Altered Attitudes of People toward Robots: Investigation through the Negative Attitudes toward Robots Scale *

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Abstract

It is important to measure what images, opinions, and attitudes people have developed toward robots and how they can be changed, from scientific and engineering perspectives. This paper reports results of social research on Japanese people's attitudes toward robots by using "the Negative Attitudes toward Robots Scale (NARS)." They revealed that attitudes toward robots differ depending on assumptions about robots such as their type and task, and there may be gender differences associated with them. Based on the results, the paper then discusses how people's attitudes toward robots can be altered.

Introduction

It is known that the concept of "robots" itself is very old. However, it is only recently that they have appeared as commercialized products in daily life. This fact implies that the concept of robots itself or mental images of robots may be changed. Thus, it is important to determine what images, opinions, and attitudes people have had toward robots and how they can be altered, from scientific and engineering perspectives such as design issues and market research on robots.

Regarding the measurement of human mental images and impressions toward robots, there are plenty of published studies. Shibata, Wada, & Tanie (2002; 2003; 2004) reported international research results on people's subjective evaluations of a seal–type robot they developed, called Palo, in several countries including Japan, the U.K, Sweden, Italy, and Korea. Their results revealed that there were differences in subjective evaluations of the robot among genders and ages, and that nationality also affected the evaluation factors. Friedman, Kahn, & Hagman (2003) investigated people's relationships with robotic pets by analyzing more than 6,000 postings in online discussion forums about one of the most advanced robotic pets currently on the retail market, Sony's robotic dog AIBO. Furthermore, Kahn *et al.* (2004) examined preschool children's reasoning about and behavioral interactions with AIBO. Their important suggestion is that people in general, and children in particular, may fall prey to accepting robotic pets without the moral responsibilities that real, reciprocal companionship and cooperation involves. In addition, Nomura *et al.* (2005b) reported the results of social research on visitors to an exhibition of communication robots, called "Robovie" (Ishiguro *et al.* 2001), suggesting that even in Japan, younger generations do not necessarily like the robots more than do elder generations. These studies are focused on specific commercialized robots.

On the other hand, some studies examined more general images independent of specific robots. Suzuki *et al.* (2002) developed a psychological scale for measuring humans' mental images toward robots, while Kashibuchi *et al.* (2002) showed by using this scale that humans' mental images toward robots are positioned in the middle of a one–dimensional scale, where one pole corresponds to humans and another pole corresponds to just physical objects. Woods & Dautenhahn (2005) investigated the difference in relations of robots' appearances to emotions toward them between children and adults, using a questionnaire–based method and photographs of several robots. In addition, Bartneck *et al.* (2005b; 2005a) reported the influences of cultural differences and personal experiences with robots into attitudes toward robots by using a psychological scale measuring negative attitudes toward robots, "the Negative Attitudes toward Robots Scale (NARS)" developed by Nomura, Kanda, & Suzuki (2006).

This paper also reports results of social research on people's attitudes toward robots by using the above psychological scale NARS. The focus of this research is on relationships between negative attitudes toward and assumptions about robots such as their types and tasks (Nomura *et al.* 2005a). Based on the results, we discuss how people's attitudes toward robots can be altered.

Attitudes toward Robots

Psychological Concept of Attitudes and Robots

An attitude is psychologically defined as a relatively stable and enduring predisposition to behave or react in a certain way toward persons, objects, institutions, or issues, and the source is cultural, familial, and personal (Chaplin 1991). This definition of attitudes implies that they can be affected

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Table 1: The English Version of Negative Attitude toward Robots Scale and the Subscales that Each Item Is Included

