

Implications on Humanoid Robots in Pedagogical Applications from Cross-Cultural Analysis between Japan, Korea, and the USA

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Abstract— Humanoids are the most advanced robots and have been expected to act in various fields including education. Thus, it is important to investigate in different cultures what people actually assume when they encounter the word “humanoid robots,” from not only a psychological perspective but also an engineering one, focusing on such aspects as design and market of robotics. For this aim, a cross-cultural research instrument, the Robot Assumptions Questionnaire (RAQ) was administered to university students in Japan, Korea, and the USA. As a result, it was found that the Japanese students more strongly assume autonomy, social relationships, and emotional capacity of humanoid robots than the Korean and USA students, and there are more detailed cultural differences of assumptions about humanoids related to daily-life fields, in particular, pedagogical fields. Moreover, it was found that the USA students have more ambivalent images of humanoids than the Japanese students, and the Korean students have more careful attitudes toward humanoid robots than the Japanese students. In addition, the paper discusses engineering implications of the research results.

I. INTRODUCTION

It is only recently that humanoid robots have appeared as commercialized products in daily life, even in Japan that is regarded as one of the most advanced nations in the development of robotics industries. These robots have been expected to act in various fields, including communication tasks in daily life. On the other hand, there may be differences in psychological reactions toward humanoid robots between nations. For example, Kaplan [1] suggested these differences between the West and Japan from the perspective of the nature. Thus, it is important to investigate in different cultures what people actually assume when they encounter the word “humanoid robots,” from not only a psychological perspective but also an engineering one that focuses on such aspects as design and marketing of robotics. In particular, it is useful in considering applications of humanoid robots to pedagogical fields in several countries (for example, [2, 3]).

There are some existing research works dealing with cultural differences of psychological reactions toward robots. Shibata et al., [4] 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. Although their results revealed that nationality affected the evaluation factors, they were limited to a specific type of robots. Bartneck et al., [5] reported some cultural differences on negative attitudes toward robots between several countries including the USA, Japan, the UK, and the Netherlands. However, this study did not take into account cultural differences of assumptions about robots. Before discussing cultural differences of attitudes or emotions toward robots, those of assumptions about robots should be investigated in the current situation where realistic attributes, concrete tasks, or images of robots are not fixed.

On the other hand, Nomura et al., [6, 7] reported some relationships between assumptions about, anxiety toward, and negative attitudes toward robots. However, these studies were limited to one culture, using Japanese data samples. Moreover, the questionnaire items used in the studies were not designed for cross-cultural studies focusing on humanoid robots. This paper reports the results of cross-cultural research aiming at a more detailed investigation of assumptions about humanoid robots based on comparisons between Japan, Korea, and the USA.

II. METHOD

A. Subjects

Data collection for the cross-cultural study was conducted from May to July, 2006. The participants were university students in Japan, Korea, and the USA. Tab. 1 shows the sample size and mean age of the participants.

TABLE 1. SAMPLE SIZE AND MEAN AGE OF PARTICIPANTS

Country	#. Univ	Male	Female	Total	Mean Age
Japan	1	200	111	313	18.68
Korea	3	159	158	317	23.54
USA	1	96	69	166	23.98

TABLE 2. ITEMS IN THE ROBOT ASSUMPTIONS QUESTIONNAIRE (RAQ)

Degree of autonomy to be assumed for humanoid robots	Choice 1: Complete self decision-making and behavior Choice 2: Self decision-making and behavior for easy tasks, and partially controlled by humans for difficult tasks Choice 3: Completely controlled by humans, such as via remote controllers
Level of social relationship with humans to be assumed for humanoid robots	Choice 1: Equal to humans Choice 2: Similar to pet animals Choice 3: Similar to tools
Degree of emotional capacity that humanoid robots are assumed to have	Choice 1: Emotional capacity equal to that of humans Choice 2: Some capacity for emotion, but not as much as humans Choice 3: No capacity for emotion at all

Roles that humanoid robots are assumed to play in the society
(seven-graded scales from 1: Not likely at all to 7: Almost certainly)

