EVALUATING HUMAN- ROBOT INTERACTIONS FROM INSIDE AND OUTSIDE:
COMPARISON BETWEEN FIRST-PERSON AND THIRD-PERSON PERSPECTIVES

Kazuki YANAI[a], Aiko MURATA[a,c], Ryota MIZUTANI[b], Akira ICHIBOSHI[b], Kazunari KOMATSUZAKI[b], Roshan THAPLIYA[b], Katsumi WATANABE [*a, d]

[a] *Waseda University, Japan, katz@waseda.jp*
[b] *Research & Technology Group, Fuji Xerox Co., Ltd., Japan*
[c] *Japan Society for the Promotion of Science, Japan*
[d] *The University of Tokyo*

ABSTRACT

Evaluating the quality of human-robot interactions is essential for designing social robots. To design an integrated system with robots and people working together in an office or school, it is important to consider not only how a person feels when directly interacting with a robot (first-person perspective), but also how people evaluate the interaction from a third-person perspective. In this study, we aim to identify the factors in human-robot interaction that improve communication from the first-person and the third-person perspectives and examine the relationship between these factors. First, we asked participants to interact with a robot and videotaped their interactions. After the interaction session, the participants completed questionnaires for evaluating the interaction from a first-person perspective. Next, we showed this video to another group of participants and asked them to evaluate the robot-participant interactions. This was done to get a third-person perspective. The third-person perspective evaluations were mostly consistent among the evaluating participants. On the other hand, the third-person evaluations did not necessarily match those from the first-person perspective. However, several factors in the first-person evaluations correlated with how people would have a good impression toward the observed interaction. The results suggest that certain factors contribute to forming consistent impressions of human-robot interactions from the third-person perspective.

Keywords: *Human-robot interaction, Interaction evaluation, Third-person perspective*

* Corresponding author.

1. INTRODUCTION

There are growing needs for robots that are capable of not only assisting physical manipulation (e.g., precise motion in manufacture), but also supporting and being involved in human social life by facilitating and/or mediating social interactions (Tahir et al., 2014). There is a high demand for such robots to develop an integrated system with robots and people working together in an office (Asoh et al., 2001), school (Kanda et al., 2007), and other situations. To design robots working with groups of people, it is important to consider not only how a person feels when directly interacting with a robot (first-person perspective) but also how people evaluate the interaction from a third-person perspective. This is because one of expected functions of such social robots working with groups of people is to motivate participations and facilitate smooth group interaction/communication. Although some studies have assessed the impression of human-robot interactions from first-person perspective (e.g., Kanda, Ishiguro & Ishida, 2001; Ogata & Kanno, 2000), there are few studies investigating how a third-person observing the communication between the human and the robot feels about that interaction. However, the feelings for the communication might have a profound impact on the motivation of a third-person observer to join and enjoy the conversation with the robot.

Given that there might be mismatches between the evaluation from a third-person perspective and the feelings of the person in a first-person interaction in the context of human emotion recognition (Busso & Narayanan, 2008), the interaction with the robot could form different impressions in the first-person perspective and the third-person perspective. Therefore, in this study, we aim to identify factors in human-robot interaction that improve communication from the first-person and the third-person perspectives and examine the relationship between the factors.

In Experiment 1, we asked participants to interact with a communication robot and videotaped their interactions. After the interaction session, they completed the questionnaires regarding their impressions of the robot and the quality of the communication (i.e., the first-person perspective). In Experiment 2, we showed the interaction videos to another group of participants and asked them to answer a questionnaire about the impression of the robot/participant and the quality of the communication in the video (i.e., the third-person perspective).

2. EXPERIMENT 1

2.1. Methods

2.1.1. Participants

A total of 24 people (21 males and 3 females; age ranging from 28 to 50) participated in Experiment 1. They provided written, informed consent, and agreed to having their behavior videotaped during the experiment.

