4th International Symposium on New Frontiers in Human-Robot Interaction
21–22 April 2015, Canterbury, UK
M. Salem, A. Weiss, P. Baxter, K. Dautenhahn (Eds.)

Differences on Social Acceptance of Humanoid Robots between Japan and the UK

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Abstract. To validate a questionnaire for measuring people's acceptance of humanoid robots in cross-cultural research (the Frankenstein Syndrome Questionnaire: FSQ), an online survey was conducted in both the UK and Japan including items on perceptions of the relation to the family and commitment to religions, and negative attitudes toward robots (the NARS). The results suggested that 1) the correlations between the FSQ subscale scores and NARS were sufficient, 2) the UK people felt more negative toward humanoid robots than did the Japanese people, 3) young UK people had more expectation for humanoid robots, 4) relationships between social acceptance of humanoid robots and negative attitudes toward robots in general were different between the nations and generations, and 5) there were no correlations between the FSQ subscale scores, and perception of the relation to the family and commitment to religions.

1 INTRODUCTION

In recent years, several studies have revealed the influences of human cultures into feelings and behaviors toward robots [1, 2, 3, 4, 5, 6], and some of them focused on social acceptance of robots. Evers, et al. [1] revealed differences between the US and Chinese people on their attitudes toward and the extent to which they accepted choices made by a robot. Li, et al. [2] found an interaction effect between human cultures (Chinese, Korean and German) and robots' tasks (teaching, guide, entertainment and security guard) on their engagement with the robots. Yueh and Lin [5] showed differences on preferences of home service robots between Taiwanese and Japanese people.

The research group also have been developing a questionnaire to measure and compare humans' acceptance of humanoid robots between nations, and explore factors influencing social acceptance of humanoids including cultural ones [7, 8]. The questionnaire, called "Frankenstein Syndrome Questionnaire" (FSQ), aims at clarification of differences on social acceptance of humanoid robots between the Westerners and Japanese based on Kaplan's idea [9] reflecting the concept of "Frankenstein Syndrome" originated from genetic engineering [10]. The surveys using this questionnaire suggested age differences on acceptance of humanoid robots in Japan [11], and some differences between the UK and Japan [8].

However, the previous studies had some problems on sampling in the sense that data from an online survey and that based on a normal paper-and-pencil method were mixed in one nation sample. As a result, the factor structure extracted from the sample was not stable [12]. Moreover, the previous survey did not take into account verification of criterion-related validity of the questionnaire.

To overcome the above problems, an online survey was conducted in both the UK and Japan under more strict control of sampling. The survey included another psychological scale of which validity had already been supported, the Negative Attitudes toward Robots Scale [13]. The scale was used to verify correlations between social acceptance of humanoid robots and attitudes toward robots in general, to investigate the criterion-related validity of the Frankenstein Syndrome Questionnaire.

As well as cultures, the survey aimed at exploring other factors related to social acceptance of humanoid robots. As factors to be explored, the survey firstly focused on age. In the survey conducted in Japan about ten years ago, our research group found that persons in their 40s had positive opinions of robots in comparison with other generations [14]. Thus, the survey aimed at comparing one group of persons in their 50s with another in their 20s to clarify age differences. Moreover, a survey conducted in Japan and Sweden adopted perceptions of the relation to the family and commitment to religions as indices reflecting differences between these different nations [15]. Thus, the survey also included these two factors "the relation to the family" and "commitment to religions".

The paper reports the results of the survey, and discusses the implications from the perspective of development of humanoid robots.

2 Method

2.1 Date and Participants:

The survey was conducted from January to February 2014. 100 Japanese and 100 UK respondents were recruited by a survey company at which about one million and six hundred thousand Japanese and one million and one hundred thousand UK persons have registered. Respondents in each nation were limited to people who were born and had been living only in the corresponding nation. The respondents consisted of fifty persons in their 20s (male: 25, female: 25) and fifty persons in their 50s (male: 25, female: 25) in each of the nations.

The homepage of the online survey had been open for these participants during the above period. The questionnaire of the online survey was conducted with the native language for the respondents in each of the nations.

