Culturally Variable Preferences for Robot Design and Use in South Korea, Turkey, and the United States

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ABSTRACT
Based on the results of an online survey conducted with participants in South Korea (N=73), Turkey (N=46), and the United States (N=99), we show that people's perceptions and preferences regarding acceptable designs and uses for robots are culturally variable on a number of dimensions, including general attitudes towards robots, preferences for robot form, interactivity, intelligence, and sociality. We also explore correlations between these design and use characteristics and factors cited as having an effect on user perceptions and acceptance of robots, such as religious beliefs and media exposure. Our research suggests that culturally variable attitudes and preferences toward robots are not simply reducible to these factors, rather they relate to more specific social dynamics and norms. In conclusion, we discuss potential design and research implications of culturally variable and universally accepted user preferences regarding robots.

Categories and Subject Descriptors
H.1.2 [User/Machine Systems]: Human Factors; H.5.2 [User-Centered Design]; I.2.9 [Robotics]: Commercial robots and applications; K.4: Computers and Society

General Terms
Design, Human Factors

Keywords
Cross-cultural study, robots in society, Korea, Turkey, United States, survey, robot design, robot application, user preferences.

1. INTRODUCTION
As the notion of using social robots in everyday contexts with non-expert users gains traction around the world, cultural variability in robot adoption and use has become an important practical problem for developers and a significant research issue. Scholars have shown that our expectations and understandings of technology are "shaped… by the specific cultural and historical resources the world makes available to us" [24]. Culturally variable beliefs, practices, and social norms can therefore be expected to affect robot design, adoption and use.

Both the popular media and scientists are debating cultural differences in the design and projected use of robots in society. East Asian countries like Japan, referred to as a place where robots are "priceless friends" [10], and South Korea, which is implementing service robots as a part of its national information technology policy [14], are expected to readily adopt robots into society. Scholars identify cultural factors such as animism and favorable media representations of robots as possible causes of the positive image of robots in Japan (e.g. [9]; [13]; [15]) and Korea [14]. In contrast, the United States (US) are often described as less accepting of robots due to fears of job loss to automation and threatening media portrayals of robots [3]. Cross-cultural research on people's perceptions of robots challenges the assumption that the Japanese are peerlessly accepting of robots while Americans hold more negative views (e.g. [1]; [20]). Critical studies of robotics in Japan further suggest that positive perceptions of robots are the result of active efforts by the government, industry, and academia to encourage societal acceptance of robotics, rather than of pre-existing cultural predispositions ([11]; [25]).

The development of robotic technologies and applications for global markets requires a deeper understanding of cultural factors that affect robot acceptance and use. It is particularly important to empirically evaluate assumptions about the effects of culture on perceptions of robots. We present the results of a survey performed in the US, S. Korea, and Turkey exploring the incidence and correlations of factors previously identified as relevant to robot design and use, including religious beliefs, popular media portrayals of robots, and preferences for robot appearance and use. Our results show culturally variable perceptions regarding robots design and use, and suggest that culturally variable preferences are not directly explained by previously emphasized factors, such as religious affiliation and media exposure. We identify both culturally specific and universal preferences that can be taken into account in robot design and conclude by discussing the importance of understanding user preferences about robots in the context of situated social norms and practices, rather than generalized cultural characteristics.

2. RELATED WORK
Studies have shown that cultural factors affect the design of robotic technology and researchers' "visions of future possibilities" for robots in society [8]. Shaw-Garlock [22] contrasts the design visions of two social robotics projects, Repliee in Japan and Kismet in the US, to show that history, theology, and popular culture surrounding robots play a role in robot design. Culturally defined conceptions of sociality, such as implicit and explicit displays of affect, also affect the way robots are designed [20]. Suchman [24] suggests that "autonomous, rational agency" is "the prevailing figuration of Euro-American imaginaries" of artificial intelligence and robotics and their role in society. Some Japanese robotics researchers explicitly use notions of cultural specificity and fit to inspire and legitimize the development of socially interactive robots [21].

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The importance of culture as a framework for making sense of robots in daily life extends to the way users perceive and interact with robots. Bartneck et al [2] find significant cultural variation in negative attitudes towards robots among Dutch, Chinese, German, American, Japanese, and Mexican participants. MacDorman et al show that US and Japanese participants have similar attitudes towards robots, suggesting that factors such as history and religion may affect differences in their willingness to adopt robots [20]. Survey evaluations of the seal-like robot PARO by participants from Japan, the UK, Sweden, Italy, South Korea, Brunei, and the US found that all participants evaluated the robot positively, but identified its most likeable traits differently according to the country [23]. In the context of human-robot teamwork, Evers et al found users from China and the US respond differently to robots [6] and that robots are more effective in influencing the opinions of human team-members when they use culturally appropriate forms of communication [19]. Lee et al. found that culturally variable meanings of the home and collectivist and individualist models of interaction in S. Korea and the US, respectively, affect participants' design preferences for domestic robots [17].

