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General Republics' Opinions on Robot Ethics: Comparison between Japan, the USA, Germany, and France

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Abstract. Ethical issues on robots need to be investigated based on international comparison because general publics' conceptualizations of and feelings toward robots differ due to different situations with respect to mass media and historical influences of technologies. As a preliminary stage of this international comparison, a questionnaire survey based on openended questions was conducted in Japan, the USA, Germany and France ($N = 100$ from each countries). As a result, it was found that (1) people in Japan tended to react to ethical issues of robotics more seriously than those in the other countries, although those in Germany tended not to connect robotics to ethics, (2) people in France tended to specify unemployment as an ethical issue of robotics in comparison with the other countries, (3) people in Japan tended to argue the restriction of using and developing robots as a solution for the ethical problems, although those in France had the opposite trend.

1 Introduction

The recent development of robotics has begun to introduce robots into our daily lives in our homes, schools, and hospitals. In this situation, some philosophers and scientists have been discussing robot ethics [8, 15, 12, 4, 2]. Asaro [1] argued that robot ethics should discuss the following three things: the ethical systems to be built into robots, the ethics of people who design and use robots, and ethical relationships between humans and robots. Lin [6] proposed the following three broad (and interrelated) areas of ethical and social concerns about robotics:

Safety and errors: including mistakes of recognition by battle robots and security against hacking.
Law and ethics: including codes of ethics to be programed into robots, companionships between humans and robots, responsibility of robot behaviors.
Social impact: including economical and psychological change of the society.

Recently, several researchers have been investigating solutions for these ethical problems. However, the opinions of the general public of different countries have not sufficiently been investigated from the perspective of robot ethics. Some existing studies found the general public's preferences of robot types in the context of domestic use [14], expectation of task types in domestic household robots [11], attitudes regarding robots' suitability for a variety of jobs [17], safety perception of humanoid robots [5], and fear and anxiety [9]. However, these survey studies did not focus on the ethical issues of robots.

Moreover, the ethical issues of robots need to be investigated based on international comparison because general publics' conceptualizations of and feelings toward robots differ due to different situations with respect to mass media and historical influences of technologies. In fact, recent studies [16, 19, 13, 18] show differences of opinions of robots between countries, including attitudes toward robots [3, 20], images of robots [10], and implicit attitudes [7]. In addition, interpretations of the word "ethics" differ between countries because of different social norms. Thus, we should compare the opinions of the general publics of several countries when they face the words "robots" and "ethics" at the same time. This comparison will contribute to preparation of discussion on the international consensus of robotics applications.

As a preliminary stage of the international comparison on robot ethics issues, a questionnaire survey based on open–ended questions was conducted in Japan, the USA, and Europe. To take into account the historical influences of wars into the ethical perspectives of military robotics, the survey in Europe was conducted in Germany and France, which were a defeated country and a victorious country in World War II, respectively. This paper reports the results of the survey and then discusses the implications.

2 Method

2.1 Participants and Data Collection Procedure

The survey was conducted from January to February, 2013. Respondents were recruited by a survey company (Rakuten Research). When the survey was conducted, the numbers of possible respondents registered to the company was about 2,300,000 in Japan, 2,780,000 in the USA, 310,000 in Germany, and 450,000 in France. Among the people randomly selected from these large pools of samples based on gender and age, a total of 100 people of ages ranging from 20's to 60's participated in the survey in each of the four countries. Table 1 shows the sample numbers based on country, gender, and age categories.

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The questionnaire consisting of open–ended items was conducted via Internet homepages in all the countries.

Table 1. Sample Numbers Based on Countries, Gender, and Age Categories

		20's	30's	40's	50–60's	Total
Japan	Male	13	12	13	12	50
	Female	12	13	12	13	50
	Total	25	25	25	25	100
USA	Male	11	13	12	14	50
	Female	11	14	18	7	50
	Total	22	27	30	21	100
Germany	Male	12	11	16	11	50
	Female	10	12	15	13	50
	Total	22	23	31	24	100
France	Male	10	15	12	13	50
	Female	20	8	10	12	50
	Total	30	23	22	25	100
Total		99	98	108	95	400

2.2 Measures

As mentioned in the introduction section, the survey aimed at investigating interpretations of the general publics when they face the words robots and ethics at the same time. To measure and compare their primitive conceptualization between the countries, we did not instruct the definitions of "robots" or "ethics".