- Role 1. Housework
- Role 2. Communication partners in the home
- Role 3. Physical tasks in the office
- Role 4. Intelligent tasks in the office, including communication
- Role 5. Tasks related to life-and-death situations in hospitals
- Role 6. Tasks related to nursing, social works, and education
- Role 7. Monotonous assembly line work in factories
- Role 8. Toys in the home or at amusement parks
- Role 9. Tasks hard for humans to do, or tasks in places hard for humans to go (such as burdensome tasks in space, the deep sea, or the battlefield)
- Role 10. Acts of hostility in the battlefield, such as causing blood shed

Images to be assumed for humanoid robots
(seven-graded scales from 1: Not likely at all to 7: Almost certainly)

- Image 1. Raise difficult ethical issues
- Image 2. Beneficial to society
- Image 3. A cause of anxiety in society, for example, as a cause of unemployment
- Image 4. Very interesting scientific and technological products
- Image 5. A technology requiring careful management
- Image 6. Friends of human beings
- Image 7. A blasphemous of nature

B. Instrumentation

A questionnaire for measuring assumptions about robots was prepared based on discussion between researchers of engineering and psychology in Japan, Korea, and the USA, as follows.

Considering the existing research result on assumptions about robots [8], questionnaire items measuring degrees of characteristics which humanoid robots are assumed to have, and answer types were discussed. As a result, the items about autonomy, social relationship with humans, emotionality, roles to be played in the society, and images of each type of robot were prepared. On the items of autonomy, social relationship, and emotionality, degrees of the assumptions were measured by three levels of answers. On roles and images, ten and seven items were prepared respectively, and each item had seven-graded scale answer to measure degrees of the assumptions. Table 2 shows these items.

The questionnaire, the Robot Assumptions Questionnaire (RAQ), was originally made in Japanese, including the instructions. Then, the English version was made through formal back-translation.

C. Procedures

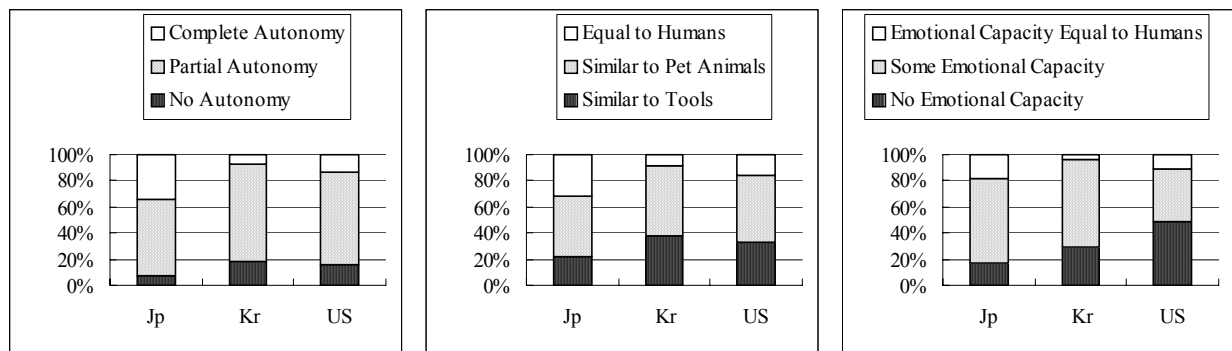
Each colleague was sent the English version of the RAQ including the instructions to be read to the students. In these instructions, it was indicated that humanoids mean “Humanoid robots between the sizes of human children and adults.”

In Japan, the Japanese version of the questionnaire was administered to undergraduate classes in the departments of engineering and social sciences. In the USA, the English version was administered to both graduate and undergraduate classes in the schools of engineering and psychology. In Korea, back-translation from the English to the Korean was performed, and then the Korean version of the questionnaire was administered to classes in the departments of natural sciences, engineering, and social sciences. Participation was voluntary.

