Perception of an Android Robot in Japan and Australia: A Cross-Cultural Comparison

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Abstract. This paper reports the results from two experiments, conducted in Japan and Australia, to examine people's perception and trust towards an android robot. Experimental results show that, in contrast to popular belief, Australian participants perceived the robot more positive than Japanese participants. This is the first study directly comparing human perception of a physically present android robot in two different countries.

Keywords: Android robot, cross-cultural, human-robot interaction, robot perception, trust.

1 Introduction

It is apparent that recent technological advances will soon enable robots to live amongst humans; robots will be present in workplaces, schools, hospitals, shops, homes, etc. As the number of interactions between humans and physically present robots increases, it is important to examine the impact of these robots during the interaction. Current research in human-robot interaction (HRI) faces significant challenges, not only in terms of technological improvements but also in terms of social acceptability of robots. It is believed that the social aspects of interactive robots could be at least similar to those of humans [1].

Human perception of robots has been generally shaped by information obtained through social media (e.g. movies, newspaper, internet, etc.) and not by real interactions with physically present robots. In spite of significant research in HRI, direct contact to a physically present robot is still the exception rather than the norm. It has been shown, however, that the presence of an embodied robot plays a crucial role in the way people perceive it [2]. Previous studies also revealed that the expectations and attitude towards robots change based on their appearance [3]. To accurately evaluate the perception of robots, participants should ideally be in direct contact with physically present robots [2, 4].

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Android robots, a specific type of robots designed to look and act like humans, have been reported to trigger different reactions from people when compared to other robot types such as pet-like robots and humanoid robots [5]. The objective of this research is to measure and compare human trust, perception and attitudes towards a physically present android robots in two different countries, Japan and Australia.

Changes in the participants' trust and general perception before and after interacting with the robot were measured and correlated with the participants' personality traits. This paper extends a previous experiment in trust and perception performed exclusively with Japanese participants [6]. A cross-cultural comparison with a total of 111 participants is presented.

1.1 Literature Review

For years, science has studied how attributes such as nationality, religion, race and socioeconomic class influence the way people think and behave. The country of origin of two people, for example, could have a strong influence on the distance kept between them during social interaction [7]. According to resent research [8], even facial expression recognition is culturally dependent.

It is commonly believed that robots are perceived differently by Eastern and Western cultures. American movies such as "The Terminator" and "I, Robot", for example, present robots with negative connotations towards them and displays them as threatening technology or machines out of control. The Frankenstein complex [9] even describes people's anxiety towards robots as a representation of their fear towards technological creatures that could threat humankind. This behaviour is not observed in Eastern cultures, such as Japan, where robots are displayed as heroes or helpers (e.g. "Astro boy", "Doraemon"). It has been speculated that the Japanese holistic understanding, that is, the notion that living beings, non-living objects and gods are all ascribed to have a soul, might be a basis for this attitude [10]. This stereotype, however, is not necessary true. Robotic heroes are also present in Western culture, for example in movies such as "Star Wars" and "Wall-E", while previous studies revealed that Japanese people are not "robot lovers" while Western cultures are not "robot haters" [11, 12].

Recent studies in HRI, demonstrated that people's behaviour towards robots might vary across cultures. Wang et al. [13], for example, reported that Chinese and American participants are more likely to heed recommendations when robots behave in more culturally normative ways, while Chinese participants expressed a more negative attitude towards the robot. Trovato et al. [14], furthermore, found that Egyptians prefer an Arabic speaking robot and feel a sense of discomfort when interacting with a Japanese robot. Opposite feelings were observed in the Japanese participants. A different study [15] suggests that Egyptian participants perceive a receptionist robot more positively and more anthropomorphic than English-speaking participants. When comparing Chinese, Korean and German participants [16], it was found that cultural differences exist in participant's perception of likeability, engagement, trust and satisfaction. Cultural differences were also found when children of different age groups interacted with the iCat

robot in a card game where children from Pakistan were much more expressive than Dutch children [17].

In contrast, Shibata et al. [2] found no difference between participants from Japan and the UK when answering a questionnaire about the seal robot "Paro", but found that physical interaction improved the subjective evaluation. A study evaluating the differences in attitude towards robot showed no differences between Japanese, Chinese and Dutch participants [18] and a comparison of explicit and implicit attitudes towards robots between Japanese and American participants showed multiple similarities [11].

