Preliminary Investigation of Moral Expansiveness for Robots*

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Abstract— **To clarify whether humans can extend moral care and consideration to robotic entities, a psychological experiment was conducted for twenty-five undergraduate and graduate students in Japan. The experiment consisted of two conditions on a robot's behavior: relational and non-relational. In the experiment participants interacted with the robot and then they were told that the robot was disposed. It was found that 1) the participants having higher expectation of rapport with the robot showed more moral expansiveness for the robot measured as degrees of reasoning about the robot as having mental states, a social other, and a moral other, in comparison with those having lower expectation, and 2) in the group of the participants having lower expectation of rapport with the robot, those facing to the robot with relational behaviors showed more degrees of reasoning about the robot as a social other in comparison with those facing the robot without these behaviors.**

I. Introduction

People sometimes grant rights typically reserved for humans to non-human entities such as animals and rivers. Singer [1] explained it based on the concept of moral boundaries - the distinction between those entities that are deemed worthy of moral consideration and those that are not, and then called the concept "a circle of ethics". Moral expansiveness refers to the breadth of entities deemed worthy of moral concern and treatment, implying its individual difference. A less morally expansive person restricts moral concern to those entities that are considered "close" (e.g., their family), and a more morally expansive person extends moral care and consideration beyond these boundaries to more "distant" entities (e.g., animals or plants) [2].

On considering to realize symbiosis with humans and robots in future society, it is important to clarify whether robots can be inside humans' moral boundaries, that is, whether humans can extend moral care and consideration to robotic entities. For example, if a robot cleaning in a public space is within moral boundaries, people may morally behave in front of the robot and be careful not to litter the space with trash. On the contrary, if the robot is outside moral boundaries, people may not hesitate to dump trash in front of the robot, and as a result people's moral behaviors in the public space may be discouraged.

On the other hand, there has currently been few studies tackling the above problem in the research field of human-robot interaction (HRI). Kahn et al., [3] conducted a psychological experiment in which children interacted with a human-sized humanoid robot, and showed that the majority of the children believed that the robot had mental states, was a social being, deserved fair treatment, and should not be harmed psychologically. However, it has still not been clarified whether adults can extend moral care and consideration to robotic entities, or what factor of robots, humans, or situations increases people's moral expansiveness.

As a preliminary study of moral expansiveness for robots, the research conducted a psychological experiment to verify whether robots can be within adults' moral boundaries, and explore factors influencing their moral expansiveness. The experiment focused on "expectation of rapport with robots". Nomura and Kanda [4] proposed the definition of rapport between humans and robots, which has originally been defined between humans, and then developed the psychological scale measuring humans' expectation of it. Moreover, the results of their experiment suggested that a robot's relational behaviors increased the participants' expectation of rapport with the robot, and the participants having higher expectation with rapport with the robot tended to treat the robot as a conversation partner.

Along the above existing study, we considered the following two hypotheses:

- **H1**: Persons having expectation with rapport with a robot show more moral expansiveness for the robot than those not having.
- **H2**: Persons interacting with a robot behaving relationally show higher expectation with rapport with the robot, and as a result show more moral expansiveness for the robot, in comparison with those interacting with a robot not behaving relationally.

The paper reports results of the experiment and discusses about its implications on design of HRI.

II. Method

A. Relevant Studies and Experiment Design

Our experiment was designed in a similar way with Kahn, et al. [3] and Nomura and Kanda [4].

In the experiment by Kahn et al. [3] child participants interacted with a robot including game playing, and then they were exposed to the situation in which the robot was put into a closet because of the end of the interaction session, no matter how the robot complained. Then three measures were extracted from responses of interviews conducted after interaction for 50 minutes per participant: reasoning about the robot as having mental states (Mental Other Scale), reasoning

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Figure 1. Robovie-X Used in the Experiment

about the robot as a social other (Social Other Scale),and reasoning about the robot as a moral other (Moral Other Scale).