III. RESULTS

A. Autonomy, Social Relationships, and Emotionality

First, to compare between the countries on the assumed



Autonomy
 $\chi^2(4) = 77.007, p < .000$

Social Relationship with Humans
 $\chi^2(4) = 56.865, p < .000$

Emotional Capacity
 $\chi^2(4) = 73.616, p < .000$

	Jp	Kr	US	Jp	Kr	US	Jp	Kr	US		
Complete Autonomy	100↑	23↓	21	Equal to Humans	94↑	27↓	25	Emotional Capacity Equal to Humans	55↑	13↓	16
Partial Autonomy	178↓	227↑	107	Similar to Pet Animals	139	161	79	Some Emotional Capacity	188	202↑	62↓
No Autonomy	20↓	55↑	24	Similar to Tools	64↓	117↑	51	No Emotional Capacity	52↓	90	74↑

FIG.1 RESULTS OF χ^2 -TESTS AND RESIDUAL ANALYSIS FOR THE NUMBERS OF RESPONDENTS FOR THE DEGREES AND LEVELS OF AUTONOMY, SOCIAL RELATIONSHIP WITH HUMANS, AND EMOTIONAL CAPACITY OF HUMANOID ROBOTS (↑VALUE UPPER THAN THE EXPECTED FREQUENCY, ↓VALUE LOWER THAN THE EXPECTED FREQUENCY)

degrees of autonomy, the levels of social relationship with humans, and levels of emotional capacity of humanoid robots, χ^2 -tests and residual analysis were performed for the numbers of respondents for the degrees and levels. Fig. 1 shows the results.

On all the items of autonomy, social relationships, and emotionality, there were statistically significant differences on the numbers of respondents between Japan, Korea, and the USA. Moreover, residual analysis revealed the following facts.

On the autonomy item, the number of the Japanese respondents that assumed “Complete self decision-making and behavior” (34%) was larger than those of Korea and the USA (8% and 14%) at a statistically significant level. Almost all the Japanese respondents (93%) assumed autonomy of humanoid robots at the complete or partial degree, although the rates in the Korean and USA respondents were 82% and 84%.

On the social relationship item, the number of the Japanese respondents that assumed the one “Equal to humans” (32%) was larger than those of Korea and the USA (9% and 16%) at a statistically significant level. Many Japanese respondents (78%) assumed the social relationship of humanoid robots with humans at the level equal to humans or pet animals, although the rates in the Korean and USA respondents were 62% and 67%.

On the emotionality item, the number of the Japanese respondents that assumed “Emotional capacity equal to that of humans” (19%) was larger than those of Korea and the USA (4% and 11%) at a statistically significant level. Many Japanese respondents (82%) assumed the emotional capacity of humanoid robots at the degree equal to humans or to some extent, although the rates in the Korean and USA respon-

dents were 70% and 51%. In particular, about a half of the USA respondents (49%) assumed “No emotional capacity” of humanoid robots, and the number of these respondents was larger than those of Japan and Korea at a statistically significant level.

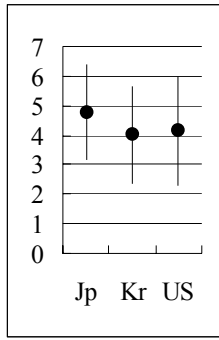
B. Roles and Images

Next, to compare between the countries on the assumed degrees of roles played by and images of humanoid robots, one-way ANOVAs with countries were performed for the scores of ten items of roles and seven items of images. The results revealed that there were statistically significant effects of countries in four items of roles including education and five items of images.

1) Roles

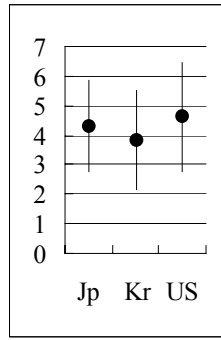
Fig.2 shows the means and standard deviations of the four role item scores for which there were statistically significant effects of countries, and results of the ANOVAs and post-hoc analysis. It was found that the Japanese respondents more strongly assumed “Communication partners in the home” than the Korean and USA respondents and the Korean respondents more weakly assumed “Intelligent tasks in the office, including communication” than the Japanese and USA respondents.

Moreover, the results revealed that the Korean respondents more strongly assumed “Tasks related to life-and-death situations in hospitals” than the Japanese respondents. Furthermore, it was found that the Japanese respondents more strongly assumed “Tasks related to nursing, social works, and education” than the Korean and USA respondents. On the other hand, there was no statistically significant difference between the countries on the items scores related to physical tasks or amusement.