Altogether, previous research suggests that cultural differences exist in certain areas of robot perception and outline the importance of a direct interaction between people and a physically present robot, but do not confirm the stereotypes of the Japanese culture generally having a more positive attitude towards robots.

2 Methodology

The experiments in Japan and Australia followed the same four-staged procedure using a female version of an android robot, Actroid-F (Fig. 1). To evaluate if factors such as prior experiences with robots, prior relationships with non-human agents such as pets [19], and the participants' personality [20] would influence the interaction with the robot, participants demographics, personality traits, and perception of the robot were evaluated in the first stage of the experiments. In addition, participants were asked if they had ever owned a pet (yes/no), and if they had been previously exposed to either virtual agents or robots (on a 5-point scale).

Fig. 1. The Actroid androids in the male (left) and female (right) versions. This experiment used the Actroid-F, the female version of the Actroid robots.

During the second stage, three simple interaction tasks with the robot were implemented. During task One and Two, the robot asked each participant to move a box from one position to another. For the third task, it asked them to touch its hand. During these tasks, the robot engaged with the participants

following a fixed protocol in either Japanese or English (i.e. greeting, asking for name and participant number) and then gave the instructions for each task. Additionally, the robot asked participants to take a chair positioned at the far end of the room, and move it to the location where they wanted to sit during the task. When the task was completed, the robot gave each participant the opportunity to ask some open-ended questions, after which it thanked them for their cooperation and asked them to wait outside the room. The researcher returned the chair to the far end of the room at the end of each task.

To evaluate the participants' trust towards the robot, during the third and final stage, an economic trust game [21] took place. An economic trust game allows to quantify trust in a relationship in an empirical, reliable and standardized way. In this case, an economic trust game was 'played' between the robot and participants in a similar context to that used in human-human interaction. In the two-player trust game, player One (the participant) is provided with a fixed amount of money (JPY 1000 in Japan and AUD 5 in Australia) and given the opportunity to send all, or part of the money to player Two (the robot). The robot would then return either more, or less money to the participant. The researcher randomly assigned the returning amount as more or less, with the only condition being that the same number of participants were paid either more or less money.

To evaluate changes in participants' perception of the robot, the questionnaires were administered before and after the interaction tasks with the robot. All experiments were video recorded for analysis.

2.1 Questionnaires

Personality Questionnaire: The Eysenck Personality Questionnaire Revised (EPQ-R) categorizes personalities in a systematic way, using the three factors of psychoticism, extraversion and neuroticism. It is also one of the few personality questionnaires that are validated in Japanese [22] and English.

Robot Perception Questionnaire: To evaluate human perception of the robot, the Godspeed Questionnaire [23] was used. The Godspeed Questionnaire measures five key concepts in HRI using 5-point scales. (1) Anthropomorphism is the attribution of a human form and characteristics to anything other than a human being. (2) Animacy is the perception of the robot as a lifelike creature. Perceiving something as alive allows humans to distinguish humans from machines. (3) Likeability describes the first (positive) impression people form of others. Research suggests [24] that humans treat robots as social agent and therefore judge them in a similar way. (4) Perceived intelligence states how intelligent and human-like participants judge the behavior of the robot. (5) Perceived safety describes the perception of danger from the robot during the interaction and the level of comfort the participants' experience.

2.2 Additional Measurements

The distance kept by participants to the robot during each task was measured at floor level from the robot's feet to the participants' chair, baring in mind that the position of the chair was chosen by each participant (Sec. 2). Note that the distance for the third task was measured before the robot's request to touch its hand.

3 Experimental Results

A total of 111 participants from the University of New South Wales, Australia and universities of Tokyo, Japan took part in these experiments (Table 1). Participants were recruited through general advertisement using posters across both universities, email lists from researcher with no direct contact with students and through word of mouth. None of the participants had previous experience interacting with android robots. Participants received monetary reimbursement (approximately AUD 5) for their participation.

Table 1. Participant demographics for Australia and Japan. The mean exposure to robots and virtual agents results from a 1-5 rating scale.

