Influences of Experiences of Robots into Negative Attitudes toward Robots*

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***Abstract*— In order to investigate what type of experiences of robots influences negative attitudes toward them, an online survey (*N* = 1,200) was conducted in Japan, by using the Negative Attitudes toward Robots Scale (NARS). The results suggested that (1) there were almost no strong relationships between types of robot experiences and gender, and age, (2) the correlations between negative attitudes toward robots and age were low, (3) experiences of robots in real situations decreased negative attitudes toward interaction with and social influences of robots in comparison with experiences via media, and (4) negative attitudes toward emotional interaction with robots were not affected by these experiences.**

I. INTRODUCTION

Negative Attitudes toward Robots Scale (NARS) is a psychological scale to measure humans' attitudes toward robots, that is, psychological states reflecting opinions that people ordinarily have about robots [1]. Since the development of this scale, some research works have found influences of negative attitudes into human behaviors toward robots, and factors affecting these attitudes. Nomura et al. [2, 3] suggested through validation of the NARS that negative attitudes toward robots had some influences on communication avoidance behaviors of humans in interaction with robots. It was also suggested that experiences of robots decreased these negative attitudes [1]. Moreover, it was revealed that negative attitudes toward robots in Japanese samples were affected by gender and assumed types and tasks of robots [4]. Furthermore, Bartneck, et al., [5] suggested cultural differences on the NARS scores through an international comparative survey among seven different countries.

Recently, several studies using the NARS have revealed relationships between negative attitudes toward and perception of robots, and influential factors into the attitudes. Syrdal, et al., [6] suggested that negative attitudes toward robots affected human evaluation of robots with different behavior styles, while restructuring and validating the NARS for British samples. Nomura, et al., [7] suggested that negative attitudes toward emotional interaction with robots affected people's acceptance of assistive robots at home and service robots in public places. Weiss, et al., [8] found in their case study that experiences of interaction with a humanoid robot decreased participants' negative attitudes toward interaction with and the social influences of robots. Cramer, et al., [9] revealed interaction effects between positivity-negativity of attitudes toward robots and a robot's touch with humans on perceived human-likeness of the robot. Wang, et al., [10] found in their experiment of HRI that Chinese participants had more negative attitudes toward robots than did the USA, and relied less on the robot's advice. Riek, et al., [11] conducted an experiment to investigate effects of cooperative gestures of a humanoid robot, and suggested that participants' negative attitudes toward robots were strongly correlated with the participants' decreased ability in decoding human gestures. Furthermore, Tsui, et al., [12] validated the modified English version of the NARS via an online survey, and then applied the scale to measurement of attitudes toward telepresence robots in their experiment.

The existing research also suggested that these attitudes are affected by some factors such as gender, culture, experiences of robots, types of robots, and contexts where robots perform. Assuming that general republic's experiences of robots increase via media and real situations as robots widespread in the society, it is important to investigate how experiences of robots affect negative attitudes toward and social acceptance of robots. However, it is not clear what type of robot experiences influences these negative attitudes.

It was suggested that actual experiences of robots acting in a physical space decrease negative attitudes toward robots [1, 8]. Nomura, et. al., [13] found in their survey that the negative attitudes decreased as experiences of robots increased (actual experiences < experiences via media < no experience). On the other hand, the survey conducted by Halpern and Katz [14] reported that the exposure to specific types of robots did not affect participants' attitudes toward robots. In other words, it has still not been clarified in more details what type of robots and what way of experiences can affect negative attitudes toward robots.

In order to clarify types of robots and ways of experiences of them influencing negative attitudes into them more precisely, an online survey was conducted in Japan. The paper reports the results and discusses about their implications.

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TABLE I. SAMPLE NUMBERS BASED ON GENERATION AND GENDER

	20's	30's	40's	50's	Total
Male	150	150	150	150	600
Female	150	150	150	150	600
Total	300	300	300	300	1200

II. METHOD

A. Date and Participants

The survey was conducted at January, 2014. Respondents were recruited by a survey company at which about one million and thirty thousand Japanese persons have registered, via the Internet. The homepage of the online survey had been open from 17th to 20th, January, 2014, for these candidates. As a result, 1,200 persons participated to the survey. Table 1 shows the sample numbers based on generation and gender of the participants.

