Exploring Effects of Educational Backgrounds and Gender in Human-Robot Interaction

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Abstract—**Recent Human-Robot Interaction (HRI) research has focused on human factors. To deepen the exploration of human factors in HRI, research has also investigated humans' educational backgrounds and gender, and the gender assignment of robots. In a psychological experiment, robot gender was assigned only by the name of the robot and a brief verbal instruction by the experimenters. The results showed that subjects with educational backgrounds of natural science and technology had stronger impressions toward the robot than did those of a social science background. Additionally, the perceived robot femininity and one of the impressions positively influenced the recall task scores of the robot's utterances, in particular in male samples.**

Keywords - ***robot; educational backgrounds; gender***

I. INTRODUCTION

Robots that are able to communicate with humans in daily life (i.e., communication robots) are expected to be utilized in many fields. The research of human-robot interaction (HRI) has primarily been exploring influential factors in robots and situations, such as cooperative behaviors [1], embodiment [2], matching between appearances and tasks [3], and task structures [4]. Recent HRI research has also focused on human factors.

As one negative psychological trait, it was suggested that the attitude and anxiety toward robots influenced human behaviors toward robots [5]. Moreover, it was also suggested that educational background, prior experience with robots, and gender affect these psychological constructs [6], [7]. Another study suggested differences due to human gender on the feelings and behaviors toward robots [8]. Some studies found interaction effects between human factors and robot factors, such as those between the human and the robot gender with respect to feelings and behaviors toward robots [9], [10] and between human gender and the structures of tasks that humans perform with robots [4]. Other studies suggest the existence of age differences [11], [12] and cultural differences [13]-[15] on the acceptance of robots.

The above studies suggest many human factors and their interaction effects on other factors in HRI. To advance the exploration of human factors in HRI, this research focused on educational backgrounds and gender since they are considered to be more fixed than prior experience with robots and negative psychological traits such as anxiety toward robots. On exploring the effects of these human factors in HRI, the gender assigned to robots should be taken into account as one of the robot factors having possible interaction effects on the human factors. In fact, both the research of interaction between humans and artificial agents and HRI suggest the effects of gender assignment on humans [16]-[18], and some HRI studies also found interaction effects due to the human gender and the robot gender [9], [10].

To explore the effects of educational backgrounds and gender on the interaction with robots, a psychological experiment was conducted in Japan as a case study. This paper reports the results of the experiment and discusses the implications from the design perspective of HRI.

II. METHOD

To investigate the effects of human and robot factors and their interaction effects preliminarily, an experiment was conducted to measure and analyze human cognition and feelings toward a robot under the condition in which the robot was labeled as a male or a female. The research questions in the experiment were as follows:

(i) How can human educational background, human gender, and robot gender influence the cognition and feelings toward the robot?

(ii) How can these factors have interaction effects?

The experiment was conducted with a 2 x 2 x 2 between-subject design of the subjects' educational backgrounds, the robot gender and the human gender.

A. Subjects

The experiment was conducted from November to December, 2010. A total of thirty-nine subjects participated to the experiment (male: 17, female: 22, natural science and technology education: 13, social science education: 26). The subjects were university students in the western part of Japan and received one-thousand yen as compensation.

The research was supported in part by the Japan Society for the Promotion of Science, Grant–in–Aid for Scientific Research No. 21118006.

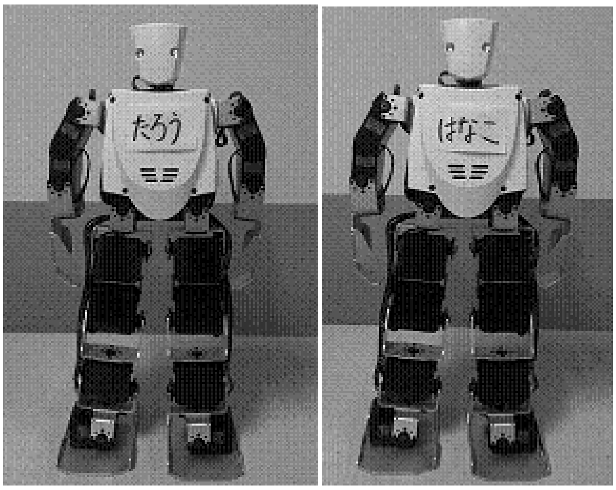

Figure 1. “Robovie-X” used in the experiment (left: labeled as a male, right: labeled as a female).