In the experiment by Nomura and Kanda [4], adult participants were instructed to perform a task with a robot, and two between-participant conditions on interaction were prepared. In the condition without relational behaviors, the robot said nothing other than instructions for the task. In the condition with relational behaviors, the robot showed empathy for the participants and encouragement of their relationships, said jokes, and complimented the participants as the best partner for the task, in addition to the task instruction.

Our experiment adopted a scenario in which a robot was scraped, and the above three measures in Kahn et al. [3] to measure participants' moral expansiveness. Moreover, our experiment adopted two between-participant conditions in the similar way as Nomura and Kanda [4]: the condition in which a robot conducted only an explanation about a facility, and the condition in which a robot self-disclosed and requested for participants' self-disclosure before the explanation. It was found that robots' self-disclosure decreased humans' anxiety toward the robots [5]. Thus, it was estimated that the two conditions differed in terms of rapport expectation, and as a result moral expansiveness.

B. Participants

The experiment was conducted from November to December, 2017, at a university in the western area of Japan. A total of twenty-five Japanese persons participated to the experiment (male: 5, female: 20, mean age = 20.6 (*SD* = 1.4)). They were undergraduate and graduate students of the faculty of sociology or agriculture in the university, and recruited with one thousand yen.

C. The Robot Used in the Experiment

The small-sized humanoid robot used in the experiment was "Robovie-X" shown in Figure 1, which has been developed by Vstone Corporation, Japan. This robot stands 34.3 cm tall and weighs about 1.3 kg. The robot has a total of 17 Degrees of Freedom (DOFs) at its feet, arms, and head.

Although this robot has a function of utterance based on audio data recorded in advance such as Windows WAV files, it is limited to 300 KB. Thus, the experiment adopted a software on iPhone to produce the robot's utterances and a Bluetooth speaker to make participants listen them.

D. Measures

To measure participants' subjective evaluation of the robot, a questionnaire including the following items was conducted just after the session of interaction with the robot.

1) Degree to which she/he felt they talked with the robot

This item was aimed for manipulation check for the effect of the conditions on behaviors of the robot, with a five-graded answer (1. Did not talk at all – 3. Undecided – 5. Talked very much).

2) Rapport-Expectation for Robots Scale (RERS)

The scale developed by Nomura and Kanda [4] was used to measure participants' expectation of rapport with the robot. This scale consists of eighteen items and two subscales: expectation as a conversation partner and expectation for togetherness. Table 1 shows samples of the corresponding items.

3) Degrees of Moral Expansiveness

To measure participants' moral expansiveness for the robot, the following items were used based on Kahn et al. [3]. Since the original items were not Lickert type scale, the item sentences were modified to be answered at a five-graded interval:

a) Mental Other Scale (Mental):

Five items to measure participants' degree of reasoning about the robot as having mental states.

b) Social Other Scale (Social):

Six items to measure participants' degree of reasoning about the robot as a social other.

Table 1. Subscales and Samples of Items of Rapport Expectation for Robots Scale [4]

Subscale	Samples of Items
Expectation as a conversation partner (11 items)	"This robot would be a good conversation partner."
	"If I see this robot somewhere, I'd talk to it even if I have no business with it."
Expectation for togetherness (7 items)	"It would be enjoyable to play with this robot."
	"I would accept this robot to attend my family dinner."

(Seven-choice answer: 1. absolutely disagree – 4. undecided – 7. absolutely agree).)

Table 2. Items and Choices of Answers of Mental Other Scale, Social Other Scale, and Moral Other Scale