B. Survey Design

The questionnaire of the online survey consisted of the following items:

1) Experiences of robots:

Three-graded answer with "1. I have ever seen actual robots", "2. I have ever seen robots via mass media such as TV news and newspapers, although I have never seen actual ones." and "3. I have never seen robots".

2) Types of experienced robots:

Only in cases of 1 and 2 at the above item on experiences of robots. Three-graded answer with "1. Humanoid type", "2. Animal type", and "3. Others". Participants were asked to answer the most impressive type of robot in their experiences responded at the first item.

3) The Japanese version of the NARS:

14 items classified into three subscales: S1, "negative attitude toward interaction with robots" (six items); S2, "negative attitude toward the social influence of robots" (five items); and S3, "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 is calculated by adding the scores of all items included in the subscale, with some items reverse coded. Thus, the minimum and maximum scores are 6 and 30 for S1, 5 and 25 for S2, and 3 and 15 for S3, respectively.

In the survey, the questionnaire did not instruct the definition of robots, or include any photo and image of robots.

III. RESULTS

A. Experiences of Robots

Based on the answers for the items on experiences of robots, the participants were classified into the following groups:

TABLE II. SAMPLE NUMBERS BASED ON PARTICIPANT GROUPS AND GENDER ON EXPERIENCES OF ROBOTS, AND MEAN AGES

	ERH	ERO	EMH	EMO	NOE
Male	115	65	273	56	91
Female	81	44	291	61	123
Total	196	109	564	117	214
Mean age	40.1	39.9	41.0	36.0	37.4
SD	11.3	10.0	10.8	11.5	11.2

ERH: Participants who had actually seen humanoid-type robots

ERO: Participants who had actually seen other types of robots

EMH: Participants who had seen humanoid-type robots via media

EMO: Participants who had seen other types of robots via media

NOE: Participants who had never seen robots

- ERH: Participants who had actually seen humanoid-type robots (Male: $N = 115$, Female: $N = 81$)
- ERA: Participants who had actually seen animal-type robots (Male: $N = 14$, Female: $N = 29$)
- ERO: Participants who had actually seen other types of robots (Male: $N = 51$, Female: $N = 15$)
- EMH: Participants who had seen humanoid-type robots via media (Male: $N = 273$, Female: $N = 291$)
- EMA: Participants who had seen animal-type robots via media (Male: $N = 31$, Female: $N = 47$)
- EMO: Participants who had seen other types of robots via media (Male: $N = 25$, Female: $N = 14$)
- NOE: Participants who had never seen robots (Male: $N = 91$, Female: $N = 123$)

The estimated interval with 99.9% confidence of the population rate in which actual humanoid-type robots had been experienced was [13.0%, 20.1%]. Moreover, the estimated interval with 99.9% confidence of the population rate in which humanoid-type robots had been experienced in real situations or via media was [58.6%, 67.9%], and showed an extreme bias in robot experiences. To reduce influences of the sample biases in analyses, the groups of participants who had actually seen animal-type (ERA) or other types of robots (ERO) were integrated into one group of participants who had actually seen non-humanoid-type robots (ERO). In the same way, the groups of participants who had seen animal-type (EMA) or other types of robots via media (EMO) were integrated into one group of participants who had seen non-humanoid-type robots via media (EMO). Table 2 shows the sample numbers based on these participant groups and gender, and mean ages in the participant groups.

A χ^2-test found a gender bias in the participant groups, although the effect was small ($\chi^2(4) = 15.517$, $p = .004$, Cramer's $V = .114$). An ANOVA with the groups X gender for ages found only the main effect of the groups having a weak effect size (F(4,

1190) = 8.206, $p < .001$, $\eta^2 = .027$).

B. NARS Subscale Scores

Cronbach's α-coefficients were .873 for "negative attitude toward interaction with robots", .798 for "negative attitude toward the social influence of robots", and .753 for "negative attitude toward emotional interaction with robots", respectively. These values showed the sufficient internal consistencies of these NARS subscales.

Table 3 shows Pearson's correlation coefficients between the NARS subscale scores and participants' ages. It was revealed that the correlations between the ages and subscale scores were low. Moreover, there was no gender difference on these correlations.

For each of the NARS subscale scores, a univariate ANOVA with robot experience groups X gender was conducted. Table 4 shows the results of the ANOVAs including the effect sizes, and post-hoc analyses with Bonferroni's method ($\alpha = .05$). Moreover, Figure 1 shows means and standard deviations of these scores.

