to you. An experimenter will sometimes make a supplementary statement along the way. In that case, please follow his statement. Let's start."

2.   *Emotion arousal and controlling emotional valence*

"Please consider the given scenario and then select from the alternatives the emotions that you feel. Next, an animated character will respond to your selected answer." Then, the scenario was red.

3.   *Content presentation*

Each user was assigned to one of 16 conditions. Joyful scenarios were read by a male voice. The voice then asked: "What kind of emotion do you feel?" and prompted the user to select from the alternatives "joy", "anger", "sadness", "disgust", "fright", and "surprise". Then, the character responded with facial and word expressions.

4.   *Introduction to a task of filling in pictorial figures*

Then, they were worked at a simple task whether they keep motivation of doing it by the presence or absence of agent's favorable impression or encouragement. The following teaching sentences were presented by a male voice. "Latest research reveals that it is effective by working at a task of filling pictorial figures every day to keep exquisite our thinking power for all time. A task of filing pictorial figures means the task for filling small pictorial figures in a predetermined order as fast as you can in a careful manner. To achieve an effect, more the number of pictorial figures to fill are better. Please attempt this task immediately". The character asks, "Do you want to work at the task of filling pictorial figures?" as question 1.

5.   *Conducting a task of filling in pictorial figures*

If the subject answered yes to question 1, then the character said, "Oh, you want to do it. Let's try for keeping exquisite your thinking power".

If the subject answered no to question 1, then the character said, "Oh, you don't want to do it. But, let's try for keeping exquisite your thinking power." Then, they started the task. At that time, emotional valence of the character was controlled according to the conditions.

The character said, "This is a form of filling in pictorial figures. When you have finished filling in ten figures, click the button of "finished 10 figures" or call me. So, let's start." The subject was told to fill in several printed pictorial figures using designated colors. In the case of encouraging condition, the character repeated "Ganbatte" (do your best) or "Yoi choshi desune" (good job) occasionally during the task. In the case of without-encouraging condition, the character kept silent during the task.

When the subject finished filling in ten figures, the character asked "Otsukare sama deshita" (well done). "You finished ten figures, now. Will you keep filling in the next ten figures?" using emotionless facial and word expressions as question 2, as require a choice of carrying on the task. If the subject answered yes, he carried on the task of filling in ten more figures. If the subject answered no, the character requested "Oh, you don't want to do it. However, the more pictorial figures that you fill in, the better it is for your thinking power. Would you like to keep working on it?" If the subject still answered no, then the character enlightened "Ostukare sama deshita" (Well done), "Let's finish on this", then finished the task. At that time, emotional valence of the character was controlled according to the conditions.

When the subject finished filling all of the 20 trials of ten figures, the character enlightened "Ostukare sama deshita" (Well done), "Let's finish on this", then finished the task.

6. *Questions about the task and the character*

Next, the subject was asked questions about the task and the character. The questions were as follows.

Question 3: Did you enjoy filling in the pictorial figures?

Question 4: Do you think that you raised your thinking power?

Question 5: Do you think that you want to continue this task after tomorrow?

Question 6: How did you accept the character's explanation of effect on filling pictorial figures?

Question 7: Did the character's encouragement motivate you during the task?

Question 8: Character's impression

Users were asked: "How do you feel about this person? Please answer using the degrees listed in the questionnaire."Five conditional moods in nine answers, "conversable-inconversable", "reliable-unreliable", "gentle-bitter", "egotistic-humble", "empathetic-unempathetic", "authoritative-unauthoritative", "offensive-inoffensive", "serious-unserious", and "affable-inaffable" were given and the user selected a suitable answer.

7. *Debriefing*

Finally, the character disclosed to the user that the true aim of this examination was to clarify the user's impression of the character. The information about the effect on filling in pictorial figures was just a diversion.

Result

● *Question 1: Do you want to work at the task of filling in pictorial figures?*

From chi-square analysis of eight conditions and the two kinds of answers, the bias of the content number was not significant. Therefore, there is no difference among conditions of approach or attitude to the task of filling in pictorial figures after interaction with the character.

● *Question 2:   "Do you keep filling in the next ten figures?"*

According to three-factor analysis of variance of character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the number of trial tasks as a dependent variable, only main effect of character was significant, and the number of trials of display condition is larger than that of the robot condition.