2.1.2. Robot

We used the robot "Pepper" (SoftBank Corp.) for the experiment. The robot spoke to the human and behaved based on one of two scenarios. The two scenarios were made to manipulate impression of the robot. One scenario was designed to provide an extroverted impression, while the other was designed to provide an introverted impression (see Table 1). The characteristics of Pepper were designed and deployed by Fuji Xerox as a part of study of next generation UIs in office deployment.

Table 1: Introvert scenario and extravert scenario

Introvert scenario	Good morning Mr.xxx. I have been waiting for you. Did you sleep well last night? I see. It is very important to have a good quality sleep. Hey, why not do a complexion check? Could you please show me your face? You look well. I look forward to working with you today.
Extrovert scenario	Good morning Mr.xxx! How are you feeling today? I see. Your smile is very popular among others. Hey, why not do a smile check? Please smile at me. Nice! Ok then, keep up the good work with that smile!

2.1.3. Procedure

Each participant was asked to enter the room where the robot was setup. After the participant moved closer to the robot, the robot started to speak to the human based on one of the two scenarios (extroverted scenario or introverted scenario). The participant was asked to interact with the robot freely. When the scenario ended, each participant was required to leave the room and complete the questionnaire outside the room. All participants interacted with the robot in both scenarios (extrovert and introvert) sequentially. The order of the scenarios was counterbalanced across participants.

2.1.4. Questionnaire

In order to evaluate how the scenarios would influence the impression of the robot, we included the following items for the evaluation: (1) the degree of extroversion of the robot, (2) ease of talking to the robot, (3) the occurrences of eye contact with the robot, (4) friendliness of the robot, (5) the degree of satisfaction while communicating with the robot, (6) smoothness of the communication with the robot, (7) desire to ask something of the robot, and (8) desire to meet the robot again. Additionally, we measured the extroversion/introversion score of each participant by using the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1994).

2.2. Results

As expected, the mean of the evaluation of extroversion of the extrovert robot from the first-person perspective was higher than that of the introvert robot (t_{23}= 5.10, p < .0001, Figure 1). This indicates that the scenarios provide the intended effects on the impression of the robots.

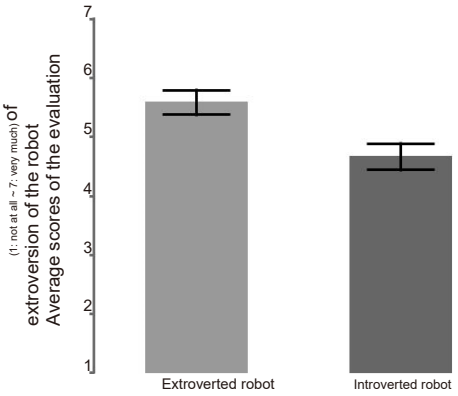

Figure 1: Average scores of the evaluation of extroversion of the robot. The bars represent the standard errors of the means.

Figure 2 shows the average scores of the impressions for each robot (extrovert/introvert) from the first-person perspective. Compared with the extrovert robot, the introvert robot gave the impression that the eye contact was more frequent (t_{23} = 2.55, p = .018) and that the communication was smoother (t_{23} = 2.74, p = .012). Further, the degree of satisfaction with the communication tended to be higher with the introvert robot than with the extrovert robot (t_{23} = 1.86, p = .076)