	Australia	**Japan**
Total	56	55
Female	35	37
Male	21	18
Mean Age	28.8	22.6
Mean exposure to robots	3.9	3.72
Mean exposure to Virtual Agents	2.5	2.43

3.1 General Cross-Cultural Differences

There were several differences between the datasets from Australian and Japanese participants. Australians had a higher pet ownership (Chi square test; $p<0.001$) and had higher psychoticism ($t(107.92) = -2.96$, $p = 0.003$) and extraversion ($t(102.92) = 5.47$, $p<0.001$) scores. Furthermore, Japanese participants came significantly closer to the robot in each consecutive task (Table 2; task 1 vs. task 2 $t(54) = 4.87$, $p = 0.001$; task 2 vs. task 3 $t(54) = 2.67$, $p = 0.05$; Bonferroni corrected, as reported in the previous study [6]). However, this effect was not observed in the Australian participants.

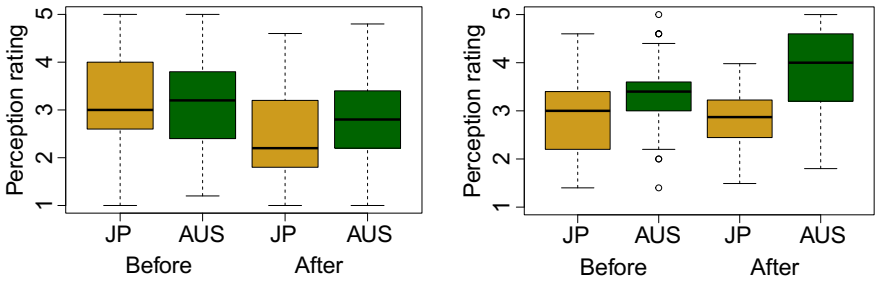
3.2 Changes in Human Perception of the Robot

Anthropomorphism: Lower anthropomorphism ratings were observed after the interaction for participants in both countries: $t(53) = 4.22$, $p<0.001$ for Japan and $t(55) = 2.50$, $p = 0.01$ for Australia. This means that in both cases

Table 2. Mean distances (in cm) to the robot for Australia and Japan

	Task 1	Task 2	Task 3
Australia	123.8	121.5	122.7
Japan	128.2	119.9	116.1

the perception of anthropomorphism of the android reduced significantly after the interaction. Furthermore, anthropomorphism was rated significantly higher in Australia—when compared to Japan—after the interaction ($t(108.7) = 1.9$, $p = 0.05$), but not before (Fig. 2(a)).



(a) Anthropomorphism. (b) Likeability.

Fig. 2. Anthropomorphism and likeability for Japan (yellow) and Australia (green). The left plot shows a decrease in anthropompohism for both countries while the right plot shows an increase in likeability only for Australia.

Animacy: Animacy rating did not significantly differ between countries and there were no significant changes as a result of the interaction either in Japan or Australia.

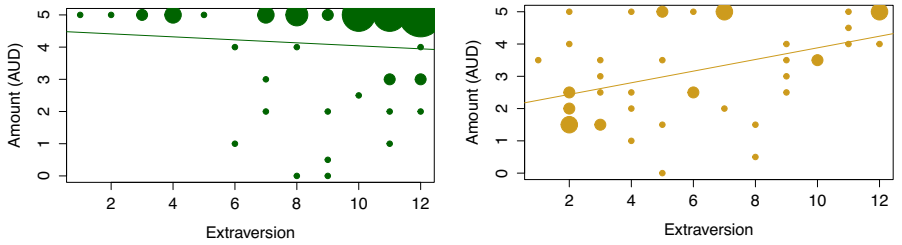
Likeability: Significant differences were found in the likeability rating of the robot before, as well as after the interaction task (Fig. 2(b)). Australian participants liked the robot significantly more than Japanese participants. Before the interaction, Australians rated the robot more likeable ($t(107.91) = 3.48$, $p<0.001$) after the interaction, the likeability of the robot even increased in Australia and remained the same in Japan.