In investigating particular cultural factors that may explain variability in user reception and acceptance of robots, researchers have paid particular attention to the influence of media, religion, and social beliefs. Kaplan identifies animistic beliefs, aesthetic views of nature, and portrayals of robots in popular media as factors that affect positive views of robots in Japan [13]. Kitano suggests that specificities in Japan's social, historical and cultural development led to its unique conceptualization of robot ethics [15]. Robotics research in the US and other Western countries has been described as influenced by Christian beliefs about transcendence and the special nature of humans (e.g. [9]). Media portrayals of robots as positive and friendly or negative and threatening have also been used as explanations for differences in the design and popular image of robots in Japan and the US [3]. The relationship of these factors to user evaluations and preferences has yet to be systematically and empirically studied.

3. STUDY DESIGN

The study presented here contributes to research on cultural differences in user perceptions of robots by using a survey to gauge general user attitudes and preferences toward robots, as well as to explore the correlations between widely discussed cultural factors (e.g. media, religion) and user preferences. The surveys were preformed in three cultural contexts – the US, S. Korea, and Turkey – all of which have moderate to high levels of technological development and are seen as important economic markets. The US is included as a developed Western country, S. Korea is a technologically advanced East Asian country, and Turkey is a swiftly developing Middle Eastern technology market.

3.1 Participants

Our survey was completed by 73 Korean, 99 American and 46 Turkish respondents, all native to and currently living in the participating countries. We recruited participants through word of mouth, resulting in a subject pool with diverse ages and occupations beyond university students and staff, who have been the main participants in prior cross-cultural HRI studies. All participants had at least a high school education. 70/99 US participants were living in Bloomington IN, though their hometowns were distributed across the U.S.; all Korean participants lived in Seoul; all Turkish participants in Istanbul. See Table 1 for other demographic details.

Table 1. Demographic information on participants

		Korea M N=73	US N=99	Turkey N=46
Average age [M(sd)]		34 (11.47)	35 (15.77)	34 (8.31)
Gender	Male (N)	44	38	29
	Female (N)	29	57	17
	Other (N)	0	4	0
Education	High school	19	21	6
	College	42	41	16
	Graduate	12	37	24
Technological expertise 1: Beginner – 7: expert [M(sd)]		3.8 (1.47)	5.0 (1.17)	5.0 (1.16)

3.2 Method

Our survey explored general patterns in people's perceptions and preferences regarding robots. After signing the online consent form, participants answered questions on nine topics: 1) *general views about robots* (e.g. acceptance of robots in various use contexts, 2) *form factors* (e.g., materials, size, level of human-likeness), 3) *intelligence* (e.g., social awareness, level of autonomy), 4) *sociability* (e.g., social roles, personality), 5) *interactivity* (e.g., interaction modes and capabilities), 6) *religious beliefs and social norms* (e.g., religious affiliation, agreement with statements related to Confucianism, Animism, Christianity, etc.), 7) *media exposure* (e.g., knowledge and evaluation of fictional robots such as Astroboy and Terminator), 8) *evaluation of existing robots* (e.g., Aibo, Geminoid, Roomba), and 9) *demographic questions* (e.g. gender, age, income). The exact format of the questions is described in the Results section. Our questions were based on literature on robot design and acceptance (e.g., [5, 7, 18]) and cultural factors related to user perceptions of robots [2, [2, 17]). Participants received a version of the survey in their native language (English[16], Korean, and Turkish).

In our analysis, we describe the general patterns of user preferences and evaluations of robots within the three cultural groups, investigate the effects of specific cultural factors (e.g. religion, media exposure) on these preferences, and explore other salient factors that affected participant preferences. The statistical analyses presented were all performed using SPSS. Due to the unbalanced nature of our national samples, we used a mixed linear model to test the effects of nationality and the other demographic data (e.g. gender, age) on the design preferences and beliefs about robots of our participants. Subsequent post hoc inter-group comparisons with the Sidak adjustment were used to determine the source of significant differences among groups. We also examined correlations between potentially salient independent variables (e.g., religion, media exposure, previous experiences with robots, age, gender) and participants' design preferences with appropriate correlation tests, as described below.

4. RESULTS

We first describe participants' general attitudes toward robots as well as their preferences regarding various attributes of robots, including form factors, intelligence, sociality, and interactivity. We then discuss participants' explicit expressions of religious belief and their agreement with various social and cultural norms, and explore the correlations between their beliefs and robot design and use preferences. We also analyze participants' knowledge about robots in the media and its effects on their evaluations of actual and fictional robots.

4.1 General Attitudes towards Robots

We asked participants to state the extent to which they would want robots to assist them in different use contexts (e.g. the home, office, hospital). The evaluation was on a 5-point scale (1: "Not at all" to 5: "To a great extent", which we from here on refer to as the "5-point opposition scale"). Participants could also choose "I don't know" as an answer, which we excluded from the analysis. Using mixed-effects analysis for variance, we found a significant effect of nationality on participants' acceptance of robots in different contexts (see Table 2). Post hoc comparisons showed Korean and Turkish participants were more willing to have robots in all contexts in comparison to US participants, except for dangerous locations. US participants were generally unwilling to use robots in everyday spaces, but found factories and dangerous environments to be appropriate use contexts for robots.