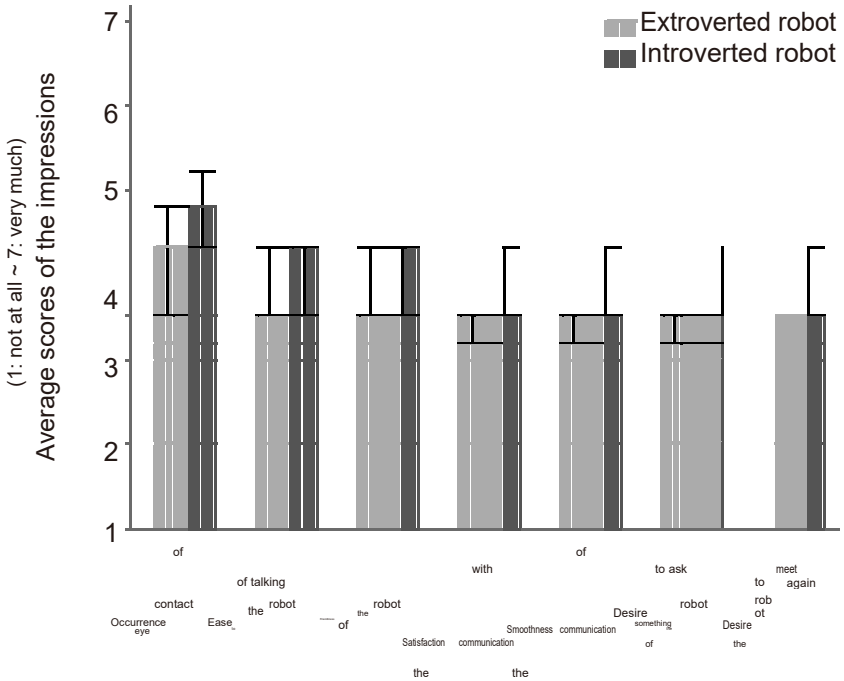

Figure 2: Average scores of the impressions from the first-person perspective for each robot (extrovert/ introvert). The bars represent the standard errors of the means.

3. EXPERIMENT 2

3.1. Methods

3.1.1. Participants

A total of 15 participants, different from those in Experiment 1, participated in Experiment 2 (6 males and 9 females; age ranging from 18 to 24). They provided written, informed consent before the experiment.

3.1.2. Stimuli

As 24 participants of Experiment 1 interacted with the two kinds of the robot sequentially, a series of videos were used in Experiment 2. It consisted of 48 video clips in which each participant was present in two videos. The video stimuli were divided into two stimulus sets so that the same person does not show up in a single stimulus set twice. The two stimulus sets were presented to the participants of Experiment 2 sequentially. Within the stimulus set, the video stimuli were shuffled randomly and the order of the presentation of the stimulus-sets was counterbalanced across the participants. Participants had a chance to rest after watching the first stimulus set.

3.1.3. Procedure

Video stimuli and following questions were presented on the computer-monitor of MacBook Pro (Retina, 15-inch, Mid 2015, Apple Inc.). At the beginning of every trial, each video clip was presented for up to about 40 s (from beginning to end of the conversation). Then, nine questions about the impression of the communication were asked sequentially (Figure 3). The next trial started after participants answered the questions.