2.2 Survey Design:

The questionnaire did not give the explicit definition of robots, or include any photo and image of robots, except for the instruction on humanoid robots just before conducting the Frankenstein Syndrome Questionnaire. The scale on attitudes

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toward robots in general was firstly conducted, and then the Frankenstein Syndrome Questionnaire was conducted since the reverse order had a possibility that envisions of humanoids evoked by the conduction of the FSQ affected the measurement of attitudes toward robots in general. The concrete items and scales in the survey were as follows:

Perception of the Relation to the Family and Commitment to Religions:

The following two items, which were used in the comparison survey between Japan and the Northern Europe by Otsuka et al. [15], were presented on the face sheet measure participants' degrees of perception of the relation to the family and commitment to religions:

- Do you think you relate to your family members? (five-graded answer from "1. I completely agree" to "5. I completely disagree")
- Does such notion as "I have nothing to do with religion or faith" apply to you? (five-graded answer from "1. It strongly applies to me" to "5. It does not apply to me at all.")

Negative Attitudes toward Robots Scale (NARS):

To measure participants' attitudes toward robots in general, the NARS [13] was adopted in the survey. The scale consists of 14 items classified into three subscales. The first subscale (S1, six items) measures negative attitude toward interaction with robots (e.g., "I would feel paranoid talking with a robot."). The second subscale (S2, 5 items) measures negative attitude toward the social influence of robots (e.g., "Something bad might happen if robots developed into living beings."). The third subscale (S3, 3 items) measures negative attitude toward emotional interaction with robots (e.g., "I feel comforted being with robots that have emotions.").

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.

Frankenstein Syndrome Questionnaire (FSQ):

The questionnaire was developed to measure acceptance of humanoid robots including expectations and anxieties toward this technology in the general public [8,11]. It consists of 30 items shown in Table 1. Each questionnaire item was assigned with a seven-choice answer (1: "Strongly disagree", 2: "Disagree", 3: "Disagree a little", 4: "Not decidable", 5: "Agree a little", 6: "Agree", 7: "Strongly agree".).

Just before conducting the FSQ, the definition of "humanoids robots" was instructed only with texts as follows:

"Humanoid robots are robots that roughly look like humans, that have two arms, legs, a head, etc. These robots may be very human-like in appearance (including details such as hair, artificial skin etc.), but can also have machine-like features (such as wheels, a metal skin etc)."

3 RESULTS

3.1 Subscales of the FSQ and Reliability:

Although previous studies had explored the factor structures in the FSQ [8,13], they were sufficiently not stable to be replicated across studies [12]. To extract the subscales of the FSQ again, a factor analysis with maximum likelihood method and Promax rotation was conducted for the 30 items. Although the analysis found five factors having eigen values more than 1, the scree plot showed that the difference on the eigen values between the fourth and fifth factors was small. Thus, the factor analysis was conducted based on four-factor structure. The cumulative contribution of these four factors was 52.8%.

After removing items having factor loadings more than .3 on more than one item, item analysis using Cronbach's α-coefficients and I-T correlations was performed for each factor in turn to select items in the corresponding subscale. Table 1 shows the results of these analyses.

The subscale corresponding to the first factor consisted of 9 items representing negative feelings toward social impacts of humanoid robots such as "Humanoid robots may make us even lazier." Thus, the subscale was interpreted as "negative feelings toward humanoid robots." The subscale corresponding to the second factor consisted of 8 items representing positive expectation of humanoid robots in the society such as "Humanoid robots can be very useful for teaching young kids." Thus, the subscale was interpreted as "expectation for humanoid robots". The subscale corresponding to the third factor consisted of 3 items representing negative feelings toward humanoid robots at religious and philosophical levels such as "The development of humanoid robots is blasphemous." Thus, the subscale was interpreted as "root anxiety toward humanoid robots". The fourth factor was removed in the analysis since it consisted of only two items.

Cronbach's reliability coefficients α, showing the internal consistencies of the subscales, were .899 for "negative feelings toward humanoid robots," .861 for "expectation for humanoid robots," and .859 for "root anxiety toward humanoid robots." These values showed sufficient internal consistencies for all three subscales. The score of each subscale was calculated as the sum of the scores of all items included in the subscale ("negative feelings toward humanoid robots": max 63, min 9, "expectation for humanoid robots": max 56, min 8, and "root anxiety toward humanoid robots": max 21, min 3).

3.2 Comparison between Nations and Generations:

FSQ Subscale Scores:

Three-way ANOVAs with gender by nation (Japan vs. UK) by generation (20's vs. 50's) were conducted for the subscale scores of the FSQ. Table 2 shows the results. For "negative feelings toward humanoid robots," the main effects of gender and nations were at statistically significant levels although the effect size on gender was small. For "expectation for humanoid robots," only the first order interaction effect between nations and generations was at a statistically significant level.

