Differences of Expectation of Rapport with Robots Dependent on Situations

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ABSTRACT
An online survey for 1,200 Japanese participants from 20's to 50's was conducted to clarify what type of robot and under what situation humans expect rapport with, and explore human factors influential into these expectations. The survey was based on hypothetical situation method consisting of three situations: a vacuum robot, a pet-type robot, and a robot instructor. The results suggested that; 1) expectations of rapport with robots were dependent on types of robots and application contexts, and were directly not affected by experiences of robots; 2) these expectations were influenced by negative attitudes toward social influences of and emotional interaction with robots, and emotional sensitivity for others; 3) expectations of rapport with robots were influenced by different psychological factors dependent on robot types and application contexts.

Author Keywords
Expectation of rapport with robots; psychological scale; hypothetical situation method

ACM Classification Keywords
H.1.2 [User/Machine Systems]: Human factors

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., [9] 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 [1] developed a robot designed to sustain long-term relationships with users to assist them lose weight. Leite, et al., [3] designed a robot for long-term interaction with a capability for empathetic interaction. 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 this stage, it is necessary to clarify what type of robot and under what situation humans expect rapport with. In addition to these robot and situational factors, human factors should also be investigated as influential ones.

As a preliminary study for the above aim, an online social survey was conducted based on a hypothetical situation method on robot types and contexts of robotics applications. Among many human factors, this survey focused on the following ones. The first one is negative attitudes toward robots. It was found that this factor can affect humans' communication behaviors toward robots [6]. The second one is experiences of robots. It was suggested that this factor can influence attitudes toward and expectation for robots [5, 7]. The third 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.

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

METHOD

Data Collection

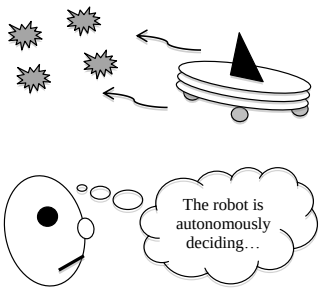
The survey was conducted in January, 2014. Respondents were recruited by a survey company at which about one million and thirty thousand Japanese persons have registered, via the Internet. Among people randomly selected based on gender and age, a total of 1,200 persons ranging from 20's to 50's participated in the survey. The respondents at each of the generations (20's, 30's, 40's, and 50's) consisted of 150 males and 150 females. A questionnaire was conducted online, via a WEB page.

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 robots behaved. Based on a between-participant design, each respondent was assigned to one of these hypothesized situations. Among 150 male and 150 female participants at

HAI 2014, October 29–31, 2014, Tsukuba, Japan.

http://dx.doi.org/10.1145/2658861.2658869



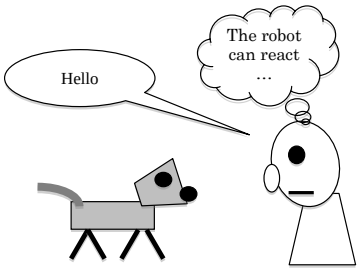
You are at a room for a lecture in your school or a job in your company.

A vacuum robot is cleaning the room.

This robot does not have function of communication with humans, but continues to clean the room while identifying the state of the room autonomously.

When completing cleaning, the robot moves toward a power station to charge the buttery by itself.

(a) A vacuum robot



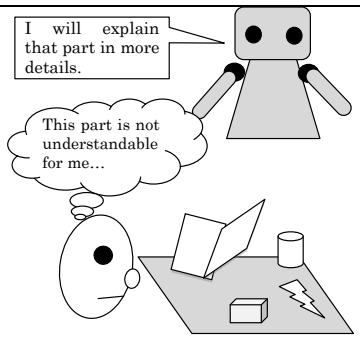
You are in an outdoor amusement park.

Some people are playing with a pet-type robot.

This robot does not have function of communication of utterance toward humans, but reacts moving the body when humans touch or speak to it.

When a person completes playing with the robot, it moves toward another person's playing.

(b) A pet-type robot



You are tackling a study for a lecture in your school or training in your company. This is your first experience of the study.

A robot instructor is assisting your learning.

This robot can communicate with humans by understanding humans' utterances and performing to utter.

The robot observes your state in learning the study, and explains contents hard for you to understand.

(c) A robot instructor

Figure 1: Pictures and Texts in the Instruction of the Hypothetical Situations

each of the generations (20's, 30's, 40's, and 50'), 50 male and 50 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 vacuum robot having autonomy and no communication function, 2) a pet-type robot in an amusement park, and 3) a robot instructor in learning novel contents. The instruction of the situations was conducted with pictures and texts. Figure 1 shows these pictures and texts.