Item No.	Questionnaire Items	Subcale
1	I would feel uneasy if robots really had emotions.	**S2**
2	Something bad might happen if robots developed into living beings.	**S2**
3	I would feel relaxed talking with robots.*	**S3**
4	I would feel uneasy if I was given a job where I had to use robots.	**S1**
5	If robots had emotions, I would be able to make friends with them.*	**S3**
6	I feel comforted being with robots that have emotions.*	**S3**
7	The word “robot” means nothing to me.	**S1**
8	I would feel nervous operating a robot in front of other people.	**S1**
9	I would hate the idea that robots or artificial intelligences were making judgments about things.	**S1**
10	I would feel very nervous just standing in front of a robot.	**S1**
11	I feel that if I depend on robots too much, something bad might happen.	**S2**
12	I would feel paranoid talking with a robot.	**S1**
13	I am concerned that robots would be a bad influence on children.	**S2**
14	I feel that in the future society will be dominated by robots.	**S2**

(*Reverse Item)

by cultural backgrounds and personal experiences. Moreover, the classical psychological theory suggests that they can be changed based on mental congruity (Osgood & Tannenbaum 1955; Newcomb 1953; Heider 1958). These facts imply that attitudes toward robots can be altered by some factors including cultural backgrounds and personal experiences.

Bartneck *et al.* (2005b; 2005a) suggested that cultures may influence attitudes toward robots. Moreover, Nomura, Kanda, & Suzuki (2006) suggested the influence of personal experiences with robots on attitudes toward them, such as individuals' experiences on really acting robots. However, these studies lack perspective on what types and tasks of robots people assume. It is considered that attitudes toward robots can more directly be influenced by assumptions about robots than by cultures and personal experiences, although these assumptions can be affected by cultures and personal experiences. Thus, we should focus on assumptions about robots to investigate alternation of attitudes toward robots. These assumptions can be altered by cultural situations such as media, and their distribution can affect that of attitudes toward robots. Of course, cultural differences can produce differences in attitudes toward one specific type of robot such as humanoids, as Kaplan (2004) mentioned. Thus, we can consider several types of differences in attitude toward robots as follows:

- Differences in attitudes between different assumptions about robots in one culture.
- Differences in attitudes toward one specific type of robot between different cultures.
- Differences in assumptions about robots and their relationship to attitudes toward robots between different cultures.

As mentioned above, Bartneck *et al.* (2005b; 2005a) suggested the possibility of there being cultural differences in attitudes toward robots. This paper deals with the first issue in the above list.

Negative Attitudes toward Robots Scale

As one of the measurement tools, in this paper we use the Negative Attitude toward Robots Scale (NARS) to measure people's attitudes toward robots through social research. This scale was developed to determine humans' attitudes toward robots, and its internal consistency, factorial validity, and test–retest reliability have been confirmed based on Japanese respondents (Nomura, Kanda, & Suzuki 2006). As mentioned above, the research by Bartneck *et al.* (2005b; 2005a) was based on this psychological scale.

This scale consists of fourteen questionnaire items. Table 1 shows the English version of the NARS, which was translated using back–translation. These items are classified into three subscales, **S1**: “Negative Attitude toward Situations of Interaction with Robots” (six items), **S2**: “Negative Attitude toward Social Influence of Robots” (five items), and **S3**: “Negative Attitude toward Emotions in Interaction with Robots” (three items). The number of grades for each item is five (1: I strongly disagree, 2: I disagree, 3: Undecided, 4: I agree, 5: I strongly agree), and an individual's score on each subscale is calculated by summing the scores of all the items included in the subscale, with the reverse of scores in some items. Thus, the minimum and maximum scores are 6 and 30 in **S1**, 5 and 25 in **S2**, and 3 and 15 in **S3**, respectively.

Social Research

To investigate the differences in attitudes between assumptions about robots in one culture, we administered the following social research.

Method

The social research was administered from November 2005 to March 2006. The participants were Japanese university and special training school students. The Japanese version of the NARS was administered during lecture time. Participation by the respondents was voluntary.