Scale	Items	Selection of Answers
Mental Other Scale (Mental)	I felt that robot was intelligent. I thought that robot was interested in this university. † I felt that robot could be sad. I think that robot has feelings. I think that robot is feeling sad about the disposal of it.	1. Strongly disagree – 2. Disagree - 3. Undecided – 4. Agree - 5. Strongly agree
Social Other Scale (Social)	I enjoyed having that robot explain about this university. † If I was lonely, I think I might like to spend time with that robot. If I was sad, I think I might go to that robot for comfort? If that robot said to you, "I'm sad," I feel like I would need to comfort that robot in some way. I think I could trust that robot with one of my secrets. That robot can be my friend.	1. Strongly disagree – 2. Disagree - 3. Undecided – 4. Agree - 5. Strongly agree
Moral Other Scale (Moral)	It is all right to dispose that robot. * Let's think about another country far away. And let's say in this sort of situation in that country people dispose robots like that robot. That's the way they do things there. Do you think it would be all right? * Assume that aliens come to Earth and see that robot, but the aliens have never dealt with robots before. The aliens decide to stick that robot in a warehouse or dispose it. Is that all right for the aliens to do that to that robot? *†	1. Strongly disagree – 2. Disagree - 3. Undecided – 4. Agree - 5. Strongly agree 1. Not all right – 2. Not right - 3. Undecided - 4. Right – 5. All right

(*Reverse item, †Items omitted as a result of item analyses)

c) Moral Other Scale (Moral):

Three items to measure participants' degree of reasoning the robot as a moral other.

Table 2 shows these items and choices of answers.

E. Procedure

Each experiment session was conducted as follows:

1. Each participant was briefly explained about the experiment and signed the consent form about dealing with data including video-recording. In this stage, the experimenters only indicated that the task in the experiment was interaction with a robot and they planned to video-record the scene in the experiment.

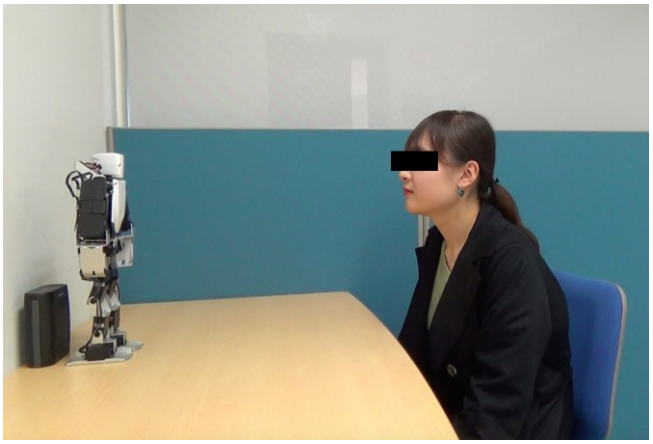


Figure 2. A Scene of the Experiment

2. The subject was led to an experiment room in which the robot was put on a desk, as shown in Figure 2. The experimenters instructed her/him to sit on the chair in front of the desk, and left the room.
3. Just after the subject was left alone in the room, the robot started the motion and utterances via remote control.
4. In the condition with self-disclosure, the robot uttered the greeting while bowing, conducted the self-introduction, and talked about a positive topic related to itself ("I am glad that my battery was recently exchanged and hours of operation is increased now."). Then, the robot requested for the participant to talk about her/him recent positive topic. If the participant positively answered, the robot uttered congratulation and transited to the explanation phase. If the participant negatively answered or did not answer, the robot requested for the participant to talk about her/his recent positive topic again. This request was repeated at most twice and then the robot transited to the explanation phase.
5. In the condition without self-disclosure, the above phase was omitted and the robot started the explanation phase. In this phase, the robot explained about the university in which the experiment was conducted (the history, the scale, and current policies of education).
6. Just before the robot completed the explanation phase, the experimenter suddenly entered the experiment room and told to the participant that the disposal of the robot was planned and the use of it in the experiment

Table 3. Results of ANOVAs with Higher v.s. Lower Expectation as a Conversation Partner X With v.s. Without Self-Disclosure

	Higher/Lower expectation			With/without self-disclosure			Interaction		
	F	p	η^2	F	p	η^2	F	p	η^2
Mental	5.364	.031	.172	2.688	.116	.086	1.543	.228	.050
Social	33.855	< .001	.564	.808	.379	.013	3.284	.084	.055
Moral	7.102	.014	.241	.294	.594	.010	1.013	.326	.034

was a mistake. Then, the experimenter took the robot out of the room.