Figure 1 shows the means and standard deviations of the subscale scores of "negative feelings toward humanoid robots" and "expectation for humanoid robots". Bonfferoni Post Hoc tests revealed that the UK respondents in their 20s had higher expectation for humanoid robots than the UK respondents in

Item No.	Item Sentences	Factor			
		I	*II*	*III*	*IV*
30	Widespread use of humanoid robots would take away jobs from people.	**.929**	.076	-.098	-.212
4	Humanoid robots may make us even lazier.	**.766**	.037	-.057	-.077
12	If humanoid robots cause accidents or trouble, persons and organizations related to development of them should give sufficient compensation to the victims.	**.705**	.113	-.285	.132
8	I am afraid that humanoid robots will encourage less interaction between humans.	**.697**	.026	.167	-.015
20	I feel that if we become over-dependent on humanoid robots, something bad might happen.	**.681**	-.071	-.011	.245
17	I would hate the idea of robots or artificial intelligences making judgments about things.	**.655**	-.132	.279	-.045
11	I would feel uneasy if humanoid robots really had emotions or independent thoughts.	**.548**	-.055	-.004	.178
27	Something bad might happen if humanoid robots developed into human beings.	**.512**	-.048	.191	.193
23	*Humanoid robots should perform dangerous tasks, for example in disaster areas, deep sea, and space.*	***.493***	***.346***	*-.242*	*.055*
16	I am concerned that humanoid robots would be a bad influence on children.	**.491**	-.171	.245	.148
24	*Many humanoid robots in society will make it less warm.*	***.452***	*.009*	***.396***	*.144*
13	I can trust persons and organizations related to development of humanoid robots.	-.147	**.777**	.256	-.018
15	Humanoid robots can be very useful for teaching young kids.	-.225	**.737**	.262	.077
10	I don't know why, but I like the idea of humanoid robots.	-.259	**.733**	.044	.295
25	*I trust persons and organizations related to the development of humanoid robots to disclose sufficient information to the public, including negative information.*	*-.015*	***.720***	***.314***	*-.210*
19	Humanoid robots can make our lives easier.	.204	**.672**	-.282	.118
3	Persons and organizations related to development of humanoid robots are well-meaning.	.103	**.672**	-.018	-.054
18	Humanoid robots are a natural product of our civilization.	-.072	**.660**	.083	-.111
28	Persons and organizations related to development of humanoid robots will consider the needs, thoughts and feelings of their users.	.303	**.547**	-.119	.022
5	Humanoid robots can be very useful for caring the elderly and disabled.	.054	**.544**	-.184	.144
6	Humanoid robots should perform repetitive and boring routine tasks instead of leaving them to people.	.123	**.524**	-.053	.200
29	The development of humanoid robots is blasphemous.	-.032	.013	**.892**	.001
9	The development of humanoid robots is a blasphemy against nature.	-.038	.000	**.863**	.077
26	*Technologies needed for the development of humanoid robots belong to scientific fields that humans should not study.*	*-.072*	*.203*	***.663***	*.058*
21	I don't know why, but humanoid robots scare me.	.297	-.205	**.567**	.006
22	*I feel that in the future, society will be dominated by humanoid robots.*	***.314***	***.331***	***.403***	*-.186*
1	*I am afraid that humanoid robots will make us forget what it is like to be human.*	*.234*	*-.097*	***.379***	***.323***
7	People interacting with humanoid robots could sometimes lead to problems in relationships between people.	.240	.049	.292	**.547**
2	*Humanoid robots can create new forms of interactions both between humans and between humans and machines.*	*.010*	***.433***	*-.112*	***.474***
14	Widespread use of humanoid robots would mean that it would be costly for us to maintain them.	.248	.099	.037	**.452**

(Items shown with Italic: reduced based on the criterion of factor loadings more than .3 on more than one item and item analysis)

Table 1. Items of the Frankenstein Syndrome Questionnaire and Results of Factor Analysis

their 50s ($p < .0.13$) and the Japan participants in their 20's ($p < .0.55$). There were neither main effects nor any interactions for "root anxiety toward humanoid robots" (mean = 9.9, *SD* = 4.1).