The face sheet used in administering this survey included items that asked respondents to answer which type of robots

Table 2: The Number of Respondents Who Selected Each Robot Type and Task

Robot Type		Robot Task 1	2	3	4	5	6	7	8	9	10	11	Total
1	N	53	8	0	5	9	19	26	11	30	31	4	196
	ϕ	.255***	.059	-.088	.000	-.024	-.072	.001	.148**	-.162**	-.028	-.094	
2	N	12	1	1	3	0	2	9	1	21	20	3	73
	ϕ	-.012	-.047	.033	.047	-.111*	-.137**	-.014	-.047	.078	.135*	.007	
3	N	1	2	1	0	5	23	13	0	5	10	1	61
	ϕ	-.179***	.005	.043	-.070	.060	.340***	.101	-.077	-.143**	-.006	-.049	
4	N	0	0	0	1	0	2	1	0	21	1	1	27
	ϕ	-.125**	-.048	-.024	.020	-.063	-.039	-.077	-.048	.367***	-.096	-.002	
5	N	0	1	1	0	2	0	1	0	0	0	0	5
	ϕ	-.052	.112	.251*	-.018	.180*	-.042	-.022	-.020	-.060	-.051	-.023	
6	N	0	0	0	0	4	1	1	0	0	1	0	7
	ϕ	-.062	-.024	-.012	-.022	.319***	.009	.004	-.024	-.072	-.009	-.027	
7	N	2	0	0	1	0	0	1	0	9	3	6	22
	ϕ	-.053	-.043	-.021	.031	-.057	-.090	-.063	-.043	.111*	-.021	.298***	
Total	N	68	12	3	10	20	47	52	12	86	66	15	391

Robot Type: 1: human–size humanoids, 2: small–size humanoids, 3: acting huge objects, 4: animals, 5: stationary objects, 6: arm manipulators, 7: others

Robot Task: 1: housework, 2: office work, 3: public service such as education, 4: medical or welfare service, 5: construction or assembling tasks, 6: guard or battle,

Robot Type: 7: tasks in places hard for humans to go or hazardous locations such as the space and the deep sea, 8: the service trade, 9: communication partners or playmates, 10: amusement, 11: others

(Correlation Coefficients: ϕ–Coefficients, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$, p–Values: Results by Fisher's Method)

they assumed and which tasks they assumed the selected robots do. The choices for the former item were: 1: human–size humanoids, 2: small–size humanoids, 3: acting huge objects, 4: animals, 5: stationary objects, 6: arm manipulators, and 7: others. The choices for the latter item were: 1: housework, 2: office work, 3: public service such as education, 4: medical or welfare service, 5: construction or assembling tasks, 6: guard or battle, 7: tasks in places hard for humans to go or hazardous locations such as the space and the deep sea, 8: the service trade, 9: communication partners or playmates, 10: amusement, 11: others. These choices were determined based on the pilot study by Nomura *et al.* (2005a).

In addition to the above face sheet and the NARS, two psychological scales were administered to investigate relationships between attitudes toward robots and personal traits. One is the State–Trait Anxiety Inventory (STAI), which is used for measuring general anxiety (Spielberger, Gorsuch, & Lushene 1970). The emotion of anxiety is generally classified into two categories: state and trait anxiety. Trait anxiety is a trend of anxiety as a characteristic stable in individuals whereas state anxiety is an anxiety transiently evoked in specific situations and changed depending on the situation and time. STAT consists of twenty items for measuring state anxiety (STAI–S) and twenty items for measuring trait anxiety (STAI–T).

The other scale is the Report of Communication Apprehension (PRCA–24) (Pribyl *et al.* 1998). PRCA–24 measures communication apprehension in four contexts: public speaking, meetings, small–group discussion, and dyads. Each context corresponds to six items. In this administration, only six items corresponding to dyads were used to investigate their relationships with the NARS subscales directly related to interaction with robots (**S1** and **S3**).