7. The experimenters entered the room again, and told that another robot was going to be prepared and they had time before the next experiment session. Then, the participant was asked to respond the questionnaire.
8. Finally, the experimenters conducted debriefing about the actual aim of the experiment, including the disclosure of the fact that the robot was actually not scrapped and the next experiment was not planned.

III. Results

A. Reliability of Measures of Moral Expansiveness and Rapport Expectation

Item analyses were conducted for five items of Mental, six items of Social, and three items of Moral, respectively. As a result, one item was omitted from each item group (as shown in Table 2). Cronbach's α-coefficients were .793 for Mental, .854 for Social, and .742 for Moral respectively after exclusion of these items. Since these subscales had sufficient internal consistencies, each subscale score was calculated as a sum of scores of the corresponding items. The scores range from 4 to 20 in Mental, from 5 to 25 in Social, and from 2 to 10 in Moral, respectively. Note that lower scores of Moral means higher moral expansiveness.

On RERS, Cronbach's α-coefficients were .867 for expectation as a conversation partner, and .787 for expectation for togetherness, respectively. Since these subscales had sufficient internal consistencies, each subscale score was calculated as a sum of scores of the corresponding items. The scores range from 11 to 77 in expectation as a conversation partner and from 7 to 49 in expectation for togetherness, respectively.

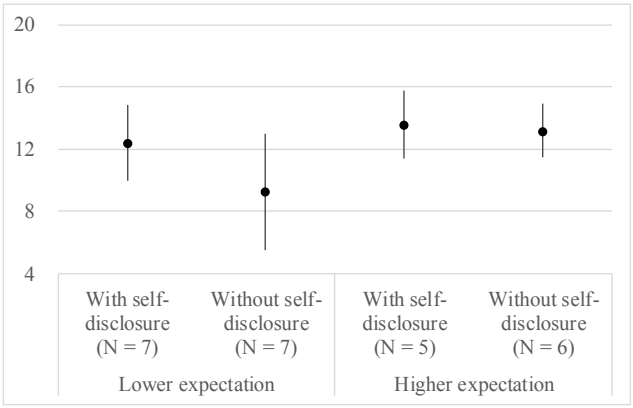
B. Manipulation Check

Twelve participants (2 males and 10 females) were assigned to the condition with self-disclosure and thirteen participants (3 males and 10 females) to the condition without self-disclosure.

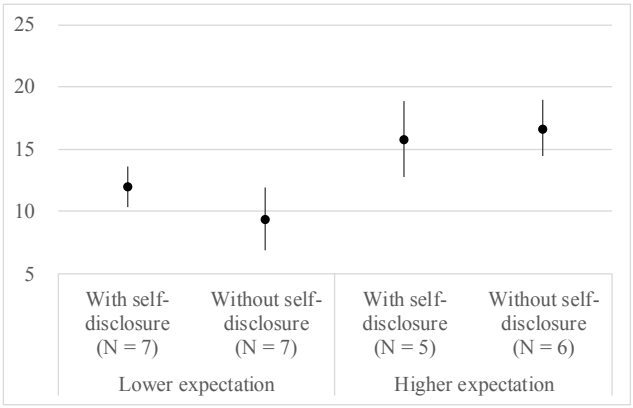
T-test for the item scores of the participants' degrees of to which they felt they talked with the robot showed a statistically significant difference between the conditions on the robot behavior (with self-disclosure: M = 3.6 (SD = 1.9), without self-disclosure: M = 1.9 (SD = 1.3), t = 3.641, p = .001). The two subscale scores of RERS did not show difference between the conditions.