The questionnaire solicited information about (1) age, (2) gender, (3) occupation (subject of study if respondents were students), and (4) three questions about ethics and robotics. The questionnaire items about ethics and robotics were open–ended, and designed to elicit a wide variety of responses:

Q1: What would you image when hearing "robots" and "ethics" at the same time?
Q2: What sort of ethical problems would happen when robots widespread in society?
Q3: How should we solve the problems mentioned in item 2?

The questionnaire was conducted in Japanese, English, German, and French languages in Japan, the USA, Germany, and France, respectively. The response sentences in Germany and France were translated into English.

3 Results

3.1 Coding of Open–Ended Responses

For quantitative analyses, the open–ended responses were manually classified into categories based on the contents of the responses. This classification coding was determined by two coders. The first coder dealt with both Japanese and English sentences. The second coder consisted of two people, one for the Japanese sentences and another for the English sentences.

First, coding rules were created for each item. Then, two coders independently conducted the coding of 40% of the responses ($N = 40$ from all the responses of each country), and calculated the κ–coefficients showing the degrees of agreement between the two coded results in order to validate the reliability of the coding rules. The coefficients showed sufficient reliability of the coding rules. Table 2 shows coding rule numbers, examples of sentences in the coding, and κ–coefficients. Furthermore, the two coders interactively discussed the contents of the responses and coding results until they reached a consensus about each coding.

3.2 Q1: Images When Hearing "Robots" and "Ethics" at the Same Time

In Q1, each participant's response was classified into one of the three categories shown in Table 2. Responses assigned L0 showed no concrete image. In the German and French samples, several wrote sentences meaning that the words "robots" and "ethics" clashed with each other. Responses assigned L1 stated images from science fiction contents. Responses assigned L2 included realistic concerns of robotics in society and ambiguous apprehension toward the development of robots.

Table 3 shows the distributions of answer categories based on the countries and the results of a χ^2-test and a residual analysis with $\alpha = .05$. Approximately 60% of the respondents mentioned some apprehension toward robotics. The χ^2–test showed differences between the countries in the category distribution. The residual analysis revealed that in the Japan sample, the frequency of L0 was lower than average and that of L1 was higher than average at statistically significant levels. Moreover, in the German samples, the frequency of L0 was higher than average and that of L2 was lower than average. Furthermore, in the French samples, the frequency of L1 was lower than average and that of L2 was higher than average at statistically significant levels.

To visualize the relationships between countries and images of robots and ethics, a correspondence analysis was performed for the cross-table shown in Table 3. The correspondence analysis allows us to visualize the relationship between categories appearing in a cross–table in two-dimensional space. In this visualization, categories similar to each other are placed at proximate positions. Our analysis using this method aims to clarify the relationship between the countries and respondents' images when hearing "robots" and "ethics" at the same time. We should note that the dimensional axes extracted from the data in the cross–table are specific to the table data and are used to visualize relative distances between categories; that is, they do not correspond to any absolute measure, and so it is difficult to assign realistic meanings to these axes.

Figure 1 shows the results of the analysis. The USA is positioned at the middle point between the three answer categories, and Germany is located at L0. Japan is positioned at the middle point between L1 and L2, and France is near L2. These results can be summarized as follows:

- Compared with the other countries, less German respondents specified images in which robots and ethics appeared at the same time.
- More French respondents specified apprehension toward robotics than did the respondents in the other countries.
- More Japanese respondents specified images from virtual contents in comparison with the respondents in the other countries.