B. The Robot Used in the Experiment

The small-sized humanoid robot used in the experiment was “Robovie-X,” shown in Fig. 1, which was developed by Vstone Corporation. This robot stands 34.3 cm tall and weighs approximately 1.3 kg. The robot has a total of 17 degrees of freedom (DOFs) in its feet, arms, and head. This large number of DOFs allows it to execute various gestures such as walking, bowing, and even a handstand. Moreover, this robot has the function of utterance based on audio data recorded in advance by, for example, Windows WAV files, which are limited to 300 KB.

To control the effects of appearance, motion, and voice under the gender condition, gender assignment for the robot was performed only by labeling it with a masculine or feminine name. These names are typical and classical gender names in Japanese culture (male: “Taro,” female: “Hanako”). As shown in Fig. 1, the names were shown to the subjects by a small paper with the written name that was attached to the front of the robot. Moreover, when the subjects faced the robot at the beginning of the experimental session, the experimenters introduced the robot as a male or female robot while mentioning the names.

The appearance, motion, and voice of the robot were common under both robot gender conditions. The utterances from the robot were synthesized from the Japanese text data by using “Easy Speech,” “Text-to-Speech Engine Japanese version,” “Sound Engine Free” (free software), Microsoft SPAI 4.0, and L&H TTS 3000. The quality of the voice was artificial and neutral in gender.

Table I shows the contents uttered by the robot. It consists of seven items related to self-introduction, including the gender name. Except for the name, these items were neutral in gender from the perspective of current Japanese culture. Moreover, the utterances were polite with the “desu/masu” form in Japanese. In the table, the underlined words were the targets used for a recall task performed by the subjects in the experiment (explained in Section II-D). In both gender conditions, the robot performed the behavior of bowing by inclining its upper body forward at the utterances of the greeting. After this behavior, the robot stood without any motion during the utterances.

C. Procedures

Each session was conducted based on the following procedures:

(i) Each subject was briefly told about the experiment and signed the consent form. In this stage, the experimenters only indicated that the task in the experiment was interaction with a robot.

(ii) The subject was led to an experimental room in which the robot was placed on a desk, as illustrated in Fig. 2. The experimenters instructed the subject to sit on the chair in front of the desk and introduced the robot to him/her while mentioning the gender of the robot. Then, the experimenters left the room.

(iii) Just after the subject was left alone in the room, the robot executed the bowing motion on the desk and produced the utterances, as mentioned in the previous section. The robot was remotely controlled by the experimenters outside of the room.

TABLE I CONTENTS UTTERED BY THE ROBOT

Greeting:	“Hello.”
Japanese	“Konnichiwa”
Name:	Male condition: “I am Taro.”; Female condition: “I am Hanako.”
Japanese	Male condition: “Watashi / wa / Taro / to / moushi-masu”; Female condition: “Watashi / wa / Hanako / to / moushi-masu”
Birthday:	“My birthday is July 12.”
Japanese	“Tanjo-bi / wa / nanagatsu / juninichi / desu”
Hometown:	“I am from Osaka Prefecture”
Japanese	“Shusshin / wa / Osaka-fu / desu”
Workplace:	“I am currently working at the cafeteria in Ryukoku University.”
Japanese	“Genzai / Ryukoku / daigaku / no / gakusei-shokudo / de / hataraite / imasu”
Hobby and specialty:	“My hobby is playing tennis, and my specialty is English conversation.”
Japanese	“Shumi / ha / tenisu / de / tokugi / ha / eikaiwa / desu”
Future hope	“I wish to be a school teacher in the future.”
Japanese	“Shorai / wa / gakko / no / sensei / ni / naritai / desu”
Thanks:	“Thank you very much for your listening to my introduction.”
Japanese	“Watashi / no / jiko-shokai / wo / kiite / itadaki / arigato / gozaimashita”