There was a statistically significant main effect of the robot experience groups on negative attitude toward interaction with robots, having a moderate level of effect size. The post-hoc analysis revealed that the participants who had never seen robots had higher negative attitude toward interaction with robots than did the participants in the other groups, the participants who had actually seen non-humanoid-type robots had lower negative attitude than did the participants who had seen robots via media, and the participants who had actually seen humanoid-type robots had lower negative attitude than did the participants who had seen other types of robots via media.

On attitude toward interaction with robots, the interaction effect was also at a statistically significant level, although the effect size was small. A simple main effect test with Bonferroni's method ($\alpha = .05$) found that there was a gender difference only in the participants who had seen humanoid-type robots via media. In the male participants, there were statistically significant differences only between the participants who had never seen robots and other participant groups (ERH, ERO, EMH, ERO < NOE). In the female participants, there were more differences between the groups (ERH, ERO, EMH < NOE; ERH < EMH; ERO < EMH, EMO).

On attitudes toward social influences of robots, there were statistically significant main effects of robot experience groups

TABLE III. PEARSON'S CORRELATION COEFFICIENTS BETWEEN THE NARS SUBSCALE SCORES AND PARTICIPANTS' AGES

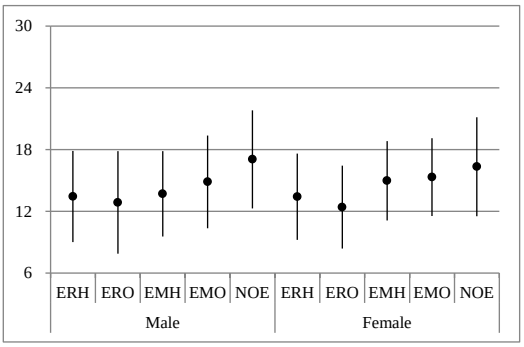
		S1	**S2**	**S3**
Age	Male	-.077	-.072	-.012
	Female	-.046	-.151**	.003
	Complete	-.063*	-.112**	-.005
S1	Male	-	.566**	-.062
	Female	-	.549**	-.048
	Complete	-	.562**	-.053
S2	Male	-	-	.113**
	Female	-	-	.136**
	Complete	-	-	.127**

(*$p < .05$, **$p < .01$)

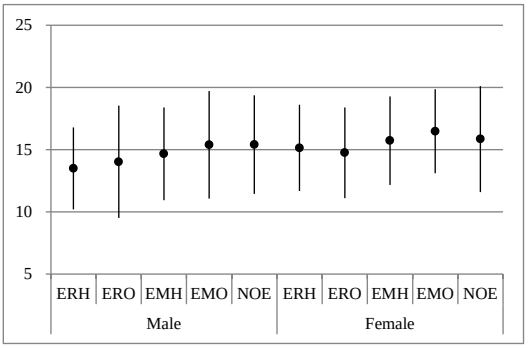
S1: Negative attitude toward interaction with robots

S2: Negative attitude toward social influences of robots

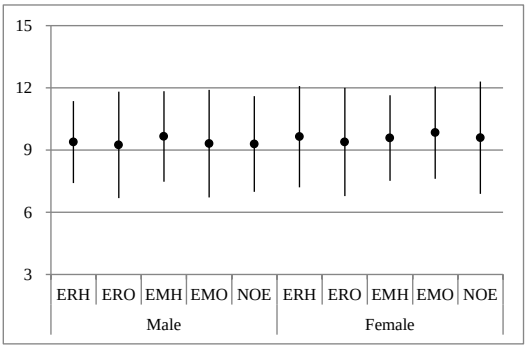
S3: Negative attitude toward emotional interaction with robots



Negative attitude toward interaction with robots



Negative attitude toward social influences of robots



Negative attitude toward emotional interaction with robots

ERH: Participants who had actually seen humanoid-type robots

ERO: Participants who had actually seen other types of robots

EMH: Participants who had seen humanoid-type robots via media

EMO: Participants who had seen other types of robots via media

NOE: Participants who had never seen robots

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

TABLE IV. RESULTS OF ANOVAS FOR NARS SUBSCALE SCORES

	Gender		Experience		Interaction		Post-hoc
	F	η^2	F	η^2	F	η^2	
S1	.140	.000	22.460***	.069	2.695*	.008	ERH, ERO, EMH, EMO < NOE; ERO < EMH, EMO; ERH < EMO
S2	14.510***	.012	5.547***	.018	.679	.002	ERH < EMH, EMO, NOE; ERO < EMO, NOE
S3	2.178	.002	.515	.002	.628	.002	