Table 2. Coding Rules of Open–Ended Responses and Reliability

Item	Rule	Label		κ
Q1:	R1:	L0:	Responses that did not image any concrete problems (e.g., "nothing", "don't think ...")	.747
		L1:	Responses that mentioned virtual contents including movies, animations, and comics (e.g., "Robocop", "Blade Runner")	
		L2:	Ones except for the above L0 and L1 (e.g., "What are the ethical rules to apply when using robots?"	
Q2:	R21:	L1:	Responses that mentioned unemployment problems (e.g., "Job losses", "Replacing people with robots so unemployment")	.922
		L0:	Others	
	R22:	L1:	Responses that mentioned crimes or wars (e.g., "People use them to spy", "With battle robots, that will make killing easier and easier")	.717
		L0:	Others	
	R23:	L1:	Responses that mentioned some problems except unemployment, crimes and wars (e.g., "Accidents by robots", "There will be no difference between humans/robots")	.711
		L0:	Others	
Q3:	R3:	L0:	Responses that did not mention any concrete problems in Q2	.647
		L1:	Responses that mentioned restriction of robots' functions, methods of using robots, and areas of robot applications, and legal preparation for the restriction (e.g., "Only use robots in certain situations", "Don't give robots the ability of "think"")	
		L2:	Ones except for the above L0 and L1 (e.g., "I have no idea", "Improvement of human morals", "Keep our manual skills")	

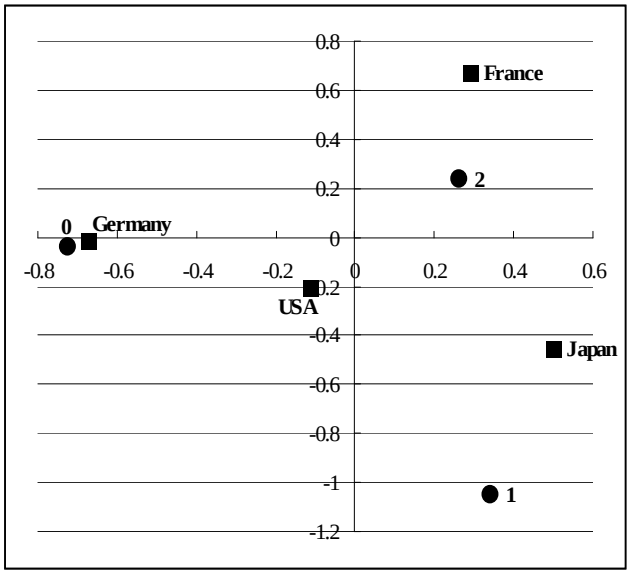

Figure 1. Result of Correspondence Analysis for Table 3

Table 3. Distribution of Answer Categories for Q1 and Results of χ^2–Test and Residual Analysis ($\alpha = .05$)

	Answer Category of R1			
	L0	L1	L2	Total
Japan	$18^{\downarrow}$	$21^{\uparrow}$	61	100
USA	30	15	55	100
Germany	$41^{\uparrow}$	10	$49^{\downarrow}$	100
France	21	$5^{\downarrow}$	$74^{\uparrow}$	100
Total	110 (27.5%)	51 (12.75%)	239 (59.75%)	400 (100%)

$\chi^2(6) = 28.448$, $p < .001$
$^{\uparrow}$: higher than the expected frequency
$^{\downarrow}$: lower than the expected frequency
L0: Responses that did not image any concrete problems
L1: Responses that mentioned virtual contents including movies, animations, and comics
L2: Ones except for the above L0 and L1

3.3 Q2: Ethical Problems in Society

In Q2, one response included several different problems. Thus, each participant's response was assigned multiple labels based on the following rules: (R21) whether it mentioned unemployment problems due to robots, (R22) whether it mentioned the use of robots in crimes and wars, and (R23) whether it mentioned some problems besides unemployment, crimes, and wars. Responses assigned as L1 in R23 included apprehension toward the physical and economical risks of robots, their influences on humans' psychological states, and ambiguous differences between robots and humans.