Measures

Experience of Robot

On the face sheet, respondents' experiences of robots were asked with a three-choice answer (1. I have seen real robots, 2. I have never seen real robots, but have seen those via media such as TV and newspapers, 3. I have never seen robots).

Negative Attitudes toward Robots

The Negative Attitudes toward Robots Scale (NARS [6]) was used to measure respondents' attitudes toward robots. This scale consists of 14 items classified into three subscales: (a) negative attitude toward interaction with robots (six items); negative attitude toward the social influence of robots (five items); and 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.

Empathy for Others

The Multidimensional Empathy Scale (MES [8]) was used to measure respondents' empathy for others. This scale consists of 24 items classified into five subscales: (a) other-oriented emotional reactivity (five items); (b) self-oriented emotional reactivity (four items); (c) emotional susceptibility (five items), (d) perspective taking (five items); and (e) 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.

Expectation of Rapport with Robots

The Rapport-Expectation with a Robot Scale (RERS [4]) was used to measure respondents' expectation of rapport with three robots appearing in the hypothesized situations.

Scale	Subscale (# of items)	Example of Item Sentences
NARS	Negative attitude toward interaction with robots (6 items)	"I would feel very nervous just standing in front of a robot."
	Negative attitude toward social influences of robots (5 items)	"I feel that if I depend on robots too much, something bad might happen."
	Negative attitude toward emotional interaction with robots (3 items)	"If robots had emotions, I would be able to make friends with them."*
MES	Other-oriented emotional reactivity (5 items)	"When I see a person feeling sad, I would like to cheer up her/him.
	Self-oriented emotional reactivity (4 items)	"Sometimes, I cannot be pleased with others' successes."
	Emotional susceptibility (5 items)	"My feeling is easy to be influenced by others."
	Perspective taking (5 items)	"Even if I am opposed to another person, I will try to understand her/his perspective.
	Fantasy (5 items)	"I tend to dream or imagine repeatedly about things that may happen to me."
RERS	Expectation as a conversation partner (11 items)	"I wish to talk with the robot about hobbies and arts."
	Expectation for togetherness (7 items)	"I would accept this robot to attend my family dinner."

(*: reverse item)

Table 1: Examples of Item Sentences in Subscales Used in the Survey

This scale consists of 18 items classified into two subscales: (a) expectation as a conversation partner (eleven items) and (b) 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.

Table 1 shows examples of item sentences in these psychological scales.

RESULTS

Internal Consistency of Measures

Chronbach's α-coefficients of the RERS subscales were .915 and .867 in expectation as a conversation partner and expectation for togetherness, respectively. α-coefficients of the NARS subscales were .872 in negative attitude toward interaction with robots, .799 in negative attitude toward social influences of robots, and .753 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: .726 in other-oriented emotional reactivity, .668 in self-oriented emotional reactivity, .712 in emotional susceptibility, .688 in perspective taking, and .681 in fantasy. Although some subscales did not show sufficient internal consistencies, these scores were used in the regression analyses to explore influential factors into participants' expectation of rapport with robots.

Influences of Experiences of Robots

Table 2 shows the sample numbers on participants' gender, age groups, experiences of robots, and assigned hypothetical situations. There was no statistically significant relationship between age groups and experiences of robots ($\chi^2(6) = 10.618$, *n.s.*), although gender bias on experiences of robots was at a statistically significant level ($(\chi^2 (2) = 13.867, p < .001$).

For the scores of the RERS subscales, three-way ANOVAs with gender X experiences of robots X the hypothetical situations were conducted. Table 3 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 experiences of robots 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 rapport-expectation with the robot instructor was higher than those with the vacuum robot and pet-type robot, and rapport-expectation with the pet-type robot was higher than that with the vacuum robot. Figure 2 shows the means and standard deviations of the RERS subscale scores based on the hypothetical situations.