Perceived Intelligence: Perceived intelligence dropped significantly in the Japanese participants ($t(53) = 7.55$, $p<0.001$) after the interaction whilst there was no significant change for the Australian participants. There was a significant difference between Australia and Japan after the interaction task ($t(92.83) = 6.10$, $p<0.0001$), with Australian participants rating the perceived intelligence significantly higher.

Perceived Safety: Perceived safety increased after participants interacted with the robot. For both cultures, ratings for perceived safety increased after the interaction tasks: t(53) = -1.99, p = 0.05 for Japan and t(55) = -3.97, p = 0.0002 for Australia. Even though the same trend was observed in both countries, the overall ratings were significantly lower in Australia before (t(104.46) = 3.02, p = 0.003) and after (t(98.89) = 2.11, p = 0.03) the interaction.

3.3 Economic Trust Game

Previous research has shown that extravert personality types tend to send higher amounts of money during an economic trust game [25]. In the current experiments, Australian participants entrusted the robot with a significant higher amounts than Japanese participants (t(109) = 4.02, p = 0.0001). At the same time, the Australian dataset shows a higher rate of extraversion (t(102.74) = 5.5458, p<0.0001). Further analysis, however, shows that extraversion affected the payback amount in the trust game only in Japan (positive correlated, R = 0.43, t(44) = 3.12, p = 0.003), but not in Australia (R = -0.09), see Fig. 3.



(a) Australia. (b) Japan.

Fig. 3. The amount paid (exchanged in AUD) as a function of extraversion score in the economic trust game for Australia (left) and Japan (right). Disk sizes represent the number of participants. Australian participants show higher amounts paid but no correlation with extraversion score, while Japanese participants show an increase of the payback with increasing extraversion score.

Furthermore, a correlation with no-pet ownership and robot perception when the payback was lower or higher was found in Japan, but no significant differences were observed in Australia. Other character traits showed no further correlations with the amount send in the trust game in either country.

4 Discussion

This paper reports the cross-cultural comparison of trust and robot perception between Japan and Australia using Actroid-F, an android robot designed to look as an exact copy of a Japanese female.

Experimental results showed that Japanese participants rated the robot lower than Australian participants for anthropomorphism, animacy, likeability and perceived intelligence before interacting with it. This contradicts the stereotype of Western cultures to reject robots and Japanese being more accepting of them.

In terms of perceived safety, Australian participants seemed more concerned and rated the robot lower than their Japanese counterparts. Although perceived safety increased in both cultures after interacting with the robot, it still remained significantly lower for Australian participants. It is believed that the overall increase by both cultures is a response to the realization that even though the robot looks like a human, its abilities are not human-like and, more importantly, the robot in its current condition is not capable of creating any damage. However the reduced overall ratings are attributed to the negative display of humanoid robots in Western cultures.

In contrast to these results, Australians perceived the robots as more "trustworthy" during the economic trust game. This is an interesting result, because although they perceived it as less safe, they trusted it more when it comes to an economic game. It is suspected that the trust exhibited in this game was partly related on how people perceive the robot from a game theory perspective, in which the 'smart' thing to do is to send higher amounts of money in order to maximize profit. The concept of trust towards a robot, however, even when simplified in an economic game seems to be much more complex.

When analysing the participants' openness for interaction, it was observed that Australian participants were generally more open to the experience and asked the robot several more questions, whereas the Japanese participants asked only 1-2 questions. Australian participants even focused on the robot's "choices" (e.g. favorite color), "dreams" and feelings (e.g. are you able to dream?, how does it feel to be a robot?).

All together, it is concluded that Western cultures might be more curious, interested and open to interact with the android robot but also more careful, explorative and challenging of the robot's limitations.

Finally, this study shows that human perception towards a robot changes after interacting with it for the first time. To date, people have very low exposure to physically present robots in their personal life, and therefore their perception towards them is influenced by media. This, however, is expected to change as the opportunities for interaction with physical present robots increase, and should be taken into account in future HRI studies.

4.1 Future Work

Several additional experiments could be considered. For example, a comparison of the current results using a human interactant, a humanoid or even more machine-like robots, instead of an android. It is expected that people will perceive and approach machine-like robots in a different manner to the android, but humans in more similar ways. The authors expect that future robot design, both in terms of appearance and behaviour, will benefit from better considerations of cultural differences.

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