Table 4 shows the distributions of answer categories based on the countries and the results of the χ^2–test and the residual analysis with $\alpha = .05$. The results can be summarized as follows:

- In the Japan sample, fewer respondents mentioned unem-

Table 4. Distribution of Answer Categories for Q2 and Results of χ^2–Test adn Residual Analysis ($\alpha = .05$)

	R21: Unemployment		R22: Crimes and Wars		R23: Other Problems	
	Not mentioned	Mentioned	Not mentioned	Mentioned	Not mentioned	Mentioned
Japan	$87^{\uparrow}$	$13^{\downarrow}$	$85^{\downarrow}$	$15^{\uparrow}$	$34^{\downarrow}$	$66^{\uparrow}$
USA	77	23	$84^{\downarrow}$	$16^{\uparrow}$	$65^{\uparrow}$	$35^{\downarrow}$
Germany	82	18	$97^{\uparrow}$	$3^{\downarrow}$	47	53
France	$64^{\downarrow}$	$36^{\uparrow}$	$97^{\uparrow}$	$3^{\downarrow}$	$60^{\uparrow}$	$40^{\downarrow}$
Total	310	90	363	37	206	194
	(77.5%)	(22.5%)	(90.75%)	(9.25%)	(51.5%)	(48.5%)
	$\chi^2(3) = 16.803$,	$p < .01$	$\chi^2(3) = 18.673$,	$p < .001$	$\chi^2(3) = 23.261$,	$p < .001$

$^{\uparrow}$: higher than the expected frequency, $^{\downarrow}$: lower than the expected frequency

ployment problems at a statistically significant level in comparison with the other countries.

  - More respondents in the French sample mentioned unemployment.

- The respondents mentioning crimes and wars as ethical problems of robotics in society were in the minority (less than 10%).
  - Nevertheless, more respondents mentioned these problems in the Japan and USA samples than in the German and French samples at statistically significant levels.
- More respondents mentioned problems besides unemployment, crimes, and wars in the Japan samples than in the samples of the other countries.
  - On the other hand, fewer respondents in the USA and French samples mentioned these problems than in the Japan and German samples.

3.4 Q3: Solutions for Ethical Problems of Robotics

In Q3, each participant's response was classified into one of the three categories shown in Table 2. Responses assigned label L0 corresponded to the ones that did not specify anything on the ethical problems of robotics in society in Q2 (that is, participants assigned L0 for R21, R22, and R23). In Q3, responses assigned label L1 mentioned restriction of robots functions, methods of using robots, and areas of robot applications. Some responses classified into this category mentioned the need of legal preparation for the restriction. Responses assigned label L2 included the ones that did not provide any concrete solution or the ones that did show some solutions except restriction of robots.

Table 5 shows the distributions of the answer categories based on the countries and the results of the χ^2–test and the residual analysis with $\alpha = .05$. The χ^2–test showed differences between the countries in the category distribution. The residual analysis revealed that in the Japan sample, the frequency of L0 was lower than average and that of L1 was higher than average at statistically significant levels. About half of them mentioned restriction of robotics usage as a solution to their ethical problems. Moreover, it was found that in the German samples, the frequency of L0 was higher than average. Furthermore, in the French samples, the frequency of L1 was lower than average and that of L2 was higher than average at statistically significant levels.

In the same way as Q1, the correspondence analysis for Q3 in Table 5 was conducted to visualize relationships between countries and solution categories for the ethical problems of robots. Figure 2 shows the result. Japan was positioned far from L0 and L2, near L1. France was positioned far from L0 and L1, near L2. The USA and Germany were positioned at the middle of L0 and L1, far from L2. These results can be summarized by the following comparisons between the countries:

- More respondents in Japan specified ethical problems of robots in society and mentioned restriction of robots in terms of functions and methods of usage as a solution to the problems.
- Fewer French respondents mentioned restriction of robots as the problem solution.
- In the USA and particularly in Germany, many respondents did not specify any problem or solution for the ethical issues of robots in society.

Table 5. Distribution of Answer Categories for Q3 and Results of χ^2–Test adn Residual Analysis ($\alpha = .05$)

	Answer Category of R3			
	L0	L1	L2	Total
Japan	$6^{\downarrow}$	$52^{\uparrow}$	42	100
USA	26	43	31	100
Germany	$27^{\uparrow}$	43	30	100
France	21	$30^{\downarrow}$	$49^{\uparrow}$	100
Total	80	168	152	400
	(20%)	(42%)	(38%)	(100%)

$\chi^2(6) = 26.536$, $p < .001$
$^{\uparrow}$: higher than the expected frequency
$^{\downarrow}$: lower than the expected frequency
L0: Responses that did not mention any concrete problems in Q2
L1: Responses that mentioned restriction of robots' functions, methods of using robots, and areas of robot applications, and legal preparation for the restriction
L2: Ones except for the above L0 and L1

4 Discussion

4.1 Findings

The survey results suggest some characteristics of Japan, the USA, Germany, and France when the general public of each country faces the issues regarding robot ethics.