Results

A total of 400 people (male: 197; female: 199; unknown: 4; mean age: 21.4) participated in the research. For the 374 samples that had no missing item in the NARS, Cronbach's α denoting reliability were 0.756 for **S1**, 0.647 for **S2**, and 0.735 for **S3** respectively. The sample data were analyzed in the following three ways:

Relations between Assumptions about Robot Types and Tasks: First, we calculated how many respondents selected each robot type and task with respect to the assumptions about robots. Then, to find relations between specific assumptions about types and tasks, ϕ–coefficients were calculated to reveal the extent of relationships between the assumption choices. In addition, we performed statistical tests with Fisher's method on selection for pairs of choices to investigate the statistical significance of these ϕ–coefficients, based on the independence among these choices. [1]

Table 2 shows the number of respondents who selected each robot type and task, and the correlations between robot types and tasks. Regarding assumptions about robot type, about 50% of the respondents selected "human–size humanoids." The humanoid type, including small–size ones, was selected by about 70% of the respondents, while the selection rate for "animals" was about 7%. The respondents who selected "others" tended to mention concrete names of

[1] For example, to investigate the correlation between "small–size humanoids" and "amusement,", one 2 $\times$ 2 cross table consisting of selection/no–selection of "small-size humanoids" and "amusement" was made, then the ϕ–coefficient was calculated and a test was done for this cross table.

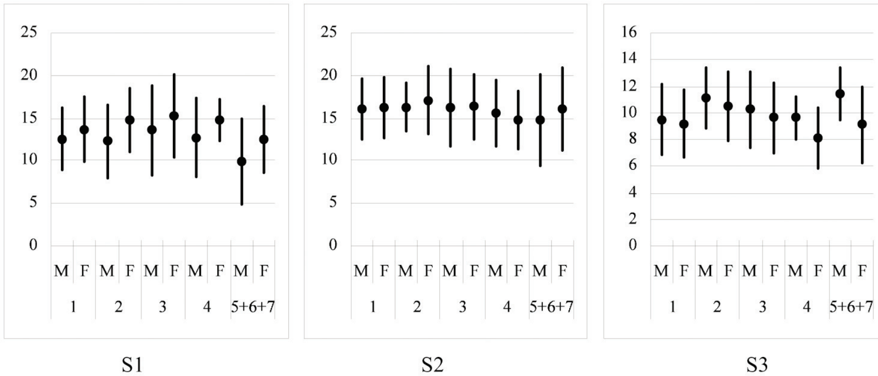

Figure 1: Means and Standard Deviations of NARS Subscale Scores based on Gender and Robot Type Subgroups (Type 1: Male $N = 92$, Female $N = 89$, 2: Male $N = 27$, Female $N = 46$, 3: Male $N = 34$, Female $N = 21$, 4: Male $N = 13$, Female $N = 13$, 5+6+7: Male $N = 16$, Female $N = 17$)