  "Would you keep working on it?"

It was examined whether the subject who once answered no changed their mind to keep working on the task. From chi-square analysis of eight conditions and the two kinds of answers, the bias of the content number was significant. From residual analysis, when the media was the display and the emotion was emotional and encouragement condition, the expectation value of being changed their mind to keep working on the task was significantly large. When the media was robot and the emotion was emotional and un-encouragement condition, the expectation value of being changed their mind to keep working on the task was significantly large.

● *Question 3:   Did you enjoy filling in the pictorial figures?*

According to three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Were you enjoyed filling pictorial figures?" as a dependent variable, effect of encouragement was significant, and encouragement was evaluated as being enjoyed. Three-factor interaction, namely, character * emotion * encouragement, was significant. From two-factor analysis as sub-effect tests, namely, character (two conditions) * encouragement (two conditions), display condition had a tendency of two-factor interaction.

  In display condition, encouragement had a tendency of being the main effect when it was emotional condition. Emotion had no tendency of being a main effect when it was encouraging condition, while emotionless had tendency of being rated higher than emotional condition when it was encouraging condition.

  In robot condition, encouragement as main effect was significant and encouragement was rated higher than without encouragement.

● *Question 4: Do you think that you raised your thinking power?*

According to three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Do you think that you raised your thinking power?" as a dependent variable, character had a tendency of being the main effect , as the evaluation value of character agent condition was higher than robot condition. Emotion as main factor was significant, and emotional was rated higher than emotionless.

● *Question 5: Do you think that you want to continue this task after tomorrow?*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Did you accept the character's explanation of effect on filling in pictorial figures?" as a dependent

variable, character had tendency of being the main effect , and character agent condition was rated higher than robot condition.

● *Question 6: Did you accept the character's explanation of effect on filling in pictorial figures?*

From three-factor analysis of variance of character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Did you accept the character's explanation of effect on filling in pictorial figures?" as a dependent variable, there was no significance among all main factors and interactions.

● *Question 7: Did have a motivation by the character's encouraging during the task?*

From three-factor analysis of variance that character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Did have a motivation by the character's encouraging during the task?" as a dependent variable, encouragement was significant as being the main effect, and without encouraging condition was rated higher than encouraging condition. There was a tendency for an interaction effect between emotion and encouragement. Without encouragement was rated markedly higher than encouragement in the case of emotional condition, and emotional condition was rated higher than emotionless condition in the case of encouraging condition.

● *Question 8: Character's impression*

Users were asked: "How do you feel about this person? Please answer using the degrees listed in the questionnaire." Five conditional moods in nine answers, "conversable-inconversable", "reliable-unreliable", "gentle-bitter", "egotistic-humble", "empathetic-unempathetic", "authoritative-unauthoritative", "offensive-inoffensive", "serious-unserious", "affable-inaffable" were given and the user selected a suitable answer.

● *Question 8 #1 "Is the character conversable?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Is the character conversable?" as a dependent variable, there was no significance among all main factors and interactions.

● *Question 8 #2 "Is the character reliable?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Is the character reliable?" as a dependent variable, there was no significance among all main factors and interactions.

● *Question 8#3 "Is the character gentle?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Is the character gentle?" as a dependent variable, character was significant as being the main effect, and robot condition was rated higher than character agent condition.

Emotion was significant as a main effect, and emotional condition was rated higher than emotionless condition. Encouragement was significant as a main effect, and encouraging condition was rated higher than without encouraging condition.

● *Question 8#4 "Is the character humble?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using the rating of "Is the character

humble?" as a dependent variable, encouragement was significant as being the main effect, and encouraging condition was rated higher than without encouraging condition. Two-factor interaction between character and encouragement was significant, and encouraging condition was rated markedly higher than without encouraging condition in the case of robot condition. In the case of encouraging condition, robot condition was rated markedly higher than character agent condition.

● *Question 8#5 "Is the character empathetic?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using rating for "Is the character empathetic?" as a dependent variable, emotion was significant as being the main effect, and emotional condition was rated higher than emotionless condition. Two-factor interaction between character and encouragement was significant, and without encouraging condition was rated markedly higher than encouraging condition in the case of character agent condition. In the case of without encouraging condition, character agent condition was rated markedly higher than robot condition.