While participant nationality did not have a significant effect on participant preferences for using robots in dangerous locations, participants who said the media represent robots as negative or useful were significantly more likely to consider dangerous locations as an appropriate context of use for robots ($p<0.05$).

Table 2. Effect of nationality on desired context of use

Context	sig		Korea N=73	US N=99	Turkey N=46
Home	<0.01	M	4.01	2.78	3.76
		SD	1.03	1.17	1.29
Hotel	<0.01	M	3.79	2.55	3.93
		SD	1.31	1.12	1.15
Museum	<0.01	M	3.82	2.41	3.48
		SD	1.07	1.06	1.30
Shopping center	<0.01	M	3.41	2.49	3.77
		SD	1.31	.93	1.22
Office	0.04	M	3.72	2.70	3.94
		SD	1.22	1.10	1.15
School	0.03	M	3.40	2.52	3.43
		SD	1.30	1.20	1.30
Sports facility	<0.01	M	3.74	3.12	3.28
		SD	1.31	1.32	1.51
Hospital	<0.01	M	4.07	3.02	4.04
		SD	1.20	1.16	1.03
Police station	<0.01	M	3.53	2.17	3.33
		SD	1.31	1.00	1.60
Factory	<0.01	M	4.71	4.19	4.77
		SD	.80	1.07	.50
Dangerous locations	0.08	M	4.55	3.78	4.69
		SD	.91	1.40	.71

4.2 Form factors

To ascertain which robot designs would be acceptable in different countries, we asked participants about their preferences for a robot's gender, materials, facial expression, and morphology. A larger proportion of US participants (US: 34%, KR: 12%, TK: 14%) did not care which form the robot takes across all questions, corroborating findings of a prior study [17].

4.2.1 Gender

We asked participants which gender they would want their robot to be (1: male, 2: female, 3: no gender, 4: no preference), with multiple choices allowed. Answers were scored by making a separate column for each choice with 1(selected)/0(not selected) for each participant prior to statistical analysis. We did not find any significant effects of nationality at $p<0.05$. Prior experience with toy robots, however, had a significant negative effect on preferences for robots with no gender ($p<0.05$).

4.2.2 Material

We also asked participants which materials they prefer to be used in robot design, allowing them to choose multiple answers (See Table 3). We scored each category as (1: selected) or (0: not selected) prior to statistical analysis. The results of a mixed-effect analysis of variance and post hoc comparisons indicated that US participants have stronger preferences for fabric over Koreans, and for plastic more than Turkish participants. US participants also chose metal significantly more often than Turkish participants, and "does not matter" significantly more often than Korean participants.

Respondents who thought media represent robots as useful ($p<0.01$) and those with higher incomes ($p<0.05$) had stronger preferences for robots made of silicon. Experience with functional robots (factory, vacuum, lawn mower) had a positive affect on preferences for having robots made out of plastic ($p<0.05$).

Table 3. Effect of nationality on material preferences

Materials	sig		Korea N=73	US N=99	Turkey N=46
Silicon	0.12	M	.59	.47	.46
		SD	.50	.50	.51
Fabric	<0.01	M	.03	.23	.10
		SD	.17	.42	.30
Plastic	0.03	M	.45	.58	.35
		SD	.50	.50	.48
Metal	0.02	M	.32	.52	.26
		SD	.47	.50	.44
Does not matter	0.02	M	.12	.31	.16
		SD	.33	.48	.37

4.2.3 Facial Expression

Participants also expressed their preferences regarding facial expressions in robots, once again being able to give multiple answers (see Table 4) and scored by giving each category a (1: selected) or (0: not selected) value. A face with dynamic facial expressions was the most commonly preferred option. Mixed-effect analysis of variance and post hoc comparisons showed that US participants preferred robots not to have facial expressions or a face at all to a significantly higher degree than Korean and Turkish participants. US and Korean participants tended to prefer fixed facial expressions more than Turkish participants.

Table 4. Effect of nationality on facial expression preferences

Expression	sig		Korea N=73	US N=99	Turkey N=46
Fixed facial expression	0.06	M	.24	.45	.06
		SD	.43	.50	.24
Changing facial expression	0.47	M	.58	.46	.51
		SD	.50	.50	.51
Does not need facial expression	0.71	M	.14	.33	.11
		SD	.35	.47	.32
Does not need face	<0.01	M	.06	.51	.23
		SD	.23	.50	.43
No preference	0.59	M	.13	.17	.09
		SD	.34	.38	.28

4.2.4 Lifelikeness

We asked participants to evaluate how much they would like to interact with robots that were machine-like, plant-like, animal-like, or human-like on the 5-point opposition scale. Mixed-effects analysis of variance and subsequent comparisons showed Koreans had a strong preference for humanlike robots compared to US participants, US participants had a strong preference for machine-like robots over others, and Turkish participants were neutral on both types (See table 5). Koreans had a significantly higher preference for animal-like robots compared to Turkish participants, and for plant-like robots compared to both US and Turkish participants. Turkish participants were significantly more negative towards plant-like robots than others, though this preference might also have been affected by exposure to robot toys, which had a significant negative effect on preferences for plant-like robots ($p<0.05$). Prior experience with factory robots also increased preference for machine-like ($p<0.05$) and animal-like robots ($p<0.05$), though not as strongly as nationality.