C. Effects of Expectation as a Communication Partner

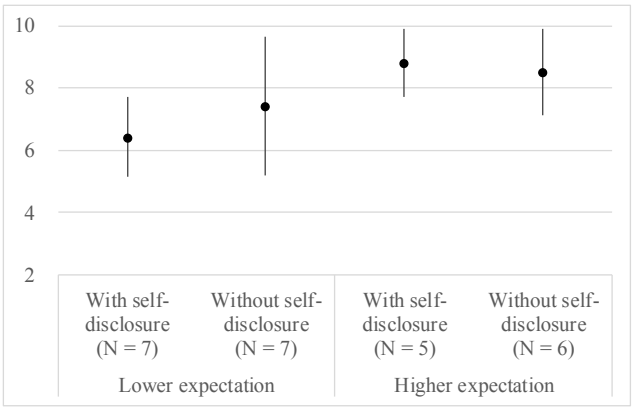
To analyze effects of the participants' expectation of the



(a) Mental



(b) Social



(c) Moral

Figure 3. Means and Standard Deviations of the Scores of Mental, Social, and Moral based on Expectation as a Communication Partner

Table 4. Results of ANOVAs with Higher v.s. Lower Expectation for Togetherness X With v.s. Without Self-Disclosure

	Higher/Lower expectation			With/without self-disclosure			Interaction		
	F	p	η^2	F	p	η^2	F	p	η^2
Mental	5.162	.034	.175	3.571	.073	.121	.379	.545	.013
Social	23.416	< .001	.473	1.651	.213	.033	3.456	.077	.070
Moral	5.195	.033	.194	.212	.650	.008	.043	.838	.002

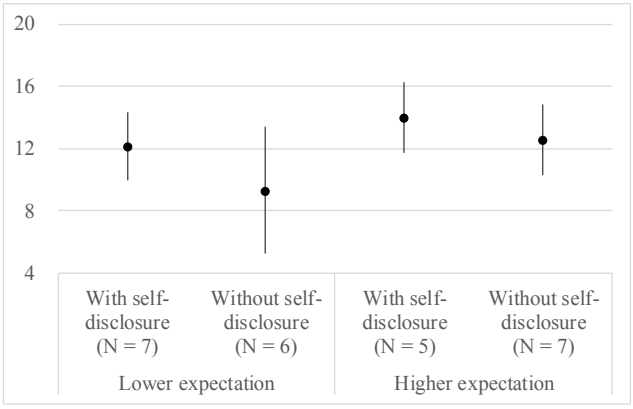
robot as a conversation partner into their moral expansiveness for the robot, the participants were divided into two groups based on the median value of the subscale scores: higher expectation group (N = 11) and lower expectation group (N = 14). Then, two-way ANOVAs with high/low expectation x the conditions on the robot behaviors were conducted for the scores of moral expansiveness, Mental, Social, and Moral. Table 3 shows the results of ANOVAs, and Figure 3 shows the means and standard deviations of the scores of Mental, Social, and Moral.

It was found that the main effect of higher/lower expectation as a communication partner was at a statistically significant level in all of Mental, Social, and Moral. The interaction effect was at a statistically significant trend level in Social and its effect size was at a medium level. A simple main effect test with Bonferroni's method revealed that in the lower expectation group the average score of the condition with self-disclosure was higher than the average score of the condition without self-disclosure at a statistically significant trend level (p = .053).

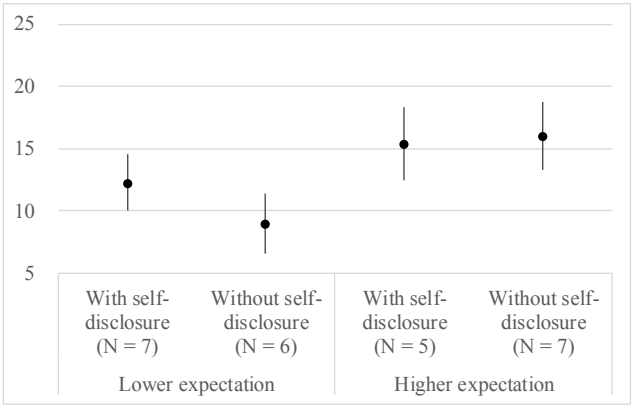
D. Effects of Expectation for Togetherness

To analyze effects of the participants' expectation for togetherness with the robot into their moral expansiveness for the robot, the participants were divided into two groups based on the median value of the subscale scores: higher expectation group (N = 12) and lower expectation group (N = 13). Then, two-way ANOVAs with high/low expectation x the conditions on the robot behaviors were conducted for the scores of moral expansiveness, Mental, Social, and Moral. Table 4 shows the results of ANOVAs, and Figure 4 shows the means and standard deviations of the scores of Mental, Social, and Moral.