(Underlined: target words for the recall task)

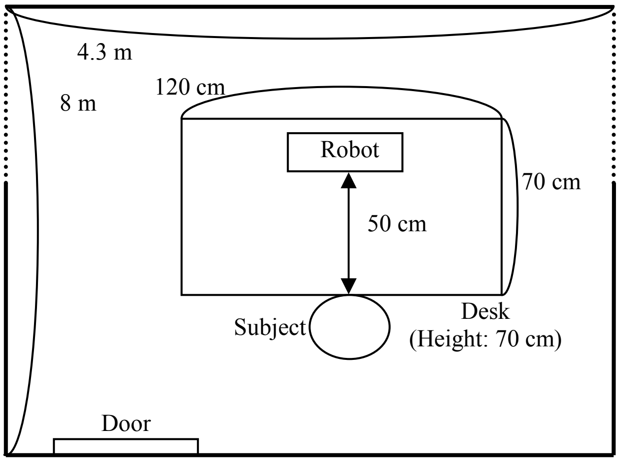

Figure 2. Overview of the room where the experiment was executed (a view from above).

(iv) Just after the robot finished the utterances, the experimenters entered the room again and indicated that the session was finished. Then, the subject responded to a questionnaire measuring his/her perception and impression of the robot, and to what degree he/she recalled the contents uttered by the robot.

(v) Finally, the experimenters interviewed the subject about the robot and the experiment, and conducted debriefing about the actual aim of the experiment.

D. Measures

The measures in the experiment were based on self-reports from the questionnaire, which consisted of two parts.

The first part contained twenty adjectives to measure the subjects' impression of the robots. Subjects were asked to respond to the degrees to which they felt the impression of the robot was represented by each adjective. Each questionnaire item had a score for rating with seven intervals (e.g., 1. I strongly disagree, 4. Not decidable, 7. I strongly agree). These adjectives included the items "feminine" and "masculine" (9th and 14th items respectively) for the manipulation check of the robot gender assignment.

The second part asked subjects to recall the following contents uttered by the robot. The contents were the seven items shown in Table I: name, birthday, hometown, workplace, hobby, specialty, and future hope of the robot.

TABLE II. ASSIGNMENT OF SUBJECTS TO CONDITIONS IN THE EXPERIMENT

		Natural Science and Technology		**Social Science**	
		Male	*Female*	*Male*	*Female*
Robot gender	*Male*	6	2	3	9
	Female	4	2	4	9

III. RESULTS

Table II shows the number of male and female subjects for each robot gender assignment. Then, the following analyses were performed.

A. Manipulation Check

To validate the effect of gender assignment of the robot, a multivariate analysis of variance (MANOVA) for the robot gender condition was conducted from the scores of the adjective items "feminine" and "masculine." The effect of robot gender was a statistically significant level (Wilks's λ = 0.614, $F = 11.337$, $p = 0.000$). The post hoc univariate analysis of variance (ANOVA) showed statistically significant effects of the robot gender on the scores of both "feminine" and "masculine" (feminine: $F = 7.835$, $p = 0.008$, $\eta^2 = 0.175$, masculine: $F = 15.549$, $p = 0.000$, $\eta^2 = 0.296$).

The subjects under the male robot condition had lower scores of "feminine" (mean = 2.6, $SD = 1.4$) than did those under the female condition (mean = 4.1, $SD = 1.9$), and the subjects under the female robot condition had lower scores of "masculine" (mean = 2.7, $SD = 1.2$) than did those under the male condition (mean = 4.6, $SD = 1.7$).

B. Impression of the Robot

To extract measures of the subjects' impression toward the robot, an exploratory factor analysis with the maximum-likelihood method and promax rotation was conducted for the items of impression adjectives, except for the items for manipulation check, "feminine" and "masculine." The result of a screen plot revealed that the six-factor structure was valid. Then, an item analysis consisting of factor loading, Cronbach's α-coefficients, and I-T correlations were performed for each of the six factors to select items in the corresponding measures. As a result, the fifth and sixth factors were removed because of their low internal consistency, and the following four measures were extracted:

(i) Politeness: consisting of five items ("polite in the way of speaking," "obedient," "favorable," "active," and "faithful"), Cronbach's α = 0.768.