Table 5. Effect of nationality on lifelikeness

Lifelikeness	sig		Korea N=73	US N=99	Turkey N=46
Machine-likeness	<0.01	M	2.88	3.48	3.06
		SD	1.16	1.09	1.31
Human-likeness	0.01	M	3.41	2.83	3.14
		SD	1.14	1.23	1.44
Animal-likeness	0.07	M	3.12	2.71	2.38
		SD	1.20	1.25	1.28
Plant-likeness	0.01	M	2.37	2.39	1.68
		SD	1.15	1.26	.98
		SD	1.14	1.27	.97

4.3 Intelligence

We asked participants their preferences regarding a robot's ability to understand their emotions, to perform tasks autonomously, and to understand social rules and cues. When asked to what extent they wanted robots to be able to *understand the users' emotions* ("1: Does not understand emotion," "2: Partially understands emotion and responds as a tool (e.g. play music)," "3: Fully understands as a friend," "4: No preference"), a majority of participants (KR: 56%, US: 57%, TK: 44%) wanted the robot to partially understand their emotional status, with no significant differences among groups. We also asked participants to *what extent robots should be autonomous* ("1: Do not want any autonomy," "2: Partially autonomous," "3: Fully autonomous," "4: No preference"). Our mixed-effect tests showed participants in all three groups preferred robots with partial autonomy (p=.63, M=1.92, SD=.60). Robots with no autonomy ranked second (24% Korean, 16% US, and 20% Turkish participants), while fully autonomous robots were the least preferred (15% Korean, 13% US, and 11% Turkish participants).

Participants rated robots according to their level of *social intelligence*, such as knowledge of etiquette, social norms, law, humor, social hierarchy, and social cues. Nationality did not have significant effect on these preferences, though age did. Preferences for robots that understand law (p=0.02), etiquette (p=.02), social norms (p=.01), humor (p=.01), and social hierarchy (p=.03) increased significantly with participant age Older participants also responded more negatively to "A robot does not need to understand social norms" (p<0.01).

4.4 Sociability

4.4.1 Expected social role of robots

Participants chose their preferences among various social roles robots could have (see Table 6), with multiple choices allowed and categories scored as (1: selected) or (0: not selected) prior to analysis. Mixed-effects analysis showed a significant effect of nationality on their preferences for robots as assistants, pets, and no social role, and a strong trend regarding robots as servants (see Table 8). All participants gave low evaluations to robots as companions (p=.23, M=.20) and teachers (p=.07, M=.19). Post-hoc comparisons showed Koreans assign social roles to robots significantly more often than other participants. Koreans preferred robots as assistants more than both Turkish and US participants, and as pets more than Turkish participants. Unlike Koreans, the majority of whom believed robots should have social roles (92%), most US participants saw robots as tools (53%).

While there were no significant effects of nationality, we found familiarity with toy robots increased preferences for robots as assistants (p<0.01), companions (p=.02), and teachers (p=.01).

Table 6. Effect of nationality on social role preferences

Social role	sig		Korea N=73	US N=99	Turkey N=46
Assistant	0.02	M	.77	.64	.51
		SD	.42	.48	.50
Companion	0.23	M	.25	.17	.26
		SD	.43	.38	.43
Teacher	0.07	M	.15	.25	.09
		SD	.36	.43	.28
Pet	0.02	M	.32	.15	.09
		SD	.47	.36	.28
Servant	0.05	M	.56	.34	.34
		SD	.50	.48	.48
No social role, robots are just tools	<0.01	M	.08	.53	.37
		SD	.28	.50	.49

4.4.2 Expected Users in Various Social Contexts

To understand the roles participants expect robots to play in different social contexts, we asked them to rate which social actors would be most likely to interact with robots in the home, school, and workplace on a 5-point oppositional scale. For *social actors in the home*, all participants had similar expectation regarding fathers (See Table 7). Preference for interaction with children was also affected by age (p<0.01) and previous experience with robots (p<0.05), so the effect of nationality is not clear. Korean and Turkish participants expected mothers and grandparents to interact with domestic robots significantly more often than US participants. Turkish participants also expected pets to interact with robots more than Korean participants. Nationality also had a significant effect on expected levels of interaction of different *social actors in schools*. Turkish participants expected principals and staff to interact with robots significantly more than Korean participants (See Table 9). Korean and Turkish participants expected more interaction with students and parents than those in the US. Turkish participants expected significantly higher levels of interaction between robots and support staff *in the workplace* compared to Korean participants. Media exposure had significant positive effects on preferences for robots to interact with executives (p<0.05), supervisors (p<0.05), and administrative assistants (p<0.05), while age had negative effects on expectations that robots will interact with administrative assistants (p<0.05) and interns (p<0.01).