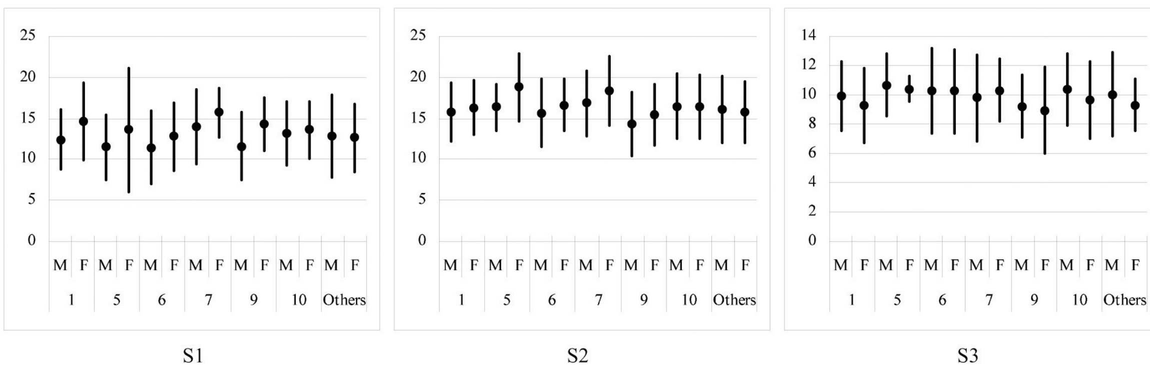

Figure 2: Means and Standard Deviations of NARS Subscale Scores based on Gender and Robot Task Subgroups (Task 1: Male $N = 30$, Female $N = 33$, 5: Male $N = 12$, Female $N = 5$, 6: Male $N = 27$, Female $N = 16$, 7: Male $N = 28$, Female $N = 19$, 9: Male $N = 22$, Female $N = 59$, 10: Male $N = 28$, Female $N = 34$, Others (2+3+4+8+11): Male $N = 31$, Female $N = 18$)

some robots appearing in the media, such as "Doraemon" and "Asimo" in their written answers.

Regarding assumptions about robot tasks, there was no bias of respondents toward a specific task; the selection rates for "housework," "communication partner or playmates," and "amusement" varied from 16% and 22%. The selection rates for "guard or battle," and "tasks in places hard for humans to go or hazardous locations" were about 12–13%. Few respondents selected "public service such as education." The respondents who selected "others" tended not to mention concrete tasks in their writtten answers.

Regarding relations between robot type and task, there was a moderate level of positive correlation between "acting huge objects" and "guard or battle," between "animals" and "communication partners or playmates," between "arm manipulators" and "construction or assembling tasks," and between "others" and "others." Moreover, there was a low level of positive correlation between "human–size humanoids" and "housework," between "human–size humanoids" and "the service trade," between "small–size humanoids" and "amusement,", between "stationary objects" and "public service such as education," between "stationary objects" and "construction or assembling tasks," and "others" and "communication partners or playmates." In addition, there was a low level of negative correlation between "human–size humanoids" and "communication partners or playmates," between "small–size humanoids" and "construction or assembling tasks", between "small-size humanoids" and "guard or battle," between "huge acting objects" and "housework," between "huge acting objects" and "communication partners or playmates," and between "animals" and "housework."

Relations of Gender and Assumptions about Robots with Attitudes toward Robots: Second, to investigate the relations between attitudes toward and assumptions about robots, two–way ANOVAs were executed with the independent variables of gender and robot type, and variables of gender and robot task, respectively [2]. In this analysis, the subgroups of respondents who selected "stationary objects," "arm manipulators," and "others" were integrated into one subgroup due to their small numbers of respondents and correlations with robot tasks. Furthermore, the subgroups of respondents who selected "office work," "public service such as education," "medical or welfare service," "the service trade," and "others" were integrated into one subgroup, due to their small numbers of respondents, correlations with robot type, and the similarity of their contents.

Figures 1 and 2 illustrate the means and standard deviations of the scores of the NARS subscales based on gender and robot type subgroups, and based on gender and robot task subgroups, respectively. In addition, Table 3 shows the F–values in the two ANOVAs for the NARS subscale scores.

For the ANOVA of gender and robot type, there were statistically significant effects regarding both gender and robot type on the scores of **S1** and **S3**, although there was no interaction effects. It was revealed that the female respondents had more pronounced negative attitudes toward situations of interaction with robots and lower negative attitudes toward emotions in interaction with robots, than the male respondents. Moreover, the post–hoc tests with Tukey's method revealed with a 5% significance level that the respondents in the subgroups of "small–size humanoids" and "huge acting objects" had stronger negative attitudes toward situations of interaction with robots than those in the integrated subgroup consisting of "stationary objects," "arm manipulators," and "others." In addition, they also revealed that the respondents in the subgroup of "small–size humanoids" had more pronounced negative attitudes toward emotions in interaction with robots than those in the subgroups of "human–size humanoids" and "animals." There were no statistically significant effects of gender, robot type, or interaction in **S2**, negative attitude toward the social influence of robots.

