Who Expect Rapport with Robots?
A Survey-Based Study for Analysis of People's Expectation*

Tatsuya Nomura and Takayuki Kanda

***Abstract*— An online survey for 600 Japanese participants from 20's to 50's was conducted to reveal who expect rapport to what robots. In concrete, the survey was based on hypothetical situation method consisting of three situations: a robot servicing in a public space, a business-partner robot in a company, and a butler robot servicing a family in a home. We measured people's expectation of rapport to these robots using a psychological scale, RERS [6, 7], and we also measured their personal traits using other scales. As expected, the result revealed that 1) the butler robot was expected as a conversation partner to be with together, more strongly than the other two robots. Further, we found that 2) rapport-expectation with the butler robot was inhibited by negative attitudes toward robots, more strongly than the other robots; 3) people with more empathy to others tended to have higher expectation to have rapport with robots.**

I. Introduction

Rapport or intimate relationships between humans and social robots are one of the most important themes human-robot interaction (HRI) studies have challenged. Tanaka, et al., [1] reported that children established peer-like relationships during long-term interaction with a robot. Lee, et al., [2] applied a personalization strategy to establish rapport with a robot in an office environment. Kidd [3] developed a robot designed to sustain long-term relationships with users to assist them lose weight. Leite, et al., [4] designed a robot for long-term interaction with a capability for empathetic interaction. Yamaji et al. [5] developed a trash box robot to build a social coupling with children in order to induce their assistance in the collection of trash. These studies expect users to form rapport with social robots.

However, it has sufficiently not been investigated what factors increase or decrease rapport between humans and robots. In order to clarify these factors in robot, situational, and human levels, we have developed the Rapport-Expectation with a Robot Scale (RERS [6, 7]) to measure humans' expectation of rapport. Our validation process for this scale suggested that robot behaviors based on relational strategies increased humans' rapport-expectation with the robot, and persons who treated a robot as a human–like conversation partner had higher rapport-expectation with the robot than those who did not [7].

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Tatsuya Nomura is with Department of Media Informatics, Ryukoku University, Otsu, Shiga 520-2194, Japan (corresponding author to provide phone: +81-77-544-7136; fax: +81-77-544-7150; e-mail: nomura@rins.ryukoku.ac.jp).

Takayuki Kanda is with ATR Intelligent Robotics and Communication Laboratories, Keihanna Science City, Kyoto 619-0288, Japan (e-mail: kanda@atr.jp).

For the purpose, we consider that 'hypothetical situations method' [8] is a useful vehicle for investigation. In the method, we presented some hypothetical situations to participants, and ask to imagine how they perceive/recognize the situation. Under the current situation, rapport with robots are still under active research. Further, conducting a real study for such rapport with robots would need an extensively long-term study. Thus, it would be very useful if we can explore influential human factors into rapport-expectation with robots without the use of real robots.

There are a few precedent studies with 'hypothetical situations method' for rapport with robots. In our early study, we have confirmed the validity of RERS [7], though it did not investigate how expectation of rapport with robots could be affected by contexts where humanoid robots act in more realistic situations. As a result, it was not clarified how negative attitudes toward robots and empathy for others influenced rapport-expectation with humanoid robots.

In order to overcome these problems, we conducted a new survey, with the focus of the following factors. The first one is negative attitudes toward robots. It was found that this factor can affect humans' communication behaviors toward robots [9]. The second one is humans' empathy for others. It can be hypothesized that persons more empathic for others are more empathic for social robots, and as a result expect rapport with the robots. Moreover, the survey aimed at exploring effects of gender and age into rapport-expectation.

The paper reports results of the survey, and then discusses about their implications on establishing long-term human-robot rapport.

II. Method

A. Data Collection

The survey was conducted in June, 2014. Respondents were recruited by a survey company at which about one million and thirty thousand Japanese persons have registered, via the Internet. Among people randomly selected based on gender and age, a total of 600 persons ranging from 20's to 50's participated in the survey. The respondents at each of the generations (20's, 30's, 40's, and 50's) consisted of 75 males and 75 females. A questionnaire was conducted online, via a WEB page.

