

Empathy between Human and Robot?

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Abstract—This paper aims at finding the answer to the essential question: Can people perceive a robot's presence as having a social existence? We attempt to apply a sociological and psychological approach to understand the influence of robot beings, by observing human emotion and perception changes while subjects watched a funny video clip in the presence of a robot or a human companion, each of which made their own typical laughing sounds. From this experiment, we found that the robot did not affect the human's positive emotions as much as a human companion did, but the robot did discourage negative emotions. However, the subjects were, in general, amused when they were watching the video with the robot. This amusement is similar to the contagious effect of sharing humor with another human being. Our findings suggest that the subjects accepted the robot's presence as a kind of existence empathically.

Keywords—human robot interaction; robot companion; empathy; emotional contagion; presence; social robot.

I. INTRODUCTION

The ability to share the feelings and emotions of others as if they were our own is important in our social life. So, empathy has been a power for change in the lives of individuals and in society. While the value of empathy has been recognized by many academics since the beginning of the 20th century [1], the importance of empathy is attracting greater attention today. This is one of the reasons we are beginning to consider the idea of empathy in human-robot interaction. If we assume that empathic ability is a necessary condition to being a member of society, then what if robots can share in the feelings of their human users? Can people accept the existence of robots as members of human society? In particular, we ask, can robots affect humans' emotions?

Robots are no longer merely tools for labor-intensive or dangerous tasks [2]. They are beginning to take on the roles of pets and are even assisting in the care of people—in other words, they are becoming “social robots” [3]. The social meaning of robots has been (and it ought to be) changing gradually. In this paper, we try to apply a sociological and psychological approach to study human-robot interaction, with a particular focus on emotion. By conducting a simple experiment, involving a participant watching a funny video clip with a robot or a human companion, we measured the changes in subjects' emotional states and their perceptions regarding the presence of the human or robot other. From this research, we

attempt to examine, to some extent, the effect of the presence of robots in a social context, and to suggest the potential social aspects of human-robot interaction.

II. METHOD

A. Participants and Independent variables

Thirty-seven college students were recruited to participate at Sungkyunkwan University in Seoul, Korea (13 males and 14 females; mean age 25.37 years; range 21–32 years).

Participants were randomly assigned to one of the two companion types while watching the funny video “Humanoid Robot, Human Companion.” The robot used in this experiment was Nao, a humanoid robot manufactured by Aldebaran Robotics. It is fully programmable and has an embedded speaker.

B. Stimulus Material

We selected a 5-minute long video clip that contains humorous components. To select the proper video clip, we did a manipulation check. On the basis of the check, we selected the two highest scored video clips for the experiment. Then, we inserted recorded human laughter sounds in the audio tracks of video 1. No laugh track was inserted in video 2: This was done to control the effect of the sound of laughter on the emotional state of the subjects. And, to control the laughing sound, we gave instructions to the human companion to laugh out loud at predetermined time points. We recorded the sound of their laughter and then modified that sound by using Gold Wave software. The modified sound was then applied as the humanoid robot's laughter.

C. Procedure

The experiment consisted of two sessions. In the first session, each participant was brought to a room equipped with a TV, a sofa, and dimmed lighting. Participants sat on a sofa and watched video 1 with the recorded laughing sound only of the assigned companion type. After watching, the participants filled out the pre-evaluation questionnaire and took a break. In the second session, the participants watched video 2 with a laughing humanoid robot or a laughing human, as per companion type, while sitting on the sofa inside the experiment room. After watching the video, participants filled in the post-evaluation questionnaire.

D. Measures

In order to measure how much a participant's emotional state changed after watching a video with each companion type, we divided the measurement sequence into two sessions: pre-evaluation and post-evaluation. The questionnaires of each session consisted of the same items handled the order effects.

1) *Emotional state*: We used a modified version of the PANAS-X 7-point Likert scale, ranging from "Not at all" to "Very much" (positive scale Cronbach's $\alpha = 0.86$; negative scale Cronbach's $\alpha = 0.88$) [4]. Emotional state was measured by considering positive and negative emotions. Each participant read each item and then commented on their emotional state by marking on a scale to indicate to what extent she or he has felt a particular way recently.

2) *Video Evaluation*: After the first session, the participants evaluated the how funny they thought video 1 was, and after the second session, they evaluated the degree of fun they experienced with video 2. We used a 10-point Likert scale, ranging from "Not very funny" to "Extremely funny".

3) *Companion's Presence*: The questions that the participants were asked about the companion's presence pertained to five categories: Realistic, natural, emotional contagion, shared emotion, and perceived presence. All the responses were applied to a 7-point scale, ranging from "Not at all" to "Very much."

III. RESULT

We subtracted the post-evaluation data from the pre-evaluation data to obtain our average data. The degree of change in positive affection by laughing companion type (humanoid robot or human) shows significant difference ($F = 4.66$; $p = 0.041$). When participants watched the video with the human companion, positive emotion was encouraged ($M = 0.77$; $SD = 1.35$; $N = 14$). But, watching with the humanoid robot discouraged positive emotion ($M = -0.073$; $SD = 0.36$; $N = 13$). However, in the case of negative affection, both the human and robot companions discouraged negative emotion, so there were no significant differences in changing degree of negative affection ($F = 0.120$; $p = 0.73$). Therefore, we conclude that a robot can affect negative human emotions when it laughs as much as a human does.

The changes in the participants' scoring, in terms of how funny they thought the videos were, according to companion type, showed no significant difference ($F = 0.072$; $p = 0.79$), which indicates that participants felt the video was funnier when they watched it with a companion than when they watched it alone in both conditions.

How the participants perceived their companion's presence was investigated, and we found that there was no difference in participants' perceptions between the robot and the human companion ($F = 46.825$; $p = 0.092$). In other words, the

presence of the robot companion was considered similar to that of the human companion in this experiment.

IV. DISCUSSION

The results proved that the hypotheses were meaningful in part. First, only negative emotion was changed equally regardless of companion type: the robot had less effect on the positive emotion of participants than did the human companions. But, the robot companion partially affected participants' negative emotions.

Second, the subjects were more amused when they watched the video with the robot, in general, which we considered to be similar to the contagious effect of watching something funny with a fellow human. It shows that the hypothesis—there will be a similar effect on how funny the participants feel that the video is when they watch it with a robot as when they watch it with a human companion—is meaningful.

Third, the reported measurement showed that the participants perceived the robot's presence as similar to that of the human companion while subjects watching video. It can be cautiously derived that the participants accepted the existence of the robot as a companion who was watching the video with them, which means that the subjects felt empathy with the laughing robot when they felt pleasant emotions. Furthermore, our experiment may provide implicit clues that the subjects accepted the robot's presence as a kind of existence empathically.

ACKNOWLEDGMENT

This research was supported by WCU (World Class University) program through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology(R31-10062), by the KORUS-Tech program (kt-2010-SW-AP-FS0-0004), by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology (2012-008188), by PRCP through NRF of Korea funded by MEST (2012-0005861), and by MKE, Korea under ITRC NIPA-2012-(H0301-12-3001).

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