(*p < .05, ***p < .001)

S1: Negative attitude toward interaction with robots, S2: Negative attitude toward social influences of robots, S3: Negative attitude toward emotional interaction with robots

ERH: Participants who had actually seen humanoid-type robots, ERO: Participants who had actually seen other types of robots,

EMH: Participants who had seen humanoid-type robots via media, EMO: Participants who had seen other types of robots via media, NOE: Participants who had never seen robots

and gender, of which effect sizes were small. The post-hoc analysis revealed that the participants who had never seen robots had higher negative attitude toward social influences of robots than did the participants who had actually seen robots, the participants who had actually seen humanoid-type robots had lower negative attitudes than did the participants who had seen robots via media, and those who had actually seen other types of robots had lower negative attitudes than did those who had seen other types of robots via media.

There was neither main nor interaction effect on negative attitudes toward emotional interaction with robots.

IV. DISCUSSION

A. Findings

In the same way as suggested by Nomura, et al., [13], the survey results found that experiences of robots decreased some negative attitudes toward robots. Actual experiences of robots more decreased negative attitudes toward interaction with and social influences of robots in comparison with experiences of robots via media, although experiences via media also had an influence into the attitudes. On the other hand, types of the experienced robots had no concrete effect on the attitudes toward robots. Moreover, negative attitude toward emotional interaction with robots was not affected by experiences of robots.

The survey results also found that age and gender had no strong effect on the attitudes. Moreover, there was no strong relationship between experiences of robot and these factors. The results of interval estimation suggested the possibility that more than half of persons in Japan experienced humanoid-type robots in real situations or via media.

B. Implications

As robots widespread in the society, it is assumed that general republic's experiences of robots increase via media and real situations. In fact, the research suggested that many people in Japan have experienced robots in their lives. Negative attitudes toward interaction with robots mean a predisposition to behave or react negatively toward interaction with robots having functions of communication with humans. Moreover, negative attitudes toward social influences of robots mean a predisposition to behave or react negatively toward influences of advanced robotics technologies into human societies. The survey results imply that these attitudes may be reduced as robots widespread. In particular, the appearance of robots in daily life situations may encourage the reduction of the negative attitudes, almost independent on generations and gender.

On the other hand, the survey results imply that negative attitudes toward emotional interaction with robots may not be reduced even if robots are experienced in the current manner. Negative attitudes toward emotional interaction with robots mean a negative predisposition for humans' and robots' expression of their emotions in interaction between them. Although the survey did not take into account, it is estimated that the quality of experiences of robots such as duration and contexts influences this type of attitude. In the current manner, experiences of robots may basically been in short-term. However, rapport or emotional bond between humans and robots may be constructed in long-term duration under specific contexts. Thus, the reduction of this type of attitude will require more time in comparison with the other two types of attitudes toward robots.

C. Limitations

The survey did not take into account some issues. First, the definition or conceptual image of robots was not instructed for the participants. Thus, individual differences on envision of robots may influence the results. Second, it did not ask for the participants to answer contexts where they experienced robots. Thus, the quality of experiences of robots is not considered, although it is mentioned in the previous section. Third, the survey limited the classification of robot types to humanoids or non-humanoids due to the bias to humanoid types in the respondents' experiences of robots. Thus, it does not reflect the previous classification of robots based on functionality [15] or contexts [16].

Moreover, the survey focused on gender, age, and experiences of robots, and did not deal with educational backgrounds of the participants, that is, whether the participants

had been educated in natural sciences and technologies, or other fields. Nomura, et al., [13] suggested that this factor had interaction effects with experiences. Furthermore, sampling in the survey was limited to the Japanese, and cultural dependence (for example, [5, 10]) is not considered.

The above problems should be tackled in the next survey or experiment. In addition, we should develop another method to complement the NARS in investigating influential factors into negative attitude toward emotional interaction with robots, such as semi-structured interview, implicit association tests [17], and another psychological scale measuring rapport between humans and robots [18].

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