Table 7. Effect of nationality on social actors in use contexts

Social actor		sig		Korea N=73	US N=99	Turkey N=46
Home	Father	0.40	M	3.29	3.23	3.53
			SD	.92	1.10	.99
	Mother	0.11	M	3.81	3.27	4.09
			SD	.94	1.11	.93
	Kids	<0.01	M	3.84	2.83	3.74
			SD	1.10	1.25	1.14
	Grandparents	<0.01	M	3.07	2.60	3.82
			SD	1.26	1.20	1.20
	Pets	<0.01	M	1.81	2.20	3.03
			SD	1.12	1.09	1.34
School	Principals	<0.01	M	2.94	3.01	3.65
			SD	1.20	1.14	1.04
	Teachers	0.07	M	3.91	3.33	3.97
			SD	1.03	1.00	.94
	Students	0.04	M	3.81	3.00	3.88
			SD	1.20	1.21	1.01
	Staff	0.02	M	3.35	3.35	3.88
			SD	1.17	1.03	1.2
	Parents	0.04	M	2.78	2.12	2.97
			SD	1.24	.97	1.26
Workplace	Executives	0.12	M	3.03	2.68	3.36
			SD	1.24	1.13	1.14
	Supervisors	0.38	M	3.33	2.96	3.42
			SD	1.15	1.06	1.12
	Administrative assistants	0.05	M	3.63	3.04	3.58
			SD	1.10	1.00	.97
	Interns	0.02	M	3.71	2.96	3.12
			SD	1.07	1.04	1.00
	Supporting staff	0.01	M	3.57	3.55	4.30
			SD	1.13	.96	.88

4.5 Interactivity

Participants were asked to choose different modes of interaction they would like to have with robots using a 5-point oppositional scale. Nationality significantly influenced interaction mode preferences (see Table 8). Korean participants preferred multiple modalities including sound and speech compared to US participants, while Turkish participants preferred smart technologies over both American and Korean participants. Male participants were more positive on using touch ($p<0.05$) and speech ($p<0.05$) as modes of interaction.

Table 8. Effect of nationality on interaction mode

Interaction mode	sig		Korea N=73	US N=99	Turkey N=46
Sound	<0.01	M	3.64	2.88	3.69
		SD	1.10	.95	1.13
Visual cues	0.61	M	3.54	3.34	3.77
		SD	1.13	.84	1.02
Gestures	0.30	M	3.45	2.84	3.63
		SD	1.10	1.10	1.26
Speech	0.01	M	4.18	3.52	3.86
		SD	.98	1.14	1.09
Touch	0.09	M	3.12	2.41	2.91
		SD	1.24	1.25	1.40
Bodily movements	0.10	M	3.41	2.78	3.44
		SD	1.10	1.10	1.21
Smart technology	0.02	M	3.78	3.71	4.49
		SD	1.08	1.07	.78

4.6 Religious and spiritual beliefs

One of our aims in this survey was to see whether participants' explicitly stated religious beliefs, which are commonly seen as an important factor in robot acceptance (e.g. [4]), were correlated with their attitudes towards and evaluations of robots.

4.6.1 Religious affiliation

Participants' explicit religious affiliations are shown in Table 9. The majority of participants in our survey (59%) identified as not religious. We did not find any correlation between participants' stated religious affiliation and their preferences for various robot design criteria (e.g. form, interactivity, intelligence).

Table 9. Effect of nationality on robot personality

Religion	Korea N=73	US N=99	Turkey N=46
Protestant	23	17	0
Catholic	4	9	0
Muslim	0	0	24
Buddhist	2	0	0
Not religious	41	57	18
Other	0	3*	0

*Mormon: 2, Jewish: 1

4.6.2 Spiritual beliefs

Participants rated their agreement with a series of statements that reflect particular beliefs and social norms, as well as their adaptations to future interactions with robots, on a 5-point oppositional scale. The statements reflected animist beliefs ("A tree has a soul," "An animal has a soul," "A robot has a soul"), Confucian social norms ("A robot needs to use the honorific to older adults," "A robot should know how to bow and whom to bow to"), and human exceptionialism ("Humans are unique among the creatures in the world," "A human is the owner of nature and can use it as a tool," "Robots should not be made in human form").

A mixed-effects analysis of variance found Koreans were strongly in agreement with both statements related to *Confucian social norms*, Turkish participants agreed with the statement on the use of the honorific, while US participants did not agree with either statement (See Table 10). *Animism* has been widely discussed as a belief/philosophy that might affect people's acceptance and perceptions of robots. Turkish participants expressed significantly stronger agreement with animist statements compared to Koreans, who agreed weakly, and US participants, who did not agree. Interestingly, these animist beliefs did not extend to robots, as all groups on average disagreed with the notion that a robot might have a soul. Nationality had a significant effect on participants' agreement with the statements that "A human is the owner of nature and can use it as a tool," with which Turkish participants disagreed significantly more than Koreans.