(ii) Mildness: consisting of three items ("heart-warming," "mild," and "gentle"), Cronbach's α = 0.815.

(iii) Ambitiousness: consisting of two items ("ambitious" and "not content"), Cronbach's α = 0.694.

(iv) Assertiveness: consisting of two items ("assertive" and "individualistic"), Cronbach's α = 0.781.

The score of each impression was calculated as the sum of the corresponding item scores (politeness: min 5, max 35, mildness: min 3, max 21, ambitiousness and assertiveness: min 2, max 14).

Then, three types of ANOVAs, robot gender × subjects' gender, subjects' educational backgrounds (natural science and technology vs. social science) × gender, and robot gender × subjects' educational backgrounds were conducted for the four impression scores. Although three-way ANOVAs with robot gender × subjects' gender × subjects' educational backgrounds should have been conducted, the number of samples in some

TABLE III. RESULTS OF ANOVAS FOR IMPRESSION SUBSCALE SCORES

		Politeness		Mildness		Ambitiousness		Assertiveness	
		F	η^2	F	η^2	F	η^2	F	η^2
Robot gender × subjects' gender	*Robot gender*	0.815	0.022	0.038	0.001	0.738	0.019	2.206	0.057
	Subjects' gender	1.380	0.037	0.000	0.000	0.647	0.017	0.111	0.003
	Interaction	0.099	0.003	0.055	0.002	1.618	0.042	1.464	0.038
Robot gender × subjects' educational backgrounds	*Robot gender*	1.581	0.039	0.002	0.000	0.867	0.024	0.075	0.002
	Educational background	4.079†	0.100	0.512	0.014	0.214	0.006	10.440**	0.211
	Interaction	0.078	0.002	0.021	0.001	0.021	0.001	2.882†	0.058
Subjects' gender × educational backgrounds	*Subjects' gender*	2.998†	0.068	0.026	0.001	0.226	0.006	0.030	0.001
	Educational background	6.607*	0.150	0.356	0.010	0.086	0.002	7.765**	0.171
	Interaction	0.851	0.019	0.953	0.026	0.277	0.008	0.267	0.006

(†$p < 0.1$, *$p < 0.05$, **$p < 0.01$)

conditions was very small, as shown in Table II. Thus, two-way ANOVAs with combinations of these three factors were conducted.

Table III shows the results of the ANOVAs. There was no main effect of robots' gender, subjects' gender, educational background, or interaction effect between them on the impression scores of "mildness" and "ambitiousness." The subjects' educational backgrounds had a statistically significant effect on the analysis combined with the effect of the subjects' gender, which showed a statistically significant trend level on the analysis combined with robots' gender for the impression scores of "politeness." The educational backgrounds also had statistically significant effects on the analysis combined with robots' gender and that with the subjects' gender for the scores of "assertiveness." The effect sizes of the educational backgrounds in these analyses were large. Fig. 3 shows the means and standard deviations of these impression scores. It was found that the subjects with an education in natural science and technology had higher scores of the "politeness" impression than did those with an education in social science.

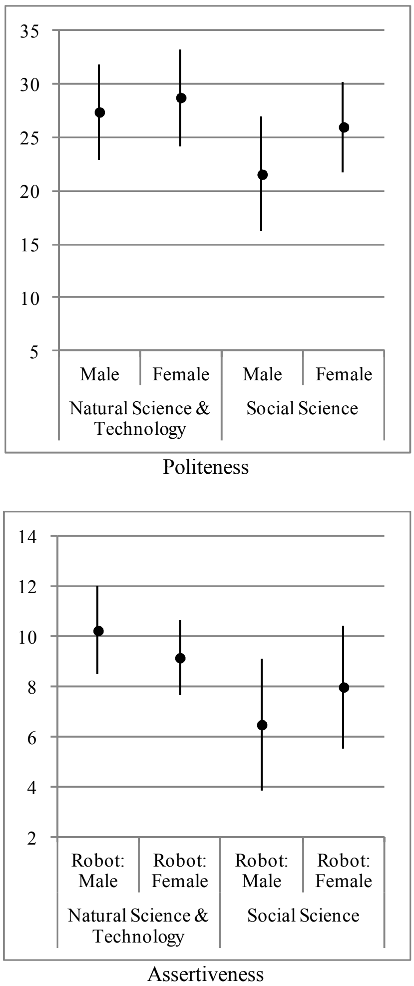

Figure 3. Means and standard deviations of impression scores.