TABLE I. ITEM SENTENCES IN SUBSCALES USED IN THE SURVEY

Scale	Subscale (# of items)	Example of Item Sentences
Expectation of rapport with robots	**RERS1:** Expectation as a conversation partner (11 items) **RERS2**: Expectation for togetherness (7 items)	"I wish to talk with the robot about hobbies and arts." "This robot would be a good conversation partner." "I would accept this robot to attend my family dinner." "If the robot has been staying with me since my birth, I will want to be together with it until my death."
Negative atitudes toward robots	**NARS1**: Negative attitude toward interaction with robots (6 items) **NARS2**: Negative attitude toward social influences of robots (5 items) **NARS3**: Negative attitude toward emotional interaction with robots (3 items)	"I would feel very nervous just standing in front of a robot." "I would feel paranoid talking with a robot." "I feel that if I depend on robots too much, something bad might happen." "I am concerned that robots would be a bad influence on children." "If robots had emotions, I would be able to make friends with them."* "I feel comforted being with robots that have emotions."*
Empathy for others	**MES1**: Other-oriented emotional reactivity (5 items) **MES2**: Self-oriented emotional reactivity (4 items) **MES3**: Emotional susceptibility (5 items) **MES4**: Perspective taking (5 items) **MES5**: Fantasy (5 items)	"When I see a person feeling sad, I would like to cheer up her/him." "I will not sympathize with otehrs even if they they failed in some situations. "Sometimes, I cannot be pleased with others' successes." "When seeing others' failures, I feel that I do not want to meet with similar situations." "My feeling is easy to be influenced by others." "I find it very hard to decide things by myself, without being influenced by others." "Even if I am opposed to another person, I will try to understand her/his perspective." "I listen to others while considering what they would like to talk with me." "I tend to dream or imagine repeatedly about things that may happen to me." "I like to fancy several things."

(*: reverse Item)

B. Survey Design

After the face sheet and psychological scales of attitudes toward robots and empathy for others were commonly conducted for all the respondents, the survey consisted of three hypothesized situations where different types of humanoid robots behaved. Based on a between-participant design, each respondent was assigned to one of these hypothesized situations. Among 75 male and 75 female participants at each of the generations (20's, 30's, 40's, and 50's), 25 male and 25 female participants were assigned to each of the three hypothetical situations. She/he was instructed to envision the assigned hypothesized situation, and then answer a psychological scale on her/his expectation of rapport with the robot that appeared in the situation.

The hypothesized situations in the survey were: 1) a service robot in a town, 2) a business-partner robot in a company, and 3) a butler robot in a home. The instruction of the situations was conducted with pictures and texts. These materials are shown in Appendix shows these pictures and texts.

C. Measures

Table 1 shows examples of item sentences in the psychological scales used in the survey.

1) Expectation of Rapport with Robots

The Rapport-Expectation with a Robot Scale (RERS [6, 7]) was used to measure respondents' expectation of rapport with three robots appearing in the hypothesized situations. This scale consists of 18 items classified into two subscales: (a) **RERS1**: expectation as a conversation partner (eleven items) and (b) **RERS2**: expectation for togetherness (seven items). Each item is scored on a seven-point scale (1: absolutely disagree – 4: undecided – 7: absolutely agree), and an individual's score on each subscale was calculated by adding the scores of all items included in the subscale, with some items reverse coded.

2) Negative Attitudes toward Robots

In psychology, an attitude is defined as a relatively stable and enduring predisposition to behave or react in a certain way toward persons, objects, institutions, or issues. The Negative Attitudes toward Robots Scale (NARS [9]) was developed to determine human attitudes toward robots, that is, psychological states reflecting opinions that people ordinarily have about robots. This scale consists of 14 items classified into three subscales: (a) **NARS1**: negative attitude toward interaction with robots (six items); (b) **NARS2**: negative attitude toward the social influence of robots (five items); and (c) **NARS3**: negative attitude toward emotional interaction with robots (three items). Each item is scored on a five-point scale: 1) strongly disagree; 2) disagree; 3) undecided; 4) agree; 5) strongly agree, and an individual's score on each subscale was calculated by adding the scores of all items included in the subscale, with some items reverse coded.