Table 10. Effect of nationality on spiritual beliefs

Beliefs	sig		Korea N=73	US N=99	Turkey N=46
A robot needs to use the honorific to older adults.	<0.01	M	3.73	2.50	3.74
		SD	1.13	1.28	1.29
A robot should know how to bow and whom to bow	<0.01	M	3.31	1.72	2.54
		SD	1.22	1.21	1.48
A tree has a soul.	<0.01	M	2.93	2.14	4.35
		SD	1.22	1.36	1.23
An animal has a soul	<0.01	M	3.34	2.84	4.59
		SD	1.30	1.55	.96
A robot could have a soul	0.54	M	2.09	1.88	2.03
		SD	1.11	1.27	1.33
A human is the owner of nature and can use it as a tool	<0.01	M	2.31	1.93	1.51
		SD	1.44	1.20	1.14
Humans are unique among creatures in the world	0.94	M	3.46	3.38	3.33
		SD	1.28	1.50	.1.73
Robots should not be made in human form	0.38	M	2.30	2.43	2.03
		SD	1.30	1.45	1.29

4.6.3 Correlations with spiritual beliefs

Pearson product-moment correlation coefficients (r) and Spearman's Rank Order (r_s) correlations were computed to assess whether participants' preferences regarding robot design and use were correlated with their religious affiliation and spiritual beliefs. The most common correlations of spiritual beliefs and robot design and use preferences were related to participants' agreement with Confucian values. Agreement with the statement that "A robot should know how to bow and whom to bow to" was positively correlated with participants' acceptance of robots in the home (r_s=.415, n=170, p<0.01), museum (r_s=.364, n=159, p<0.01), and hotel (r_s=.336, n=168, p<0.01); agreement with "A robot needs to use the honorific to older people" was positively correlated with participants' willingness to use robots in the home (r_s=.356, n=174, p<0.01), museum (r_s=351, n=164, p<0.01), and hotel (r_s=.309, n=170, p<0.01). Robot bowing was also positively correlated with preference for female robots (r_s=.354, n=171, p<0.01) and human-like appearance (r_s=.424, n=163, p<0.01); it was negatively correlated with preference for machine-like robots (r_s=-.346, n=162, p<0.01). We found negative correlations between no social role for robots and Confucian beliefs about robots bowing (r=-441, n=171, p<0.01) and using the honorific to elders (r=-319, n=180, p<0.01). A preference for robots with "no face" correlated negatively with participants' agreement with the need for robots to use the honorific (r=-.366, n=175, p<0.01) and bow appropriately (r=-.371, n=171, p<0.01). We found a positive correlation between the expected level of emotional intelligence and agreement for robots using the honorific (r=.358, n=165, p<0.01), and knowing how to bow (r=.435, n=164, p<0.01).

Beliefs in animism (e.g. A tree has a soul) showed no correlation with preferences for human-likeness, contrary to our expectations.

4.7 Media Exposure

Along with religion, media exposure is often mentioned as a defining factor in people's perceptions and acceptance of robots. To gauge media exposure and its effects, we asked participants to evaluate how robots are portrayed in the media using a 7-point semantic differential scale (positive-negative, scary-friendly, mean-kind, useful-useless, and smart-stupid). We also asked them to evaluate five fictional robots on the same scale: Japanese animations Astroboy and Doraemon, Maria from *Metropolis*, R2D2 from *Star Wars*, and Terminator (see Figure 1).

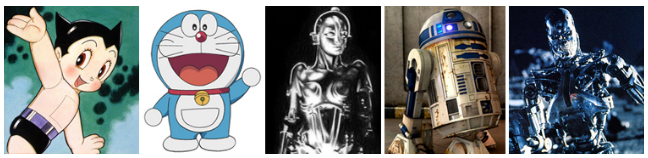

Figure 1. Astroboy, Doraemon, Maria, R2D2, and Terminator

Mixed-effects analysis of variance showed US participants considered portrayals of robots in the media to be significantly more negative, scary and mean than Korean and Turkish participants (See Table 11). All participants thought media portrayed robots as useful and smart. Koreans were more familiar with friendly robots like Astroboy (91%) and Doraemon (76%) than US (66% Astroboy, 3% Doraemon) and Turkish participants (11% Astroboy and 4% Doraemon). We did not find any correlation between being familiar with friendly robots like Astroboy and positivity towards robots, aside from a weak correlation between knowledge of Astroboy and acceptance of robots in the home (r_s =290, n=216, p<0.01).

Table 11. Effect of nationality on robots in media

Evaluation	sig		Korea N=73	US N=99	Turkey N=46
Positive - negative	<0.01	M	4.65	3.90	4.77
		SD	1.25	1.25	1.26
Friendly - scary	<0.01	M	4.66	3.72	4.26
		SD	1.16	1.21	1.34
Kind - mean	0.07	M	4.68	4.03	4.40
		SD	1.04	1.08	1.24
Useful - useless	0.69	M	5.65	5.71	5.54
		SD	1.00	.94	1.15
Smart - stupid	0.44	M	5.44	5.66	5.23
		SD	1.41	1.16	1.46

4.8 Evaluation of existing robots

Along with fictional robots, we also asked participants to evaluate existing robots using the same 7-point semantic differential scale. Robots presented were Aibo, Keepon, Wakamaru, Geminoid, Roomba, and Tmsuk (See Figure 2). Prompts to evaluate the robots were accompanied by links to YouTube videos showing their operation and basic movements in a neutral context. As we did not have a way to do physical experiments with so many participants in diverse locations, we included videos to give participants a sense of the robots' embodiment. We discuss only significant differences below due to space constraints.