The ANOVA with subjects' gender × educational backgrounds showed an effect of the subjects' gender at a statistically significant trend level for the impression scores of "politeness." The effect size was at a moderate level, and it was found that the female subjects had higher scores than did the male subjects. Moreover, the ANOVA with robot gender × subjects' educational background showed an interaction effect at a statistically significant trend level for the impression scores of "assertiveness." The effect size was at a moderate level. Post hoc analyses with Bonferroni's method found that only in the male robot condition did the subjects with an education of natural science and technology have higher scores of the "politeness" impression than did those with an education of social science (p = 0.001). There was no statistically significant difference on the other pairs of conditions.

C. Recall Task

The recall task score of each subject was defined as the total number of items which he/she recalled among the seven items of contents uttered by the robot (0–7). The three types of two-way ANOVAs were conducted for the scores in the same way as for the impression scores. The analyses found neither a main nor an interaction effect. The mean score was 3.4 and the standard deviation was 1.6.

To explore the relationships between the subjects' recall and impression of the robot, linear regression analyses with a decrement method were conducted for the recall task scores. In the analyses, the scores of the adjective items "feminine" and "masculine" used in the manipulation check, the scores of impression "politeness," "mildness," "ambitiousness," and "assertiveness," and educational backgrounds were used as independent variables. Moreover, the regressions were carried out for all samples, male samples, and female samples separately to investigate the effects of gender differences on the relationships, since some existing studies suggested gender differences between feelings and behaviors [5], [19].

TABLE IV. LINEAR REGRESSION MODELS BETWEEN PERCEIVED ROBOT GENDER AND IMPRESSION SCORES AND RECALL TASK SCORES

	Complete Samples $F(2,36) = 10.746, p = 0.000$			**Male Samples** $F(2,14) = 7.224, p = 0.007$			**Female Samples** $F(2,20) = 4.316, p = 0.051$		
Independent Variables	β	t	p	β	t	p	β	t	p
Femininity	0.359	2.706	0.010	0.437	2.151	0.049	-	-	-
Ambitiousness	0.460	3.470	0.001	0.420	2.072	0.057	0.421	2.078	0.051
R^2	0.339			0.438			0.136		

Table IV shows the results of the regression analyses. Statistically significant models were found for all samples and the male samples. These models consist of common independent variables, impressions of femininity and ambitiousness toward the robot. The coefficient of ambitiousness impression was at a statistically significant trend level in the case of the male samples. Moreover, the model for the male samples showed a higher goodness-of-fit than that for all samples. The models showed that impression of the robot as a female and impression of ambitiousness positively affected the amount of recall of contents uttered by the robot. The analysis for the female samples did not show a statistically significant model. The educational backgrounds had no effect on the recall task scores.

IV. DISCUSSIONS

A. Findings

The research suggests differences dependent on the educational backgrounds of humans in human-robot interaction. The impression scores of "politeness" and "assertiveness" suggested that the subjects with educational backgrounds in natural science and technology considered the robot more polite and assertive than did those with social science backgrounds. Moreover, these impression scores suggested the possibility that educational backgrounds had interaction effects with robot gender, although they were not strong.

Although robot gender did not have a sufficient effect in the experiment, the manipulation check suggested that even labeling the robot with gendered names and the instruction regarding gender could provide humans with the perception of robot gender. In the strict sense, the subjects in the experiment had less perception of femininity for the male-labeled robot and less perception of masculinity for the female-labeled robot, regardless that the appearance, motions, and voices had no information on gender. Moreover, the perception of femininity had a positive effect on the recall of contents uttered by the robot. The result suggests an indirect effect of gender labeling of robots on the human behaviors.