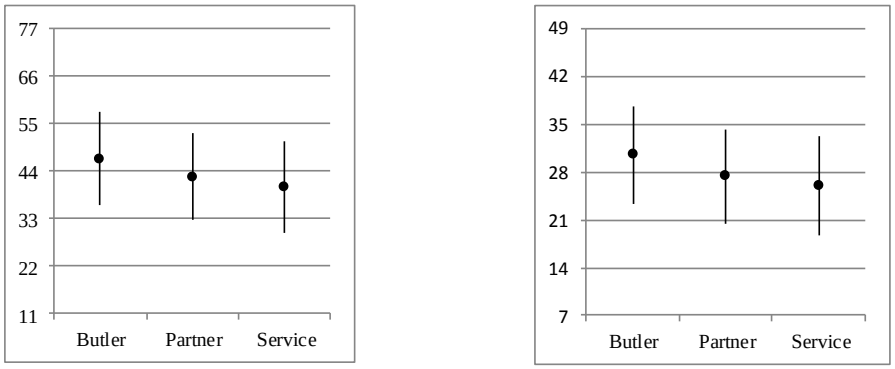
3) Empathy for Others

The Multidimensional Empathy Scale (MES [10]) was used to measure respondents' empathy for others. This scale consists of 24 items classified into five subscales: (a) **MES1**: other-oriented emotional reactivity (five items); (b) **MES2**: self-oriented emotional reactivity (four items); (c) **MES3**: emotional susceptibility (five items), (d) **MES4**: perspective taking (five items); and (e) **MES5**: fantasy (five items). Each item is scored on a five-point scale: 1) It does not apply to me at all; 2) It does not apply to me; 3) Not decidable; 4) It applies to me; 5) It strongly applies to me. An individual's score on each subscale was calculated by adding the scores of all items included in the subscale, with some items reverse coded.

TABLE II. RESULTS OF THREE-WAY ANOVAS WITH GENDER X GENERATIONS X HYPOTHETICAL SITUATIONS

		Main			First Order Interaction			Second Order Interaction
		Situation	***Generation***	***Gender***	***Situation x Generation***	***Situation x Gender***	***Generation x Gender***	
Expectation as a conversation partner	*F*	**20.879**	.585	1.614	.978	2.902	.144	1.099
	p	**< .001**	.625	.204	.439	.056	.934	.362
	$\eta 2$	**.065**	.003	.003	.009	.009	.001	.010
Expectation for togetherness	*F*	**21.289**	.219	.162	.951	1.935	.073	1.042
	p	**< .001**	.884	.687	.458	.145	.975	.397
	$\eta 2$	**.067**	.001	.000	.009	.006	.000	.010

Figure 1. Means and Standard Deviations of the RERS Subscale Scores



Expectation as a conversation partner Expectation for togetherness

Service: a service robot in a town, Partner: a business-partner robot in a company, Butler: a butler robot in a home

III. RESULTS

A. Internal Consistency of Measures

Chronbach's α-coefficients of the RERS subscales were .903 and .922 in expectation as a conversation partner and expectation for togetherness, respectively. α-coefficients of the NARS subscales were .864 in negative attitude toward interaction with robots, .810 in negative attitude toward social influences of robots, and .786 in negative attitude toward emotional interaction with robots. It was found that these scales had sufficient internal consistencies.

On the MES, α-coefficients of the subscales were: .720 in other-oriented emotional reactivity, .750 in self-oriented emotional reactivity, .667 in emotional susceptibility, .686 in perspective taking, and .679 in fantasy. Influences of Situations, Gender, and Generations into Rapport-Expectation

For the scores of the RERS subscales, three-way ANOVAs with gender X generations (4 levels: 20's, 30's, 40's, and 50's) X the hypothetical situations (3 levels) were conducted. Table 2 shows these results. On both expectations as a conversation partner and for togetherness, only the main effects of the hypothetical situations were at statistically significant levels, having moderate levels of effect sizes. There was no main effect of generation or gender, or interaction effect. Although the interaction effect between gender and situations on expectation for togetherness was at a statistically significant trend level, the effect size was small.

Post-hoc analyses with Bonferroni's method revealed that both two kinds of rapport-expectation with the butler robot were higher than those with the service robot and business-partner robot ($p < .001$). Although it was at a statistically significant trend levels ($p = .060$), expectation of rapport with the butler robot as a conversation partner was higher than that with the service robot. Figure 2 shows the means and standard deviations of the RERS subscale scores based on the hypothetical situations.

B. Relationships between Rapport-Expectation, Negative Attitudes toward Robots, and Empathy for Others

Linear regression analyses were conducted to explore influences of negative attitudes toward robots and empathy for others into expectation of rapport with robots. The RERS subscale scores were used as dependent variables, and the scores of the NARS and MES subscales, gender (male = 0, female = 1), and age were adopted as independent variables. The analyses were based on backward elimination method. We conducted the analysis for each of the hypothesized situations, since we consider that there would be different influential factors between robot types and application contexts.