Hypothetical situations	Age group	Male			Total	Female			Total
		Experiences of robots				Experiences of robots			
		I	II	III		I	II	III	
Vacuum robot	20's	13	28	9	50	10	28	12	50
	30's	19	22	9	50	16	26	8	50
	40's	13	33	4	50	14	29	7	50
	50's	13	31	6	50	10	30	10	50
	Total	58	114	28	200	50	113	37	200
Pet-type robot	20's	18	25	7	50	10	31	9	50
	30's	13	25	12	50	6	34	10	50
	40's	19	22	9	50	10	31	9	50
	50's	19	28	3	50	9	32	9	50
	Total	69	100	31	200	35	128	37	200
Robot instructor	20's	7	27	16	50	9	24	17	50
	30's	9	34	7	50	13	28	9	50
	40's	10	37	3	50	12	26	12	50
	50's	22	23	5	50	6	33	11	50
	Total	48	121	31	200	40	111	49	200
Total	20's	38	80	32	150	29	83	38	150
	30's	41	81	28	150	35	88	27	150
	40's	42	92	16	150	36	86	28	150
	50's	54	82	14	150	25	95	30	150
	Total	175	335	90	600	125	352	123	600

I. Participants who had seen real robots,
II. Participants who had never seen real robots, but had seen those via media such as TV and newspapers,
III. Participants who had never seen robots

Table 2: Numbers of Samples based on Gender, Age Groups, Experiences of Robots, and Hypothetical Situations

On the other hand, two-way ANOVAs for the NARS subscale scores with gender X experiences of robots found the following statistically significant effects: experiences of robots ($F = 38.834$, $p < .001$, $\eta^2 = .061$) and interaction ($F = 4.203$, $p = .015$, $\eta^2 = .007$) on attitude toward interaction with robots, gender ($F = 11.259$, $p < .001$, $\eta^2 = .009$) and experiences of robots ($F = 9.012$, $p < .001$, $\eta^2 = .015$) on negative attitudes toward social influences of robots.

Post-hoc tests found that: toward interaction with robots, participants who had seen real robots had lower negative attitude than did the other participants in both male and female groups, female participants having seen robots via media had lower negative attitude than did female participants who had never seen robots, and males had lower negative attitude than did females in the group of participants who had seen robots via media. Moreover, it was found that participants who had seen real robots had lower negative attitude toward social influences of robots than did the other participants, and male participants had lower negative attitude toward social influences of robots than did female participants. However, the effect sizes of these factors were small except for experiences of robots on negative attitude toward interaction with robots. Moreover, negative attitude toward emotional interaction with robots was not influenced by experiences or gender.

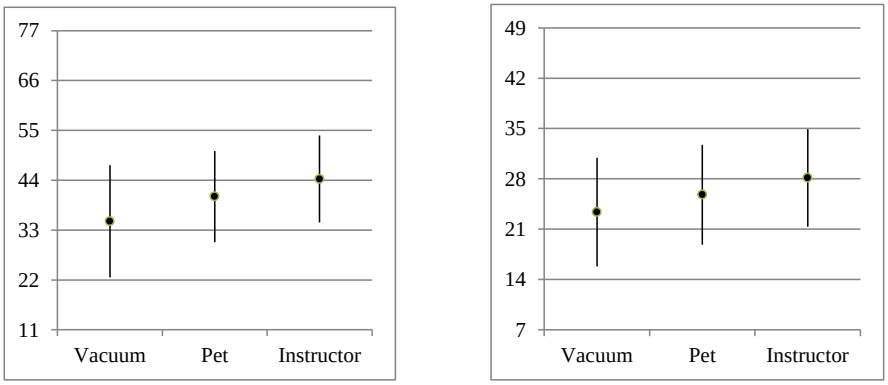
Relationships between Rapport-Expectation, Negative Attitudes toward Robots, and Empathy for Others

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 and age were adopted as independent variables. The analyses were based on backward elimination method. Moreover, they were conducted for samples in each of the hypothesized situations to explore differences of influential factors between robot types and application contexts.

Table 4 shows the extracted models in the analyses. Both expectations as a conversation partner and for togetherness were negatively affected by negative attitudes toward social influences of and emotional interaction with robots in all

		Main			First Order Interaction			Second Order Interaction
		Hypothetical situations	Gender	Experiences of robots	Situations X Gender	Situations X Experiences	Gender X Experiences	
Expectation as a conversation partner	F	52.189	.124	.015	1.239	1.330	.422	.842
	p	< .001	.725	.985	.290	.257	.656	.498
	η^2	.076	.000	.000	.002	.004	.001	.003
Expectation for togetherness	F	31.219	.047	.940	2.874	1.468	.737	.657
	p	< .001	.829	.391	.057	.210	.479	.622
	η^2	.048	.000	.001	.004	.005	.001	.002

Table 3: Numbers of Samples based on Gender, Age Groups, Experiences of Robots, and Hypothetical



Expectation as a conversation partner

Expectation for togetherness

Figure 2: Means and Standard Deviations of RERS Subscale Scores based on Hypothetical Situations

the three hypothetical situations. Negative attitude toward interaction with robots positively influenced these expectations only in the situations of the vacuum robot and pet-type robot.