The results of the regression analyses also suggested that the positive effects of perceived femininity and assertiveness impressions for the robot were higher in the male samples compared with the female samples. Although human gender did not have a direct effect on impressions of the robot and the recall of robot contents, the research suggests gender differences for the relationships between human perception, feelings, and behaviors toward the robot.

B. Implications

The above suggestions have some implications for the design of HRI. First, the educational backgrounds of robot users may affect their perception or feelings toward robots, and may have interaction effects with other human or robot factors. Although it is hard to generalize due to the small number of samples, the ANOVA actually found a second-order interaction effect between educational backgrounds, human gender, and robot gender on the "ambitiousness" impression scores ($F(1,31) = 4.740$, $p = 0.037$, $\eta^2 = 0.119$). Moreover, gender differences may exist for the relationships between perception, feelings, and behaviors toward robots. These differences imply a complex nature of user perception and feelings toward robots. Thus, robotics designers should focus on a specific type of user for specific robotics applications.

Second, the effects of robot gender assignment imply the importance of tasks and contexts where robots perform, as well as their physical gender characteristics, such as appearance and voice. If tasks and contexts where robots perform are strongly related to gender, for example, receptionists or guides in public spaces, or householders in domestic areas, then users may expect the robots to have characteristics related to a gender bias, and this expectation may lead to gender assignment with the robots even if the robots are physically gender neutral, as shown in the experiment. In other words, even if robotics designers make robots gender neutral, tasks and contexts may influence the users' gender assignment of the robots. This aspect has both positive and negative implications. If a specific combination of user factors and robot gender can encourage user cognition and behaviors toward robots under particular contexts, robotics designers can predict user reactions and optimize the robot design under the contexts. However, if this type of contexts is strongly related to existing gender stereotypes, reproduction of gender stereotypes [20] may result and cause sociological and ethical issues, such as abusive behaviors toward robots, as suggested by [17].

C. Limitations

The experiment in this study had some problems. First, due to the small number of the sampling, the second-order interaction effects between human and robot factors were not sufficiently investigated. It also resulted in the fact that Bonferroni corrections for the three types of ANOVAs, which should have been conducted in principle, could not be applied.

Second, the sampling was limited to a specific generation in a single culture, even though the possibility of cultural and age differences may exist toward the assumptions and expectations of robots [11]-[15]. Moreover, the possibility of interaction effects between cultures, gender, and educational backgrounds may influence the perceptions of robots [21]. Thus, future experiments should be based on a wider sampling to consider cultural and age differences, and their interaction effects with other factors.

The third problem is the experimental design of the research. The interaction between the subjects and robot in the experiment consist of the robot performing only a script with no feedback from the subjects or from the robot. Moreover, the experimental design did not include either an actual task with the robot or the contexts. This caused a lack of reality in the interaction experiment. Thus, the above second implication of gender and contexts does not have sufficient validity. To investigate this validity, we should explore the effects in mid- and long-term HRI under more actual contexts, including gender bias.

Finally, we did not consider the subjects' psychological characteristics, such as the locus of control [22] and anxiety [5]. Future experiments should include these psychological constructs.

REFERENCES

[1] T. Kanda, H. Ishiguro, M. Imai, and T. Ono, "Body movement analysis of human-robot interaction," in *Int. Joint Conf. Artif. Intell. (IJCAI)*, 2003, pp. 177–182.

[2] C. Kidd and C. Breazeal, "Effect of a robot on user perceptions," in *IEEE/RSJ Int. Conf. Intell. Robots Syst.*, 2004, pp. 3559–3564.

[3] J. Goetz, S. Kiesler, and A. Powers, "Matching robot appearance and behaviors to tasks to improve human–robot cooperation," in. *12th IEEE Int. Ws. Robot Hum. Interact. Commun. (RO–MAN)*, 2003, pp. 55–60.

[4] B. Mutlu, S. Osman, J. Forlizzi, J. Hodgins, and S. Kiesler, "Task structure and user attributes as elements of human–robot interaction design," in *IEEE Int. Symp. Robot Hum. Interact. Commun. (RO-MAN)*, 2006, pp. 74-79.