For the ANOVA of gender and task type, there was a statistically significant effect of task type on the scores of **S2**. The post–hoc tests with Tukey's method revealed with a 5% significance level that the respondents in the subgroup of "tasks in places hard for humans to go or hazardous locations" had stronger negative attitudes toward the social influence of robots than those in the subgroup of "communication partner or playmates." Moreover, there were statistically significant trends regarding task type in **S1** and gender in **S2**.

Correlations between NARS, STAI, PRCA–24: Third, to investigate the relations between attitudes toward robots, general anxiety, and communication apprehension, we calculated Peason's correlation coefficients r between the NARS subscales, STAI, and PRCA–24. Since there is a possibility of gender difference with respect to anxiety and communication apprehension, this calculation was done for each gender subgroup.

Table 4 displays these coefficients. The table reveals that there was a moderate level of correlations among **S1**, STAI–S, and STAI–T for the female respondents, although that for the male respondents was low. Moreover, it also reveals that there was a low level of correlation among **S1**, **S2**, and PRCA–24, although there was no such correlation for the male respondents. There was no correlation among **S3**, STAI, and PRCA–24.

[2] No ANOVAs with robot type and task were conducted due to the existence of cells in which the number of respondents was zero.

Table 3: F–Values in the Two ANOVAs for the Scores of NARS Subscales

	Gender	Robot Type	Interaction
S1	13.910^{***}	3.386^{*}	0.498
S2	0.420	1.063	0.361
S3	10.237^{**}	5.406^{***}	1.285
	Gender	Robot Task	Interaction
S1	8.460^{**}	$1.899^{\dagger}$	0.875
S2	$3.576^{\dagger}$	2.774^{*}	0.543
S3	0.914	1.421	0.360

($^{\dagger}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$)

Table 4: Peason's Correlation Coefficients r between NARS Subscales, STAI, and PRCA–24

			PRCA–24	STAI–S	STAI–T
S1	Male	r	0.008	0.181^{*}	0.185^{*}
		N	160	171	171
	Female	r	0.160^{*}	0.333^{***}	0.282^{***}
		N	176	182	183
S2	Male	r	0.041	0.043	0.092
		N	160	171	171
	Female	r	0.166^{*}	0.106	0.136
		N	176	182	183
S3	Male	r	-0.020	-0.076	-0.135
		N	160	171	171
	Female	r	0.138	0.102	-0.092
		N	176	182	183

($^{*}p < .05$, $^{***}p < .001$)

Discussion

The results of the social research mentioned in the previous section are based on Japanese respondents, that is, on one specific culture. Here, we carefully discuss the results' implications, separating those limited to Japanese culture from results that may be generalized to other cultures, particularly those related to alternation of attitudes toward robots.

Implications from the Social Research Results

The results for assumptions about robot type suggest a bias of respondents toward humanoid–type robots. On the other hand, ϕ–coefficients between this type and assumptions about robot tasks suggest that "humanoid robots" were not strongly related to specific tasks. Moreover, the correlations between "acting huge objects" and "guard or battle," between "animals" and "communication partners or playmates," and between "arm manipulators" and "construction or assembling tasks" suggest conservative images of robots that have been reconstructed via the media. This trend is similar to the results by Nomura *et al.* (2005a). These suggestions imply that more Japanese people are more biased toward humanoid–type robots than other types, but are unclear about what tasks this type of robot does.

The results of the ANOVAs for the NARS subscale scores suggest that there the respondents assuming "small–size humanoids" and "acting huge objects" had more pronounced negative attitudes toward interaction with robots than those assuming "stationary objects," "arm manipulators," and "others." We assume that the robot types "stationary objects," "arm manipulators," and "others" lead people to have conservative images of robots, such as being big computer, industrial robots, and animated robots. Thus, this suggestion implies that novel types of robots or robots related to battle evoke negative attitudes toward human interaction with robots.