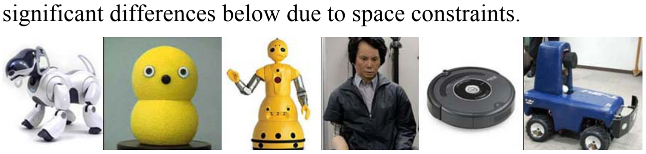

Figure 2. Aibo, Keepon, Wakamaru, Geminoid, Roomba, Tmsuk

Participants regardless of their nationality considered Aibo to be friendly (p=.651, m=5.46, sd=1.28) and kind (p=.338, m=5.12, sd=1.17). Korean and Turkish participants were more likely to evaluate Aibo as positive and useful than US participants, while Koreans saw it as smarter than US participants. Female participants also tended to report Aibo as more positive (p<0.05), useful(p<0.01), and smart (p<0.01).

Table 12. Effect of nationality on Aibo evaluation

Types of intelligence	sig		Korea N=73	US N=99	Turkey N=46
Negative - positive	<0.01	M	5.61	4.95	5.77
		SD	1.10	1.23	1.33
Useless - useful	<0.01	M	4.56	2.81	3.80
		SD	1.53	1.36	1.76
Stupid - smart	<0.01	M	4.35	3.38	3.83
		SD	1.35	1.08	1.56

Participants regardless of their nationality evaluated Keepon as positive (m=5.57, sd=1.27), neither smart nor stupid (m=4.07, sd=1.32), friendly (m=5.77, sd=1.11), and kind (m=5.25, sd=1.17). Koreans found Keepon to be more useful than Turkish and US participants.

Table 13. effect of nationality on Keepon evaluation

Types of intelligence	sig		Korea N=73	US N=99	Turkey N=46
Mean - kind	0.11	M	4.96	5.41	5.46
		SD	1.06	1.18	1.27
Useless - useful	<0.01	M	4.24	2.77	3.34
		SD	1.36	1.34	1.73
		SD	1.35	1.33	1.60

Participants regardless of their nationality considered Geminoid is neither smart nor stupid (p=.274, m=4.11, sd=1.14). Both technical expertise and nationality had a significant effect on the negativity of evaluations of Geminoid, with Korean participants showing significantly more negative impressions than US participants. Koreans also thought Geminoid is mean to a significantly greater extent than other participants. Participants with a higher level of technical expertise tended to evaluate Geminoid more positively (p<0.01). Also, male participants tended to say Geminoid is more friendly (p<0.05)

Table 14. Effect of nationality on Geminoid evaluation

Types of intelligence	sig		Korea N=73	US N=99	Turkey N=46
Negative - positive	<0.01	M	2.48	3.47	2.77
		SD	1.09	1.43	1.48
Scary - friendly	0.043	M	2.58	3.26	3.15
		SD	1.07	1.20	1.40
Mean - kind	<0.01	M	3.34	4.07	4.06
		SD	1.08	.70	.1.03

Overall, the evaluations of existing robots were not conclusive in relation to nationality of the participants due to other factors, which also suggest further avenues for future research.

5. DISCUSSION

Culturally situated studies of technology, such as Bell's ethnography of pervasive technology [4] and Ito's study of mobile phones in Japan [12], showed that cultural factors affect situated practices and sense making about technology in everyday use. Unlike these technologies, robots are not commonly used in everyday life, so we used online surveys rather than ethnographic and observational methods to explore cultural variability in user perceptions and preferences regarding robots. Our results suggest avenues for further experimental and field research as well as factors to consider in designing robots for different cultural contexts.

5.1 Culturally variable user preferences

We found that participants from the three countries surveyed had significantly different preferences regarding how robots should look, act, who they should interact with, and which contexts they should be used in. Korean participants chose robots with design characteristics that were more animate and social than those chosen by US participants, preferring robots with a human-like appearance and expressive faces. US participants, on the other hand, preferred machine-like robots made of metal and without faces or facial expressions. US participants were also more likely to say they had no preference regarding a robot's appearance. Korean participants stated it is appropriate to use robots in social contexts and roles, while US participants did not think robots should be used in everyday contexts and saw them as tools. These results fit the a prior interview study we performed with Korean and US participants [17], in which US participants had a predominantly functional view of robots, while Koreans expected robots to provide social services.

Turkish participants showed a wider diversity of opinions about robot design and use, fitting in somewhere between Korean and US participants. This may have to do with the novelty of robots in Turkey, where specific expectations about their design and use have not yet become culturally dominant. Turkish participants were generally comfortable with having robots serve in various social contexts and roles and with robots having certain human-like characteristics, such as dynamic facial expressions. They equally preferred having machine-like and human-like robots.

These results show that East Asian participants are not alone in accepting socially interactive robots and further suggest that factors beyond religious belief and media exposure, including current social norms and dynamics present across national contexts, might have important effects on this acceptance. Our results also suggest that nationality has a particularly strong effect when participants socially contextualized their preferences regarding robot design and application, such as in choosing appropriate interaction partners and social roles.