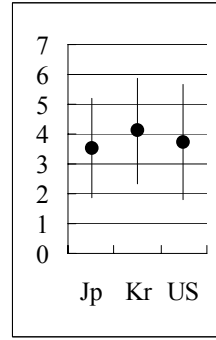
Role 2:
Communication partners
in the home

$F(2, 747) = 16.866$
 $p < .000$
Jp > Kr, US



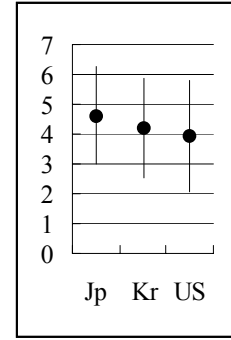
Role 4:
Intelligent tasks in the
office, including
communication

$F(2, 745) = 13.519$
 $p < .000$
Kr < Jp, US



Role 5:
Tasks related to
life-and-death situa-
tions in hospitals

$F(2, 747) = 9.048$
 $p < .000$
Kr > Jp



Role 6:
Tasks related to nursing,
social works, and edu-
cation

$F(2, 745) = 10.177$
 $p < .000$
Jp > Kr, US

FIG.2 MEANS AND STANDARD DEVIATIONS OF TASK ITEM SCORES FOR WHICH THERE WERE STATISTICALLY SIGNIFICANT EFFECTS OF COUNTRIES, AND RESULTS OF ANOVAS AND POST-HOC ANALYSIS

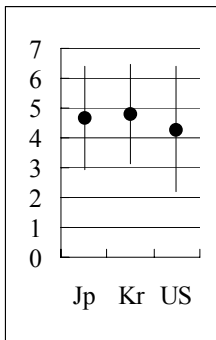


Image 1:
Raise difficult
ethical issues

$F(2, 743) = 4.255$
 $p < .05$
Kr > US

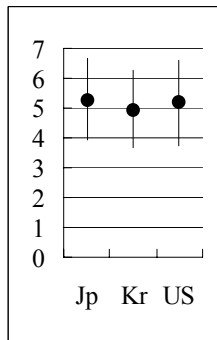


Image 2:
Beneficial to
society

$F(2, 744) = 4.822$
 $p < .01$
Jp > Kr

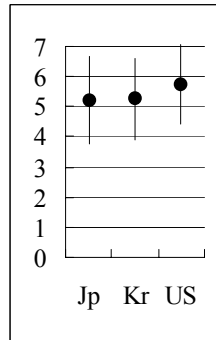


Image 4:
Very interest-
ing scientific and
technological
products

$F(2, 742) = 8.516$
 $p < .000$
US > Jp, Kr

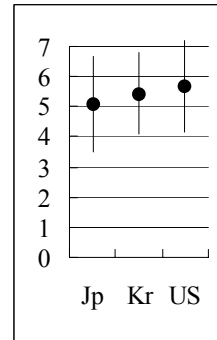


Image 5:
A technology
requiring careful
management

$F(2, 743) = 10.488$
 $p < .000$
Jp < Kr, US

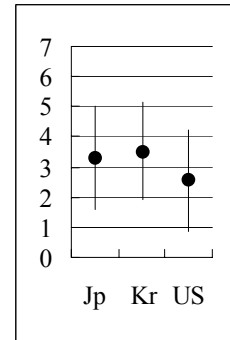


Image 7:
A blasphemous
of nature

$F(2, 743) = 18.286$
 $p < .000$
US < Jp, Kr

FIG.3 MEANS AND STANDARD DEVIATIONS OF IMAGE ITEM SCORES FOR WHICH THERE WERE STATISTICALLY SIGNIFICANT EFFECTS OF COUNTRIES, AND RESULTS OF ANOVAS AND POST-HOC ANALYSIS

2) Images

Fig.3 shows the means and standard deviations of the five image item scores for which there were statistically significant effects of countries, and results of the ANOVAs and post-hoc analysis. It was found that the Japanese respondents more strongly assumed “Beneficial to society” than the Korean respondents, and more weakly assumed “A technology requiring careful management” than the Korean and USA respondents.

Moreover, the results revealed that the Korean respondents more strongly assumed “Raise difficult ethical issues” than the USA respondents. Furthermore, it was found that the USA respondents more strongly assumed “Very interesting scientific and technological products” and more weakly assumed “A blasphemous of nature” than the Japa-

nese and Korean respondents.