Table 3 shows the extracted models in the analyses. The way of influences from negative attitudes toward robots (measured by NARS) and empathy for others (measured by MES) into rapport-expectation with the robots in the hypothetical situations are summarized as follows:

TABLE III. EXTRACTED MODELS IN LINEAR REGRESSION ANALYSES

Dependent variable	Independent variable	Service Robot			Business-Partner Robot			Butler Robot		
		β	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*
Expectation as a conversation partner	NARS1									
	NARS2				-.252	-3.906	<.001	-.261	-4.307	<.001
	NARS3	-.324	-5.163	< .001	-.285	-4.428	<.001	-.251	-4.137	<.001
	MES1	.191	2.986	.003	.182	2.828	.005	.215	3.547	<.001
	MES2				.121	1.901	.059	.166	2.750	.007
	MES3	.261	3.684	< .001				.255	4.111	<.001
	MES4									
	MES5	-.176	-2.508	.013						
	Gender	.124	1.997	.047						
	Age									
		$F(5,194) = 14.296$, $p < .001$, $R^2 = .250$			$F(4,195) = 12.772$, $p < .001$, $R^2 = .191$			$F(5,194) = 21.800$, $p < .001$, $R^2 = .343$		
Dependent variable	**Independent variable**	**Service Robot**			**Business-Partner Robot**			**Butler Robot**		
		β	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*
Expectation for togetherness	NARS1							-.193	-2.322	.021
	NARS2	-.110	-1.672	.096	-.235	-3.533	.001	-.146	-1.846	.066
	NARS3	-.263	-3.984	< .001	-.213	-3.204	.002	-.254	-3.960	< .001
	MES1	.147	2.234	.027	.170	2.547	.012	.174	2.581	.011
	MES2									
	MES3	.233	3.473	.001				.192	2.819	.005
	MES4				.144	2.170	.031			
	MES5									
	Gender									
	Age									
		$F(4,195) = 11.788$, $p < .001$, $R^2 = .178$			$F(4,195) = 9.022$, $p < .001$, $R^2 = .139$			$F(5,194) = 14.565$, $p < .001$, $R^2 = .254$		

NARS1: Negative attitude toward interaction with robots, NARS2: Negative attitude toward social influences of robots, NARS3: Negative attitude toward emotional interaction with robots

MES1: Other-oriented emotional reactivity, MES2: Self-oriented emotional reactivity, MES3: Emotional susceptibility, MES4: Perspective taking, MES5: Fantasy

- Negative attitudes toward emotional interaction with robots (NARS3):
  - Negative for both expectations as a conversation partner and for togetherness with all the three robots
- Other-oriented emotional reactivity (MES1):
  - Positive for both expectations as a conversation partner and for togetherness with all three robots
- Negative attitude toward social influences of robots (NARS2):
  - Negative for both expectations as a conversation partner and for togetherness with the business-partner and butler robots
- Emotional susceptibility (MES3):
  - Positive for both expectations as a conversation partner and for togetherness with the service and butler robots.
- Self-oriented emotional reactivity (MES2):
  - Positive for expectation of rapport with the business-partner and butler robots as a conversation partner.
- Negative attitude toward interaction with robots (NARS1):
  - Negative only for expectation for togetherness with the butler robot.
- Perspective taking (MES4):
  - Positive for expectation for togetherness with the business-partner robot.

In summary, negative attitudes toward robots tended to decrease rapport-expectations with the robots, and empathy for others increased rapport-expectations, although there was a dependency between the robots on the relationships between the constructs.

IV. DISCUSSION

A. Findings

In the survey based on hypothetical situation method, the robot as a butler to service a family in a home was expected as a conversation partner to be with together, more strongly than the robot servicing in a public place and the robot collaborating with humans as a business partner. Although there was no difference between the business-partner robot and service robot on expectation for togetherness, the business-partner robot was expected as a conversation partner more strongly than the service robot. These results revealed that expectations of rapport with humanoid robots, which

could be measured by the RERS, were dependent on application contexts.

Moreover, the application contexts in the survey influenced relationships between rapport-expectations with robots and other human factors related to robots and others. Negative attitudes to be measured by the NARS mean a kind of opinions toward robots in general. Among these attitudes, expectation as a conversation partner for the service robot was influenced only by negative attitude toward emotional interaction with robots, and those for the business-partner and butler robots were affected by this attitude and negative attitudes toward social influences of robots. Expectation for togetherness with the butler robot was influenced by all the three negative attitudes, although negative attitude toward interaction with robots did not affect this type of rapport-expectation with the service and business-partner robots. In other words, rapport-expectation with communication robots in domestic fields was influenced by more negative attitudes than robots in public fields.

Other-oriented emotional reactivity affected both types of rapport-expectation with the robots in all the situations. On the other hand, expectation as a conversation partner for the service robot was affected by emotional susceptibility, that for the business-partner robot was affected by self-oriented emotional reactivity, and that for the butler robot was influenced by both the factors. Expectation for togetherness with the service and butler robot was affected by emotional susceptibility, and that with the business-partner robot was influenced by perspective taking. In other words, rapport-expectation with robots not communicating with humans was influenced by a psychological trend of easiness to be affected by others' emotions and opinions, that with communication robots for business was affected by a trend to relate others' perspectives and inner states with the self, that with communication robots in domestic fields was affected by both the two trends.