Moreover, the results of the ANOVAs suggest that the respondents assuming "small–size humanoids" had stronger negative attitudes toward emotions in interaction with robots than those assuming "human–size humanoids" and "animals." This implies that emotional reactions toward robots are different between robot types, depending on interaction effects between design and size.

In addition, the results of the ANOVA suggest that the respondents assuming "tasks in places hard for humans to go or hazardous locations" were more negative toward the social influence of robots than those assuming "communication partner or playmates." We estimate that the image of danger in the former task assumption evoked negative attitudes toward the social influence of robots performing such tasks.

The ANOVA results also suggest that the female respondents had more pronounced negative attitudes toward interaction with robots and less negative attitudes toward emotions in interaction with robots than did the male respondents. Furthermore, the correlation coefficients among the NARS, STAI, and PRCA–24 suggest that there is also a gender difference regarding relations between negative attitudes toward robots and personal traits related to anxiety. This suggestion implies that there is a gender difference in attitudes toward robots, depending on which factor we focuse on in interaction with robots, and gender–based difference in their relations to some personal traits.

On the other hand, the correlation coefficients between the NARS subscales and PRCA–24 suggest that there is a low level of correlation between attitudes toward robots and communication apprehension as a personal trait related to interaction. This suggestion is consistent with the experimental results by Nomura, Kanda, & Suzuki (2006), in which there was only a low level of correlation between negative attitudes and communication avoidance behaviors toward robots. This implies that attitudes toward robots are not directly connected to personal communication traits at the present, since robots such as humanoids are not yet widespread in daily life and images of their tasks are not yet fixed.

Implications about Alternation of Attitudes toward Robots

Although the implications outlined in the previous section should be limited to Japanese culture in a strict sense, we can extend our discussion to other cultures to some extent. While bias toward and relations between certain assumptions about robots may be specific to each culture, what is important is that attitudes toward robots may depend on specific assumptions dominant in a given culture. In other words, if the dominant assumptions about robots are changed, the whole trend of attitudes toward robots can be altered in that culture. This may be caused by commercialization of really acting robots and media information about them.

Joinson (2002) pointed out that people tend to have either extremely positive or extremely negative attitudes toward novel technologies. As mentioned in the previous section, people may have negative attitudes toward robots unfamiliar to their culture, but as information about robots spreads, their assumptions may change and attitudes toward them may also alter.

An important problem is that gender differences may affect the alteration of attitudes toward robots. If there are currently gender differences in attitudes toward robots and their relations to some personal traits in a culture, as implied in the previous section, these differences may affect the nature of attitude change toward robots; for example, males may develop more positive attitudes toward humanoids whereas females in the same culture may come to have more negative attitudes toward them. Of course, the trend of attitude change may depend on the cultures.

Furthermore, it is not clear which personal trait affects attitude change toward robots. Although currently there may be no strong relation between attitudes toward robots and communication apprehension in a given culture, as implied in the previous section, the increasing ability of robots, in particular those related to communication, can change assumptions about robots, and as a result can change the connection between attitudes toward robots and personal traits related to communication.

The above discussion merely focuses on a possibility. To investigate it further, we should explore the psychological relationships between assumptions about robots, attitudes toward robots, and concrete emotions evoked in interaction with robots in more detail (Nomura *et al.* 2004). Moreover, we need to investigate cultural differences in assumptions about robots.

Summary

This paper reported the results of a social research project on people's attitudes toward robots by using the Negative Attitudes toward Robots Scale. The results revealed that attitudes toward robots are different depending on assumptions about robots, and there may be gender differences associated with them. Based on these results, we discussed the possibility of attitude changes toward robots, including the influence of the changing ability and commercialization of robots, media information about them, and personal traits.

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