IV. DISCUSSION

A. Findings

The results of the cross-cultural research imply several differences on assumptions about humanoid robots between Japan, Korea, and the USA.

Firstly, the results of section 3A showed that the Japanese students assume higher autonomy, social relationship with humans, and emotional capacity of humanoid robots than the Korean and USA students. This fact implies that the Japanese students more strongly assume characteristics similar to humans for humanoids than the Korean and USA students.

Secondly, the results of section 3B showed that the Japanese students more strongly assume tasks related to communication than the Korean and USA students. Moreover, they showed that the Japanese students more strongly assume tasks related to social works and education than the Korean students, although the Korean students more strongly assume tasks related to life-and-death situations such as hospitals than the Japanese students. These facts imply that there are more detailed cultural differences of assumptions about humanoid robots related to daily-life fields including education, even between the two industrial countries in Asia.

Thirdly, the results of section 3B showed that the USA students have both positive and negative images of humanoid robots in comparison with the Japanese students, as shown in the image of interesting technology requiring careful management. Moreover, the USA students have less negative images such as a blasphemous of nature, than the Japanese students. These facts imply that the USA students have more ambivalent images of humanoid robots than the Japanese students.

Finally, the results of section 3B showed that the Korean students have more negative images of humanoid robots such as ethical issues than the Japanese and USA students. Moreover, they do not have as positive image as the Japanese students, such as social benefits. These facts imply that the Korean students have more careful attitudes toward humanoid robots than the Japanese students.

B. Engineering Implications

We believe that the investigation of cultural difference will greatly contribute to design of robots, in particular, humanoid robots in pedagogical fields.

Our results in section 3 suggest that cultural differences may not be as critical a factor in applications of robots to non-daily life fields such as hazardous locations; however, we should consider characteristics of humanoid robots in their applications to daily-life fields such as schools, dependent on nations where they are applied.

For example, the results in section 3 suggested that the Korean students did not assume autonomy, social relationship, or emotional capacity of humanoid robots as well as the Japanese students. They also suggested that the Korean students more weakly assumed pedagogical applications of humanoid robots, and have more careful attitudes toward humanoids than the Japanese students. These imply that in pedagogical fields the Japanese students expect humanoids having characteristics similar to humans, like human assistants, although the Korean students do not expect these robots, but non-humanoids with partial autonomy and limited emotional capacity.

Moreover, our implications on the USA students' images of humanoid robots are inconsistent with some discourses that the Japanese like robots more than the other cultures, and that people in the USA and European do not like robots, due to the difference of religious backgrounds or beliefs [9]. Thus, we should not straightforwardly adopt general discourses of cultural differences on humanoid robots on con-

sidering their pedagogical applications. Designers should sufficiently survey people's expectation toward humanoid robots in the nation where they are applied.

C. Limitations

First, our research was limited to the three nations. Moreover, sampling of respondents in each country is biased due to the limited number of universities involved in the study. Moreover, we did not deal with differences between ages such as Nomura et al., [10] found in the Japanese visitors of a robot exhibition. Thus, the above implications may not straightforwardly be generalized as either the complete comparison between these countries, or the existence of cultural differences about humanoid robots.

To investigate more general implications, we need to extend the range of sampling to different ages and other nations, including more in Europe to discuss more detailed cultural differences. These problems should be solved in future additional research.

V. SUMMARY

From both a psychological perspective and an engineering one focusing on such aspects as design and market of robotics, a cross-cultural research instrument, the Robot Assumptions Questionnaire (RAQ) was administered to university students in Japan, Korea, and the USA. As a result, it was found that the Japanese students more strongly assume autonomy, social relationships, and emotional capacity of humanoid robots than the Korean and USA students, and there are more detailed cultural differences of assumptions about humanoids related to daily-life fields, in particular, pedagogical fields. Moreover, it was found that the USA students have more ambivalent images of humanoids than the Japanese students, and the Korean students have more careful attitudes toward humanoid robots than the Japanese students. In addition, we discussed engineering implications of the research results.

As a future direction, we consider the extension of the sampling range such as different ages and other nations.

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