[5] T. Nomura, T. Kanda, T. Suzuki, and K. Kato, "Prediction of human behavior in human–robot interaction using psychological scales for anxiety and negative attitudes toward robots," in *IEEE Trans. Robotics*, vol.24, no.2, 2008, pp. 442–451.

[6] T. Nomura, "Influences of generations, educational backgrounds, and experiences into attitudes toward robots," in *27th Annu Meeting. Japanese Cognitive Science Society*, 2010, pp. 123-129.

[7] A. Weiss, R. Bernhaupt, M. Tscheligi, and E. Yoshida, "Addressing user experience and societal impact in a user study with a humanoid robot," in *1st Symp. New Frontiers in Human-Robot Interaction*, 2009, pp. 150-157.

[8] P. Schermerhorn, M. Scheutz, and C. R. Crowell, "Robot social presence and gender: Do females view robots differently than males?" in *5th ACM/IEEE Int. Conf. Human-Robot Interaction*, 2008, pp. 263-270.

[9] A. Powers, A. D. I. Kramer, S. Lim, J. Kuo, S. Lee, and S. Kiesler, "Eliciting information from people with a gendered humanoid robot," in *14th IEEE Int. Ws. Robot Hum. Interact. Commun. (RO–MAN)*, 2005, pp. 158-163.

[10] C. Crowell, M. Scheutz, P. Schermerhorn, and M. Villano, "Gendered voice and robot entities: Perceptions and reactions of male and female subjects," in *IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS)*, 2009, pp. 3735-3741.

[11] M. Scopelliti, M. V. Giuliani, and F. Fornara, "Robots in a domestic setting: A psychological approach," *Universal Access in Information Society*, vol.4, pp. 146-155, 2005.

[12] T. Nomura, T. Kanda, T. Suzuki, and K. Kato, "Age differences in images of robots: Social survey in Japan," *Interaction Studies*, vol.10, no3, 2009, pp. 374-391.

[13] C. Bartneck, T. Suzuki, T, Kanda, and T. Nomura, "The influence of people's culture and prior experiences with Aibo on their attitude towards robots," *AI & Society*,vol. 21, 2007, pp. 217-230.

[14] T. Nomura, T. Suzuki, T. Kanda, J. Han, N. Shin, J. Burke, and K. Kato, "What people assume about humanoid and animal-type robots: Cross-cultural analysis between Japan, Korea, and the USA," *Int. J. Humanoid Robotics*, vol.5, Issue.1, 2008, pp. 25-46.

[15] L. Wang, P-L. P. Rau, V. Evers, B. K. Robinson, and P. Hinds, "When in Rome: the role of culture and context in adherence to robot recommendations," in *5th ACM/IEEE Int. Conf. Human-Robot Interaction*, 2010, pp. 359-366.

[16] A.I. Niculescu, D.H.W. Hofs, E.M.A.G. Van Dijk, and A. Nijholt, "How the agent's gender influence users' evaluation of a QA system," in *Int. Conf. User Science and Engineering*, 2010, pp. 16-20.

[17] A. De Angeli and S. Brahnam, "Sex stereotypes and conversational agents," in *Ws. Gender and Interaction: Real and Virtual Women in a Male World*, 2006.

[18] J. Carpenter, J. M. Davis, N. Erwin-Stewart, T. R. Lee, J. D. Bransford, and N. Vye, "Gender representation and humanoid robots designed for domestic use," *Int. J. Soc. Robot.*, vol.1, 2009, pp. 261-265.

[19] T. Nomura and K. Saeki, "Effects of polite behaviors expressed by robots: A psychological experiment in Japan," *Int. J. Synthetic Emotions*, vol.1, no.2, 2010, pp.38-52.

[20] J. Weber, "Helpless machines and true loving care givers: A feminist critique of recent trends in human-robot interaction," *Info, Comm & Ethics in Society*, vol.3, 2005, pp.209-218.

[21] E. T. Hall, *Beyond Culture*. New York: Anchor Press, 1976.

[22] R. Rickenberg and B. Reeves, "The effect of animated characters on anxiety, task performance, and evaluations of user interfaces," in *SIGCHI Conf. Human Factors in Computing Systems*, 2000, pp.49–56.