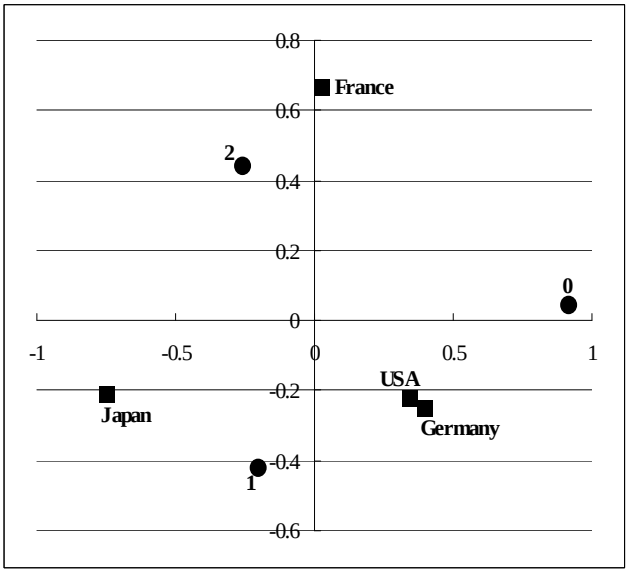

Figure 2. Result of Correspondence Analysis for Table 5

People in Japan tended to react to ethical issues of robotics more seriously than those in the USA, Germany, and France, while they were more influenced by virtual contents such as science fiction movies. In contrast, people in Germany were least likely to connect robotics to ethics. People in France, despite also being in the EU, had a different trend from those in Germany in the sense that they expressed more apprehension toward robotics.

Unemployment as an ethical issue of robotics showed different reactions between these four countries. In particular, Japan and France had opposite trends with respect to this problem. Relationships of robotics with crimes and wars also showed different reactions between the countries. Although a minority of people mentioned this issue as overall, more people tended to specify the issue in Japan and in the USA than in the two European countries.

Consideration of the solutions for the ethical problems of robotics showed opposite trends in Japan and France. Unlike the people in France, the people in Japan tended to argue for restricting the use and development of robots as a solution to ethical problems.

4.2 Implications

The above findings in the survey imply some problems when discussing issues regarding robot ethics at the international level.

First, differences are possible between countries on their general publics awareness of issues regarding robot ethics. Some people may not assume the existence of ethical problems related to robotics. It is implied that the rate of participants in the discussion about robot ethics in society may change depending on the country. Second, it is possible that individual problems have impact on the general public in different ways in different countries. People in one country may participate in discussing an ethical issue and those in another country may not. Such differences in attitudinal biases toward the discussion of robot ethics between countries would make it hard to share problems and solutions internationally. If an ethical problem regarding robots is serious in a country and potentially poses a risk in another country, leaders of the discussion should take into account the differences of awareness of the problem between the countries to establish common assumptions and ways of discussion.

4.3 Limitations

The survey adopted three simple questions and open–ended responses. Thus, the differences of opinions between countries are superficial, and deep factors causing the differences were not explored. It is estimated that these factors include religious beliefs and historical backgrounds in countries, particularly with regard to unemployment and wars. Moreover, the concept of robots may differ between countries [10].

The total number of samples in the survey was not enough to generalize the findings. To clarify more strictly differences in the general publics opinions regarding robot ethics between countries and investigate causes of the differences, we should conduct future surveys using detailed questionnaire items having sufficient validity with a wider area of samples.

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REFERENCES

[1] P. M. Asaro, 'What should we want from a robot ethic?', *International Review of Information Ethics*, **6**, 9–16, (2006).

[2] W. Barendregt, A. Paiva, A. Kappas, A. Vasalou, C. Heath, S. Serholt, C. Basedow, and A. O. Patrcia, 'Child–robot interaction: Social bonding, learning and ethics', in *Workshop proceedings of Interaction Design and Children Conference IDC14*, (2014).