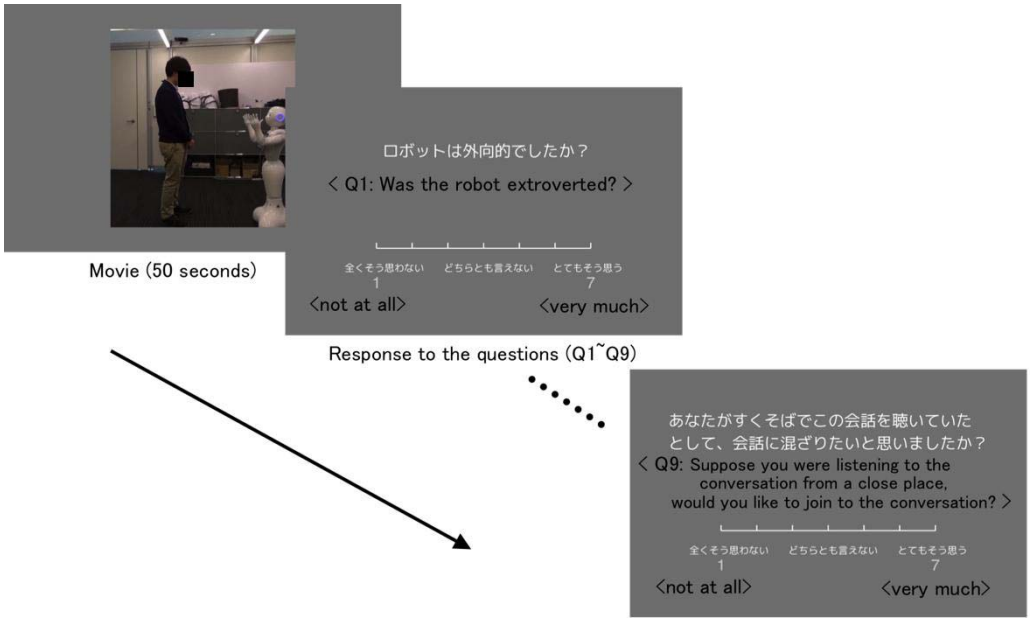

Figure 3: A sequence of events in a single trial in Experiment 2. The questions were as follows: (1) Was the robot an extrovert? (2) Was the person in the video an extrovert? (3) Did the person feel that the robot was easy to talk to? (4) Did the robot seem friendly to the person? (5) Was the communication unnatural? (the score was reversed and treated as the score of smoothness), (6) How frequently did the person have eye contact with the robot? (7) Did the person seem satisfied with the communication? (8) Was the communication good from the third-person perspective? (9) Suppose you were listening to this conversation, would you like to join to the conversation?

3.2. Results

3.2.1. Effect of the scenarios on the impression of the robots

As shown in the impression from the first-person perspective in Experiment 1, the mean evaluation of extroversion of the extrovert robot from the third-person perspective was higher (M = 5.71, SD = 0.144) than that of the introvert robot (M = 4.36, SD = 0.211) (t_{23}= 28.25, p < .0001).

Figure 4 shows average scores of the impressions for each robot (extrovert/introvert) from the third-person perspective. In contrast to the results of Experiment 1, the degree of satisfaction estimated from the third-person perspective tended to be higher for communication with the extrovert robot as compared to that with the introvert robot (t_{23} = 1.84, p = .079). Furthermore, the participants reported a greater desire to join the communications and perceived that the communications with the extrovert robot were better when compared with the communications with the introvert robot (t_{23} = 2.45, p = .022, t_{23} = 1.84, p = .079).

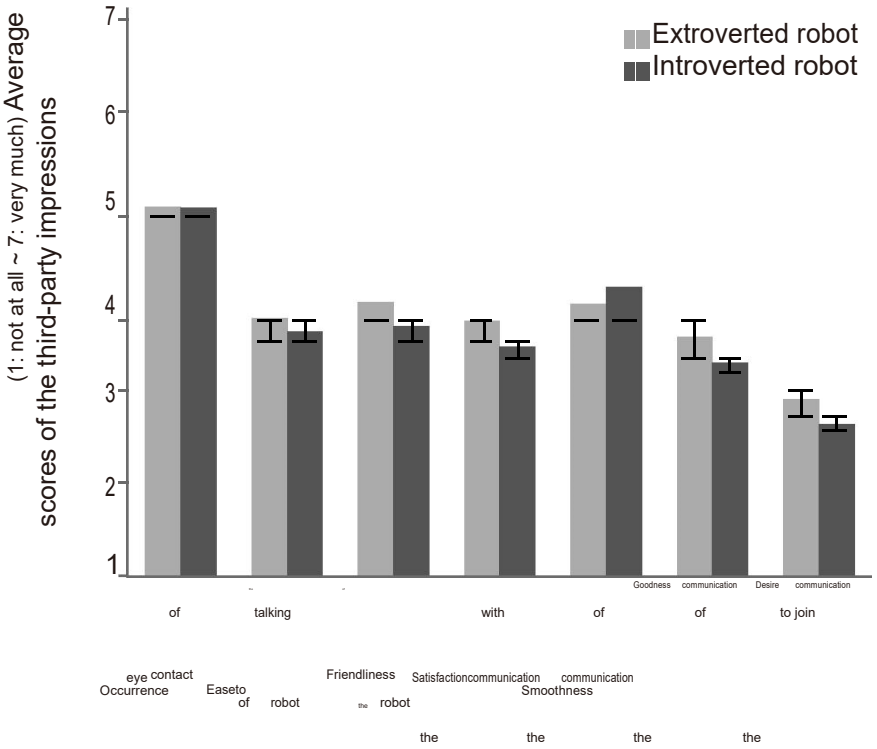

Figure 4: Average scores of the impressions from the third-person perspective for each robot (extrovert/introvert). Bars represent the standard errors of the means.