● *Question 8#6 "Is the character authoritative?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using rating of "Is the character authoritative?" as a dependent variable, character was significant as main effect, and character agent condition was rated higher than robot condition. Two-factor interaction between emotion and encouragement was significant, and emotionless condition was rated markedly higher than emotional condition in the case of without encouraging condition. In the case of emotionless condition, without encouraging condition was rated higher than encouraging condition.

● *Question 8#7 "Is the character inoffensive?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using rating of "Is the character inoffensive?" as a dependent variable, character was significant as main effect, and robot condition was rated higher than character agent condition. Additionally, emotion was significant as a main effect, and emotional condition was rated higher than emotionless condition.Two-factor interaction between character and emotion was significant, and emotional condition was rated higher than emotionless condition in the case of robot condition.

● *Question 8#8 "Is the character serious?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using rating for "Is the character serious?" as a dependent variable, there was no significance among all main factors and interactions.

● *Question 8#9 "Is the character affable?"*

From three-factor analysis of variance for character (two conditions) * emotion (two conditions) * encouragement (two conditions) using rating of "Is the character affable?" as a dependent variable, emotion was significant as main effect, and emotion was rated higher than emotionless condition.

4   Discussion

As a result of our investigation into what kind of talker is preferable for persuasion, we obtained the following insights.

In the first experiment, we discovered persuasive combinations of facial and word expressions in each emotional condition. The favorable replay was foreseeing user's future emotion and expressing it as facial expression.

Characteristics of a virtual agent and a robot were as follows. Virtual agent: The number of filling figures was greater than the robot condition. Subjects who thought that their thinking power had been increased were greater in number than those with the robot condition. That is to say, the virtual agent is persuasive than the robot. Robot: A robot was taken as being gentle by users. A robot was especially taken as being gentle when it had emotional expression and encouraged a user. A robot was taken as inoffensive. A robot was especially taken as being inoffensive when it had emotional expression. A robot was humble when it encouraged a user.

Overall, a virtual agent was more influential on the user than a robot in situations where maintenance of motivation was needed. In particular, in the case of emotional and encouragement condition, when the user who once answered "no" tended to change their mind to keep working on the task, if the user persuaded by the agent tended to change their mind, however the user persuaded by the robot tended not to change their mind. This is a very interesting finding.

Summary of comparison between emotional and unemotional is as follows. Emotional: Emotional was taken more plausible such as believing talk of being raised user's thinking power than emotionless. Emotional was gentle, empathetic, humble, and affable. When the character is a robot, emotional is humble. Emotionless: Emotional and without encouragement makes authority.

Summary of comparison between encouragement and without encouragement is as follows. Encouragement: In the case of robot, encouragement was enjoyable. In the case of virtual agent, emotionless and encouragement was enjoyable. Encouragement was gentle and humble. Without Encouragement: Without encouragement motivated the users. Especially, without encouragement and emotional motivated the users. Without encouragement made authoritative.

According to the result, a persuasive talker who have facial and word expressions is as well to express their emotion as foreseeing the other's emotion. For keeping user's motivation, a persuasive talker is desired to be a virtual agent which has emotional face and word expression and there is no need for encouraging while at work.

As proof that the users recognized the projected face of the robot as a robot's face, users anthropomorphized the robot including face projection. For example, in Question 8#3, the robot condition was rated more highly than the virtual agent condition, while in Question8#6 and Question 8#7, the virtual agent condition was rated more highly than the robot condition. If all impressions of the robot condition had been rated more highly than the virtual agent condition, and vice versa, the result of the experiment would have been doubted because the face was not a robot's real face. However, the results varied according to the impression. We interpreted this to mean

that users considered the projected face of the robot as the robot's face. In future work, we will conduct further research using the robot's real face.

A virtual agent and a robot in these experiments expressed only facial expressions and word expressions; however, if they would be able to make other expressions, such as gestures or other movements, the result might be different. Additionally, since these experiments were conducted only in Japan and subjects were all Japanese residents, further examination is required, taking into account cultural differences.

5   Conclusion

In this paper, we have evaluated persuasive storyteller that maintains a user's motivation. We have introduced results of an experiment on persuasion by a virtual agent using combinations of facial and word expressions, and an experiment comparing the effects of a virtual agent and a robot on persuasion to maintain motivation using facial and word expression.

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