Correlations with the NARS, Perception of the Relation to the Family, and Commitment to Religions:

The Cronbach's α-coefficients for the NARS subscales were .854, .779, and .842 for S1, S2, and S3, respectively. These values showed that these subscales had sufficient internal consistency.

Table 3 shows Pearson's correlation coefficients between the FSQ subscale scores, the NARS subscale scores, and item scores of relation to family and religious commitment based on the nations and generations. Tests of equality on correlation coefficients found statistically significant differences between the four respondents groups, suggesting the following trends:

		Main Effect			First Order Interaction			Second Order Interaction
		Gender	Nation	Generation	Gender X Nation	Gender X Generation	Nation and Generation	
I. Negative Feelings toward Humanoid Robots	F	6.121	24.630	.406	.027	.444	2.420	.985
	p	.014	< .001	.525	.871	.506	.121	.322
	η^2	.027	.108	.002	.000	.002	.011	.004
II. Expectation for Humanoid Robots	F	2.281	.376	2.013	.185	3.186	4.548	.855
	p	.133	.540	.158	.668	.076	.034	.356
	η^2	.011	.002	.010	.001	.016	.022	.004
III. Root Anxiety toward Humanoid Robots	F	1.877	.676	2.702	1.606	1.437	.264	.019
	p	.172	.412	.102	.207	.232	.608	.891
	η^2	.009	.003	.013	.008	.007	.001	.000

Table 2. Results of ANOVAs for the FSQ Subscale Scores

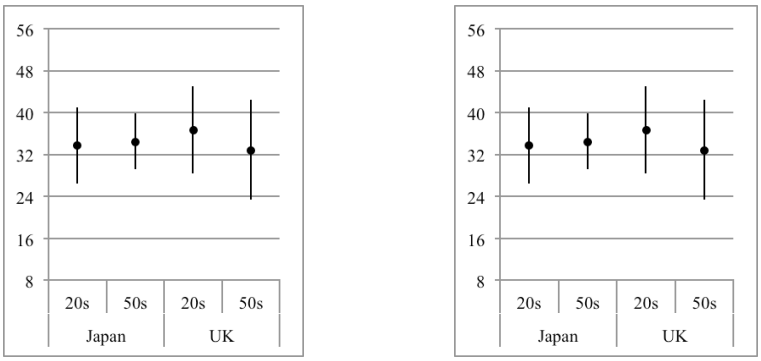

Figure 1. Means and Standard Deviations of Scores of Negative Feelings toward and Expectation for Humanoid Robots

- Between "negative feelings toward humanoid robots" and "expectation for humanoid robots" ($\chi^2(3) = 19.677$, $p < .001$): positive correlation in the Japan respondents in their 20s, and negative correlation in the UK respondents in their 50s,
- Between "negative feelings toward humanoid robots" and "negative attitude toward social influences of robots" ($\chi^2(3) = 11.091$, $p < .05$): moderate levels of correlations in the respondents in their 20s, and strong correlations in the respondents in their 50s,
- Between "negative feelings toward humanoid robots" and "negative attitude toward emotional interaction with robots" ($\chi^2(3) = 14.468$, $p < .01$): moderate levels of positive correlations only in the respondents in their 50s,
- Between "expectation for humanoid robots" and "root anxiety toward humanoid robots" ($\chi^2(3) = 12.840$, $p < .01$): a moderate level of negative correlation only in the UK respondents in their 50s,
- Between "expectation for humanoid robots" and "negative attitude toward social influences of robots" ($\chi^2(3) = 13.715$, $p < .01$): moderate levels of negative correlations only in the respondents in their 50s,
- Between "root anxiety toward humanoid robots" and "expectation for humanoid robots" ($\chi^2(3) = 11.770$, $p < .01$): strong correlation in the Japan respondents in their 20's, and moderate levels of correlations in the other respondents,
- Between "root anxiety toward humanoid robots" and "negative attitude toward emotional interaction with robots" ($\chi^2(3) = 8.279$, $p < .05$): a moderate level of positive correlation only in the UK respondents in their 50s.

On the other hand, there were moderate levels of positive correlations between "negative feelings toward humanoid robots" and "root anxiety toward humanoid robots", between "negative feelings toward humanoid robots" and "negative attitude toward interaction with robots", and between "root anxiety toward humanoid robots" and "negative attitude toward interaction with robots". Moreover, there was a moderate level of negative correlation between "expectation for humanoid robots" and "negative attitude toward social influences of robots".