[3] 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*, **21**(1–2), 217–230, (2007).

[4] G. Briggs and M. Scheutz, 'How robots can affect human behavior: Investigating the effects of robotic displays of protest and distress', *International Journal of Social Robotics*, **6**(3), 343–355, (2014).

[5] H. Kamide, Y. Mae, K. Kawabe, S. Shigemi, and T. Arai, 'Effect of human attributes and type of robots on psychological evaluation of humanoids', in *Proc. IEEE Workshop on Advanced Robotics and its Social Impacts*, pp. 40–45, (2012).

[6] P. Lin, 'Introduction to robot ethics', in *Robot Ethics: The ethical and social implications of robotics*, eds., P. Lin, K. Abney, and G. A. Bekey, 3–15, MIT Press, (2011).

[7] K. F. MacDorman, S. K. Vasudevan, and C-C. Ho, 'Does Japan really have robot mania? comparing attitudes by implicit and explicit measures', *AI & Society*, **23**(4), 485–510, (2009).

[8] A. Moon, P. Danielson, and H.F.M. Van der Loos, 'Survey–based discussions on morally contentious applications of interactive robotics', *International Journal of Social Robotics*, **4**(1), 77–96, (2012).

[9] T. Nomura, K. Sugimoto, D. S. Syrdal, and K. Dautenhahn, 'Social acceptance of humanoid robots in japan: A survey for development of the Frankenstein Syndrome Questionnaire', in *Proc. 12th IEEE–RAS International Conference on Humanoid Robots*, pp. 242–247, (2012).

[10] 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', *International Journal of Humanoid Robotics*, **5**(1), 25–46, (2008).

[11] L. Oestreicher and K. S. Eklundh, 'User expectations on human–robot co–operation', in *Proc. IEEE International Symposium on Robot and Human Interactive Communication*, pp. 91–96, (2006).

[12] L. D. Riek and D. Howard. A code of ethics for the human–robot interaction profession. Presented at WeRobot 2014 Conference, March 2014.

[13] L. D. Riek, N. Mavridis, S. Antali, N. Darmaki, Z. Ahmed, M. A. Neyadi, and A. Alketheri, 'Ibn sina steps out: Exploring arabic attitudes toward humanoid robots', in *Proc. 36th Annual Convention of the Society for the Study for Artificial Intelligence and the Simulation of Behaviour (AISB 2010)*, volume 1, pp. 88–94, (2010).

[14] M. Scopelliti, M. V. Giuliani, and F. Fornara, 'Robots in a domestic setting: A psychological approach', *Universal Access in the Information Society*, **4**(2), 146–155, (2005).

[15] A. Sharkey and N. Sharkey, 'Granny and the robots: ethical issues in robot care for the elderly', *Ethics and Information Technology*, **14**(1), 27–40, (2012).

[16] T. Shibata, K. Wada, Y. Ikeda, and S. Sabanovic, 'Cross–cultural studies on subjective evaluation of a seal robot', *Advanced Robotics*, **23**(4), 443–458, (2009).

[17] L. Takayama, W. Ju, and C Nass, 'Beyond dirty, dangerous and dull: What everyday people think robots should do', in *Proc. 3rd ACM/IEEE International Conference on Human-Robot Interaction*, pp. 25–32, (2008).

[18] G. Trovato, M. Zecca, S. Sessa, L. Jamone, J. Ham, K. Hashimoto, and A. Takanishi, 'Cross–cultural study on human-robot greeting interaction: acceptance and discomfort by egyptians and japanese', *Paladyn, Journal of Behavioral Robotics*, **4**(2), 83–93, (2013).

[19] S. Šabanović, 'Robots in society, society in robots', *International Journal of Social Robotics*, **2**(4), 439–45–, (2010).

[20] L. Wang, P-L. P. Rau, V. Evers, B. Krisper, and P. Hinds, 'When in Rome: The role of culture & context in adherence to robot recommendations', in *Proc. 5th ACM/IEEE International Conference on Human-Robot Interaction*, pp. 359–366, (2010).