Moreover, both expectations as a conversation partner and for togetherness were positively affected by emotional susceptibility in all the three hypothetical situations. Fantasy positively influenced these expectations only in the situations of the vacuum robot and pet-type robot. Other-oriented emotional reactivity positively affected only expectation for togetherness in the situation of the pet-type robot. Self-oriented emotional reactivity positively affected only expectation for togetherness in the situation of the robot instructor. Participants' age positively affected both expectations only in the situation of the pet-type robot.

DISCUSSION

Findings

The results of the survey based on hypothetical situation method revealed that expectations of rapport with robots were dependent on types of robots and application contexts, and were directly not affected by experiences of robots. These expectations were influenced by negative attitudes toward social influences of and emotional interaction with robots, and emotional sensitivity for others. Although negative attitude toward social influences of robots was affected by experiences of robots, this affection was weak. Thus, it was suggested that expectations of rapport with robots were mainly influenced by general attitudes toward robots and empathic characteristics, not related to experiences of robots.

The results of the survey also revealed that negative attitude toward interaction with robots, which was affected by experiences of robots, positively influenced rapport-expectation with the robots that had no function of utterances in the hypothetical situations. Moreover, the trend to imagine fantasy positively affected rapport-expectations with the robots that had communication functions in the hypothetical situations. They suggested that expectations of rapport with robots were influenced by different psychological factors dependent on robot types and application contexts.

Dependent variable	Independent variable	Vacuum robot			Pet-type robot			Robot instructor		
		β	t	p	β	t	p	β	t	p
Expectation as a conversation partner	NARS1	.343	6.451	.000	.131	2.305	.022			
	NARS2	-.201	-3.697	.000	-.159	-2.829	.005	-.207	-4.595	.000
	NARS3	-.337	-7.544	.000	-.332	-7.314	.000	-.347	-7.755	.000
	MES1									
	MES2									
	MES3	.143	3.211	.001	.179	3.783	.000	.111	2.495	.013
	MES4									
	MES5				.182	3.978	.000	.194	4.356	.000
	Age				.094	2.056	.040			
		$F(4,395) = 35.037$, $p < .001$, $R^2 = .254$			$F(6,393) = 20.466$, $p < .001$, $R^2 = .226$			$F(4,395) = 31.442$, $p < .001$, $R^2 = .234$		

Dependent variable	Independent variable	Vacuum robot			Pet-type robot			Robot instructor		
		β	t	p	β	t	p	β	t	p
Expectation for togetherness	NARS1	.271	4.954	.000	.137	2.365	.018			
	NARS2	-.141	-2.532	.012	-.203	-3.584	.000	-.274	-6.052	.000
	NARS3	-.339	-7.384	.000	-.345	-7.583	.000	-.320	-7.166	.000
	MES1				.088	1.870	.062			
	MES2							.091	1.864	.063
	MES3	.132	2.887	.004	.124	2.611	.009	.087	1.895	.059
	MES4									
	MES5				.104	2.190	.029	.142	3.003	.003
	Age				.138	2.986	.003			
		$F(4,395) = 28.006$, $p < .001$, $R^2 = .213$			$F(7,392) = 17.404$, $p < .001$, $R^2 = .223$			$F(5,394) = 25.771$, $p < .001$, $R^2 = .237$		

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

Table 4: Extracted Models in Linear Regression Analyses

Implications

The results of the survey imply that persons negative in influences of robots in the society and emotional bond with robots tend not to expect rapport with robots. This tendency is hard to be improved only by advertisement of robotics applications in daily life. In order to have these persons accept robotics applications, it is necessary to explain benefits and risks of the applications more politely.

The results of the survey also imply that persons not sensitive for others and not liking to image fantasy tend not to expect rapport with robots having communication functions. If these persons can accept robotics applications, it is estimated that robots as just tools are preferred.

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 differences between expectation as a communication partner and expectation for togetherness. 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 is evoked by a specific type of robot and application context. Thus, the future survey should adopt other types of stimuli such as videos.

ACKNOWLEDGMENTS

The research was supported in part by the Japan Society for the Promotion of Science, Grant–in–Aid for Scientific Research No. 25280095 and 25240042.

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