3.2.2. Consistency of the evaluations among the evaluating participants

The consistency of the evaluations among the participants in Experiment 2 were sufficiently high for all questions (Table 1), indicating that the impressions of each video was common among the third-person viewers. Thus, we calculated the average score of the responses to each question for each video and treated it as a single parameter called “the impression from the third-person perspective”

Table 2: Chronbach's alpha of the scores for each question

Questions	Chronbach's alpha
Extroversion of the person	0.94
Extroversion of the robot	0.90
Occurrence of eye contact with the robot	0.74
Ease of talking to the robot	0.88
Friendliness of the robot	0.90
Satisfaction of the person with the communication	0.89
Smoothness of the communication	0.78
Goodness of the communication	0.91
Desire to join the communication	0.87

3.2.3. Correlations between first-hand impressions and third-person evaluations

Table 2 and Table 3 show the Pearson's correlation coefficients between the impressions from the first-person perspective and those from the third-person perspective for the extrovert robot and introvert robot, respectively. If the third-person evaluations are consistent with the first-person impressions, the correlation coefficients in the boxed cells will be high. As shown in Table 2 and Table 3, the third-person evaluations did not necessarily match with those from the first-person perspective, while a few third-person evaluations correlated with the first-person impressions (Ease of talking to the extrovert robot: $r = .53$, $p < .01$, Friendliness of the introvert robot: $r = .44$, $p < .01$).

However, several factors in the first-person evaluations correlated with how people would have a good impression toward the observed interaction. For both the extrovert robot and introvert robot, subjective impression of extroversion of the robot significantly correlated with the evaluation of goodness of communication from the third-person perspective ($r = .71$, $p < .001$, $r = .70$, $p < .001$, respectively), and the desire to join the conversation ($r = .66$, $p < .001$, $r = .63$, $p < .001$, respectively). Further, subjective ease of talking to the robot and the desire for the first persons to ask the robot for favor were correlated with the evaluation of goodness of communication from the third-person perspective and the desire to join the communication (see Table 2, 3).

Table 3: Pearson's correlation coefficients between the impressions from the first-person perspective (columns) and those from the third-person perspective (rows) for the extrovert robot.

	Extroversion (EPQ score) of participants and the impressions reported from first-person perspective in the Experiment 1								
	Extroversion of the person (EPQ score)	Extroversion of the robot	Eye contact	Ease of talking to the robot	Friendliness of the robot	Satisfaction	Smoothness	Desire to ask	Desire to meet again
Extroversion of the person	.27	.72***	.14	.52**	.38†	.44*	.37†	.59**	.31
Extroversion of the robot	-.11	.04	-.03	-.10	.38†	.27	.25	.15	.01
Eye contact	.28	.45*	.13	.38†	.28	.22	.17	.52**	.22
Ease of talking to the robot	.30	.72***	.16	.53**	.41*	.46*	.34†	.62**	.36†
Friendliness of the robot	.35†	.66***	.16	.55**	.38†	.40*	.31	.63**	.32
Satisfaction	.29	.68***	.07	.56**	.35†	.39†	.29	.60**	.28
Smoothness	.34	.60**	-.01	.46*	.36†	.39†	.21	.61**	.29
Goodness	.34	.71***	.14	.52**	.38†	.46*	.32	.68***	.27
Desire to join	.36†	.66***	.03	.43*	.34	.39†	.22	.60**	.24

Table 4: Pearson's correlation coefficients between the impressions from the first-person perspective (columns) and those from the third-person perspective (rows) for the introvert robot.