B. Implications

The results of the survey imply that humans may expect rapport with communication robots servicing in domestic fields, in comparison with robots in public fields. Moreover, it is implied that these robots are expected on rapport more strongly by persons having psychological trends of easiness to be affected by others' emotions and opinions and to relate others' perspectives and inner states with the self.

On the other hand, negative attitudes toward robots, in particular, those related to interaction with robots may inhibit this expectation. If developers of humanoid robots aim at immediate widespread of the robots, they should introduce the robot into domestic fields, designing applications toward people empathic for others.

C. Limitations

Sampling in the survey was limited to the Japanese. Thus, cultural factors were not taken into account. The future survey should be extended to several countries including the USA, Korea, and the Europe.

Moreover, the results of the survey did not clarify relationships between rapport-expectation with robots and other constructs such as technology acceptance [11]. It may be caused by a limit of hypothetical situation method. From the design perspective of robotics applications, it is important to investigate what type of rapport-expectation affect intention to use, ease to use, and trustworthiness of robots. Thus, the future survey should adopt other types of questionnaires.

APPENDIX

Figure 2 shows the texts and pictures in the instruction of the hypothetical situations in the survey.

ACKNOWLEDGMENT

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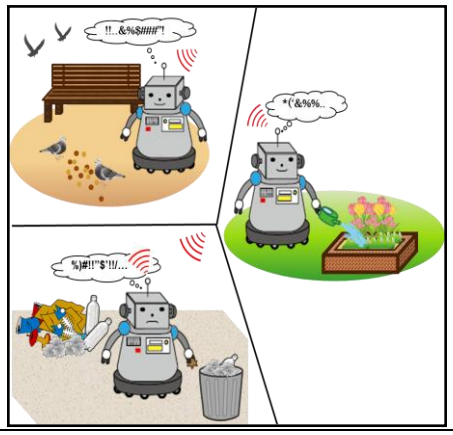
Figure 2. Pictures and Texts in the Instruction of the Hypothetical Situations

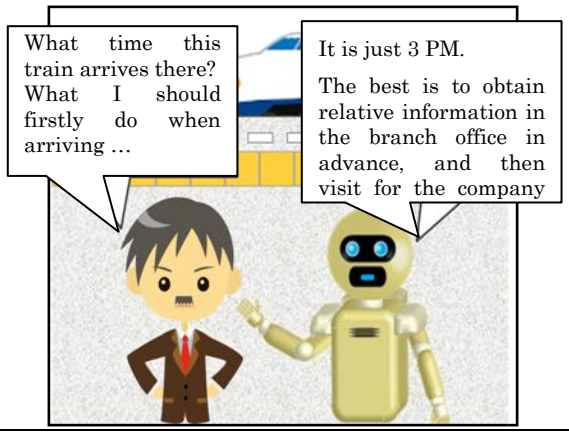


In a town, a robot services public places, including cleaning tasks.

This robot performs not only garbage collection on public roads but also various types of service tasks in the town, such as feeding birds in a park and watering a flowerbed.

Although this robot has no function of communication with humans, it can exchange information with the same type of robots (by using their own language that humans do not understand).

(1) A Service Robot in a Town

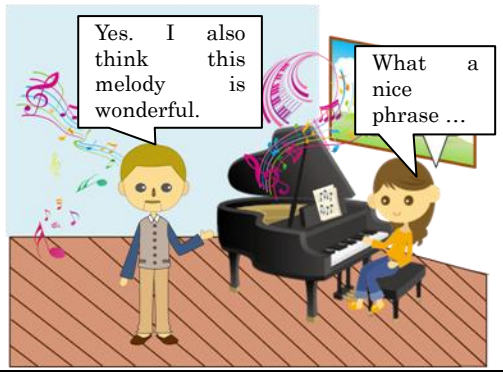


In a person's company, a robot supports various types of businesses.

This robot has a function to understand human languages and can interact with business partners including this person by uttering for itself.

The robot can go with this person on business trips, and the person consults with it about the time schedule and train routes during the trips.

(2) A Business-Partner Robot in a Company



In a person's home, a robot has performed several tasks including housework.

This robot can communicate the family members including the person, by understanding human linguistics and uttering for itself.

Moreover, this robot has a deep knowledge of some arts including music and pictures. It has shared impressions toward many pieces of music and actively discussed about them with the person, for example, by playing electric sounds while synchronizing with her/his playing music instruments.

In addition, this robot has been living in the house since the generation of the person's parents.

(3) A Butler Robot in a Home