5.2 Influence of Media and Religion

Our survey showed that participants varied in terms of their religious beliefs and levels of media exposure, but that these factors did not fully explain the cultural variations in participants' ideas about robots. We did not find any correlations among explicit religious affiliation and user preferences and evaluations of robot design and use. We did, however, find that particular social norms and spiritual beliefs were correlated with participants' statements about robots. Beliefs related to social hierarchy and etiquette (e.g. bowing, use of honorific) were relevant to Korean and Turkish participants who preferred socially interactive robots. Less practice-oriented beliefs (e.g., animal has a soul) did not carry over to user preferences regarding robot design.

Similarly, media portrayals seem to influence user imagination about robots, but did not have significant correlations with participants' acceptance of specific types of robots in society or their preferred design characteristics. Korean participants showed the highest level of exposure to robots in the media, knowing both friendly and threatening robotic characters. US participants were generally familiar with more functional robots, while Turkish participants had a low degree of exposure to the fictional robots we presented. Regardless of their familiarity with diverse robots, Korean participants had a more socially oriented imaginary of robots in society, while US participants thought of robots functionally in line with the nature of their media exposure to robots, and Turkish participants accepted a variety of robots.

Our results suggest that contextually situated social norms and behaviors might be more important for how users view and prefer to use robots than broadly defined religious beliefs and media portrayals of robots, although the latter might affect their general imagination and views. As we saw in prior research [17], users tend to envision robots within specific social contexts, so studying situated interaction and sense making in context will be crucial for developing culturally sensitive robot design.

5.3 Situating robots in social dynamics

Korean and Turkish participants were comfortable with having robots in various everyday settings, while US participants preferred to use robots mainly in industrial settings. Both US and Turkish participants were uncomfortable with having robots used in the police station, which may reflect current events involving police brutality in Turkey, and privacy concerns regarding the use of technology for surveillance in the US.

Cultural variability in participants' preferences for how robots were used further extended to the kinds of social roles they expected robots to take in these contexts. Korean participants envisioned robots as social but subservient to humans, as shown by their preference for robots addressing users with the honorific as well as their desire for robots not to initiate interaction. Korean participants' preference for robots with fixed facial expressions may also be seen as a way of symbolizing actors lower in the social hierarchy, who should not express their emotions directly to others. In their evaluations of robots, Koreans found even simple social robots like Aibo and Keepon to be useful, in contrast to other participants. US participants, who view robots mainly as functional tools, saw such robots as generally useless.

Participant preferences for specific roles of robots also reflected their local social dynamics. The extended family structure in Turkey, in which grandparents participate in the daily life of the family, made them important potential users. In both Turkey and Korea, mothers were the most common users in the home, reflecting the gendered division of domestic labor in those countries. In the US, in contrast, both father and mothers were evenly ranked as the main users of robots.

In summary, our results suggest that, rather than focusing on broad cultural factors such as differences in religious beliefs and media portrayals, researchers and designers need to study the current social dynamics in situated contexts of use to identify salient factors that can inform future robot design.

5.4 Universal design preferences for robots

Regardless of cultural background and other robot design and use preferences, all participants agreed on a few design factors for everyday robots. These were level of autonomy and control over robots. In contrast to the long-term aims of robotics to create autonomous machines, none of our participants wanted fully automated robots. Partial autonomy was preferred for robots as social actors and tools. Participants wanted to retain partial control over robots by making their actions dependent on user commands and instructions. This cross-cultural agreement suggests that appropriate levels of autonomy and modes of user control will be important to consider for robotics developers all over the world.

5.5 Limitations

While our study included a diverse set of participants from three countries, our sample was not representative of the broader population. Our respondents were generally highly educated people living in major cities and a university town. Our respondents, however, fit the profile of potential early adopters of robotic technology, so their views provide a legitimate initial overview of the initial differences that might occur across national cultures. Furthermore, our data was demographically unbalanced across the national samples. A mixed model analysis identified multiple areas of user perceptions of robots in which nationality is a significant factor, as well as additional variables that should be further explored, including gender, age, and prior exposure to robots (the latter in particular will become increasingly salient as exposure to robots in society is more likely). Finally, our use of a survey methodology for studying cross-cultural differences allowed us to pinpoint general differences but did not allow us to isolate specific factors that cause these differences (as might be possible in an experiment) or to study the situated nature of user sense making about robots, which needs to be done to understand the different meanings that users ascribe to robot categories, use contexts, and social roles. Our results point to different areas in which further studies can be performed, such as the focus on studying how robots fit into social norms and dynamics rather than focusing on user characteristics (e.g. religious belief), as well as the study of how cultural meanings may change with broader mediated and face-to-face exposure to robots.

6. CONCLUSION

Through a broad survey of user preferences for robot design and use in the US, Turkey, and S. Korea, we identified culturally variable design characteristics and salient cultural factors that affect user conceptions and evaluations of robots. Our exploratory study emphasizes the importance of performing cross-cultural studies of robots that go beyond general characteristics and delve into more contextually and socially situated dynamics of sense making and interaction to develop technologies for global markets. We particularly suggest focusing not only on cultural difference but also on similarity, and doing situated studies of robot use contexts to clearly identify how culturally variable factors might be incorporated into designing future robots.

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