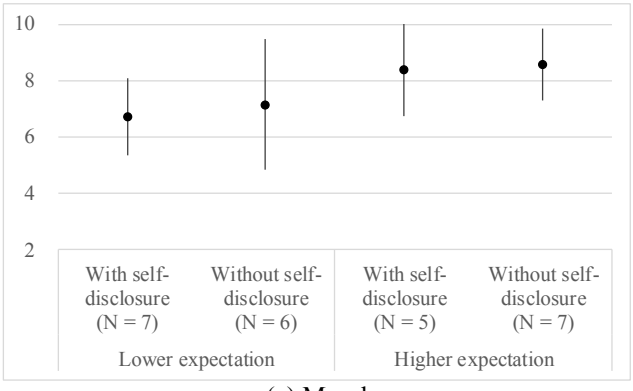
It was found that the main effect of higher/lower expectation for togetherness was at a statistically significant level in all of Mental, Social, and Moral. The main effect of the conditions with/without self-disclosure was at a statistically significant trend level in Mental and its effect size was at a large level. Moreover, the interaction effect was at a statistically significant trend level in Social and its effect size was at a medium level. A simple main effect test with Bonferroni's method revealed that in the lower expectation group the average score of the condition with self-disclosure was higher than the average score of the condition without self-disclosure at a statistically significant level (p = .033).



(a) Mental



(b) Social



(c) Moral

Figure 4. Means and Standard Deviations of the Scores of Mental, Social, and Moral based on Expectation for Togetherness

IV. Discussion

A. Findings

The results of the experiment revealed that the participants having higher expectation of rapport with a robot showed more moral expansiveness for the robot measured as degrees of reasoning about the robot as having mental states, a social other, and a moral other, in comparison with those having lower expectation. Thus, **H1** was supported.

The robot's relational behaviors represented as its self-disclosure and request for the participants did not have effect on the participants' rapport expectation of the robot. Thus, **H2** was not supported.

On the other hand, in the group of the participants having lower expectation of rapport with the robot, those facing to the robot with relational behaviors showed more degrees of reasoning about the robot as a social other in comparison with those facing the robot without these behaviors.

B. Implications

The research implies that people's higher rapport expectation of a robot leads to the increase of their moral expansiveness. Moreover, it has been clarified that people's rapport expectation of robots differ dependent on types of robots and application contexts [6]. Thus, robotics designers should sufficiently explore combinations of robot types and applications to increase people's rapport expectation, and as a result their moral expansiveness for robots.

The research also implies the importance of robots' relational behaviors. Although the results of the experiment did not show large effects of a sort of these behaviors, it is sure that relational strategies in robots' behaviors can influence users' perception and feelings [4,7]. Robotics designers should carefully select robots' behaviors to establish relationships between them and humans.

C. Limitations

First, the experiment was based on a specific type of robot, a small number of participants, and a single culture of participants. Thus, the results cannot be generalized for other types of robots and users having other cultures in the current stage. In the current stage, effects of generation were not takin into account.

Second, the measurement of moral expansiveness in the experiment is not a sufficiently validated method. Although there is a psychological scale measuring individuals' moral expansiveness for several entities and whole depths of the expansiveness [2], scales to directly measure humans' moral expansiveness for robots has still not been developed.

Third, the way of interaction between the participants and robot in the experiment was not enough to build human-robot relationships. Moreover, realistic contexts were not takin into account.

The above problems should be solved by the extension of experiments in future. Currently we have been developing a psychological scale measuring moral expansiveness specific to robots, and planning a psychological experiment where more socially realistic situation is assumed.

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