	Extroversion (EPQ score) of participants and the impressions reported from first-hand perspective in the Experiment 1								
	Extroversion of the person (EPQ score)	Extroversion of the robot	Eye contact	Ease of talking to the robot	Friendliness of the robot	Satisfaction	Smoothness	Desire to ask	Desire to meet again
Extroversion of the person	.23	.69***	.19	.47*	.43*	.17	.32	.44*	.34
Extroversion of the robot	-.07	.14	.30	.22	.16	.10	.24	.37†	.37†
Eye contact	.11	.81***	.28	.70***	.58**	.32	.54**	.46*	.23
Ease of talking to the robot	.20	.67***	.23	.39†	.45*	.10	.35†	.36†	.33
Friendliness of the robot	.13	.68***	.30	.41*	.44*	.21	.45*	.38†	.33
Satisfaction	.13	.68***	.39†	.47*	.47*	.12	.40†	.49*	.28
Smoothness	.16	.25	.07	.02	.06	-.17	-.05	.07	.08
Goodness	.14	.70***	.34	.50*	.53**	.17	.45*	.41*	.27
Desire to join	.25	.63***	.40†	.51*	.59**	.17	.41*	.53**	.33

†p<.10, *p<.05, **p<.01, ***p<.001

4. DISCUSSION

In this study, the participants directly interacting with the robot had a positive impression of the introvert robot (e.g., they reported greater satisfaction and smoothness of communication) as compared to the extrovert robot. However, the participants observing the interactions from a third-person perspective had a positive impression (e.g., good communication) and higher motivation to join the interactions with the extrovert robot as compared to the introvert robot. These results indicate that the robot's behavior different impressions when observed from the first-person perspective and when observed from the third-person perspective.

The correlation analysis revealed that the third-person evaluations did not necessarily match those from the first-person perspective, while the impressions of each interaction from third-person perspective was common among observers. However, we found that several factors in the first-person impressions could predict how people would have a good impression and a motivation to join the observed interaction. Taken together, the evaluations of human-robot interactions from the third-person perspective may differ those from the first-person perspective. These findings are partly in line with the study on the mismatches between the evaluation from third-person perspective and the feelings of the participant in the first-person in context of human emotion recognition (Busso & Narayanan, 2008) and the functional evaluation of robots from the third-person perspective (Haring et al., 2015). Nevertheless, there exist several factors in evaluations from the first person-perspective that predict better impression of human-robot interaction from the third-person perspective that may be useful in developing social robots that work with people.

REFERENCES

Asoh, H., Motomura, Y., Asano, F., Hara, I., Hayamizu, S., Itou, K., Kurita, T., Matsui, T., Vlassis, N., Bunschoten, R., & Krose, B. (2001). Jijo-2: An office robot that communicates and learns. *IEEE Intelligent Systems, 16*(5), 46-55.

Busso, C., & Narayanan, S. S. (2008). The expression and perception of emotions: comparing assessments of self versus others. *In Interspeech 2008-Eurospeech*, 257-260.

Eysenck, H. J., & Eysenck, S. B. G. (1994). Manual of the Eysenck Personality Questionnaire:(EPQ-R Adult). *EdITS/Educational and Industrial Testing Service.*

Haring, K.S., Silvera-Tawil, D., Velonaki, M., Takahashi, T., & Watanabe, K. (2015) Changes in perception of a small humanoid robot. *In Proceedings of the 6th International Conference on Automation, Robotics and Applications*. 83-89.

Kanda, T., Sato, R., Saiwaki, N., & Ishiguro, H. (2007). A two-month field trial in an elementary school for long-term human–robot interaction. *IEEE Transactions on robotics, 23*(5), 962-971.

Kanda, Ishiguro & Ishida. (2001). Psychological Evaluation on Interactions between People and Robot. *Transactions of the Institute of Systems, Control and Information Engineers, 19*(3), 362-371.

Ogata & Kanno. (2000). Experimental Evaluation of the Emotional Communication between Robots and Humans. *Transactions of the Institute of Systems, Control and Information Engineers, 13*(12), 566-574.

Tahir, Y., Rasheed, U., Dauwels, S., & Dauwels, J. (2014). Perception of humanoid social mediator in two-person dialogs. *In Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction.* 300-301.