There were no correlations between the FSQ subscale scores, and perception of the relation to the family and commitment to religions, although only the UK participants in 50's showed statistically significant correlations between these scores and perception of the relation to the family.

4. DISCUSSION

4.1 Findings:

The survey results suggest sufficient correlations between the FSQ subscale scores and NARS. It supports the criterion-related validity of the FSQ. Negative attitude toward interaction with

		FSQII	FSQIII	NARSS1	NARSS2	NARSS3	Religion	Family
FSQI	Whole	-.059	.472**	.426**	.664**	.139	.012	-.081
	Jp 20s	.381**	.534**	.316*	.605**	-.117	.001	-.179
	Jp 50s	-.234	.617**	.431**	.744**	.411**	.143	.196
	UK 20s	.149	.474**	.446**	.478**	-.049	-.133	-.147
	UK 50s	-.402**	.431**	.516**	.820**	.461**	.121	.223
FSQII	Whole		-.208**	-.076	-.169*	-.554**	-.095	-.182**
	Jp 20s		.125	.008	.186	-.383**	.047	-.155
	Jp 50s		-.182	-.159	-.307*	-.473**	-.022	-.157
	UK 20s		-.195	-.037	-.064	-.698**	-.247	-.007
	UK 50s		-.544**	-.261	-.487**	-.584**	-.079	-.317*
FSQIII	Whole			.620**	.526**	.089	.034	.054
	Jp 20s			.734**	.757**	-.113	-.113	-.101
	Jp 50s			.604**	.391**	.191	.034	.233
	UK 20s			.588**	.345*	.020	.124	-.070
	UK 50s			.562**	.593**	.420**	.138	.308*

FSQI: Negative Feelings toward Humanoid Robots, FSQII: Expectation for Humanoid Robots,
FSQIII: Root Anxiety toward Humanoid Robots,
NARSS1: Negative Attitude toward Interaction with Robots, NARSS2: Negative Attitude toward Social Influences of Robots,
NARSS3: Negative Attitude toward Emotional Interaction with Robots,
Religion: Religious Commitment, Family:Relation to Family

Table 3. Pearson's Correlation Coefficients between FSQ and NARS Subscale Scores, and Item Scores of Relation to Family and Religious Commitment

robots in general was related to negative feelings and root anxiety toward humanoid robots in both the UK and Japan.

The survey results also suggest some differences on social acceptance of humanoid robots between the two countries. The UK participants felt more negative towards humanoid robots than their Japanese counterparts. In addition, the UK participants in their 20s had more positive expectations for humanoid robots than any other group..

These results suggest some differences dependent on generation, on relationships between social acceptance of humanoid robots and negative attitudes toward robots in general. The correlation between negative attitudes toward emotional interaction with robots and negative feelings toward humanoids was at a moderate level only in 50s people. The correlation between negative attitude toward social influences of robots and expectation for humanoids also had the similar trend. The correlation between negative attitude toward emotional interaction with robots and root anxiety toward humanoids was at a moderate level only in UK participants in their 50s.

4.2 Implications:

The results in the survey imply that people in the UK have more negative feelings toward humanoid robots than those in Japan. This however, depends on the generation of the participants. Likewise, relationships between feelings toward humanoid robots and attitudes toward robots in general also depend on the generation of respondent. This suggests that changing attitudes toward some particular types of robots may not lead to acceptance of other types of robots, nor robots in general.

In order to further social acceptance of humanoid robots across cultures, designers of robots need to consider individual, generational, and cultural factors in their potential users.

4.3 Limitations and Future Works:

The survey did not take into account concrete attitudes toward the relation to family and religious commitment. It may lead to non-correlation between these factors and social acceptance of robots. On the other hand, previous research has found correlations between these factors and negative attitudes toward robots [16]. It suggests that religious and family factors may indirectly influence social acceptance of humanoid robots. Future surveys need to include this indirect influence in the survey design.

Moreover, the survey did not adopt any image stimulus of robots in order to avoid influences of images of specific types of robots. Future surveys should include more sophisticated items while exploring dominant images of robots in the corresponding nations.

In addition, the survey did not consider possible differences between human attitudes toward humanoid robots measured in questionnaires and live interactions with them, such as dealt with by Wang, et al. [17]. We need to conduct experiments to investigate how psychological constructs measured by the FSQ affect human behaviors toward humanoid robots in real situations.

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