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A CROSS-CULTURAL COMPARISON OF ATTITUDES TOWARD ROBOTS AMONG A JAPANESE AND US UNIVERSITY FACULTY USING IMPLICIT AND EXPLICIT MEASURES

Sandosh K. Vasudevan

Submitted to the faculty of the School of Informatics
in partial fulfillment of the requirements
for the degree of
Master of Science in Human-Computer Interaction
Indiana University

May 2008

Accepted by the Faculty of Indiana University,
in partial fulfillment of the requirements for the degree of Master of Science
in Human-Computer Interaction.

Masters Thesis
Committee

Karl F. MacDorman, Ph.D., Chair

Anthony Faiola, Ph.D.

Leslie Ashburn-Nardo, Ph.D.

Josette Jones, Ph.D.

This thesis is dedicated to my wonderful parents, and brother.

ACKNOWLEDGMENTS

I would like to formally thank:

Dr. Karl F. MacDorman, my advisor, for his hard work and guidance throughout this entire thesis process and for believing in my abilities. I have learned so much, and without you, this would not have been possible. Thank you so much for a great experience.

Dr. Anthony Faiola, for serving on my thesis committee. Thank you for believing in me and for your insight and guidance throughout the past two years.

Dr. Leslie Ashburn-Nardo, for serving on my thesis committee. Thank you for your support and guidance.

Dr. Josette Jones, for serving on my thesis committee. Thank you for your support and guidance.

Chin-Chang Ho, for his helpful statistics expertise. Himalaya Patel for his invaluable comments and suggestions.

My fellow graduate students, for their friendships and support. The last two years have been quite an experience and you have all made it a memorable time of my life. I will miss all of you. Good luck to each of you in your future endeavors.

My parents and my brother for their never-ending love and support in all my efforts, and for giving me the foundation to be who I am. Thank you.

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ABSTRACT

Vasudevan, Sandosh K. MS, Indiana University, May, 2008. A Cross-Cultural Comparison of Attitudes toward Robots among a Japanese and US University Faculty using Implicit and Explicit Measures. Major Professor: Karl F. MacDorman.

Japan has more robots than any other country, and robots play a role in many areas of Japanese society, including manufacturing, healthcare, and entertainment. However, there have been relatively few cross-cultural studies to examine Japan's robot-oriented culture, and the studies there have been tend to suffer from a self-selection bias by sampling among participants who are visiting robotics exhibits or robot-related news groups. In addition, no studies have considered implicit measures of attitudes toward robots, which are indicative of uncontrolled cognitive processes, thus reducing self-presentational bias.

This study presents a cross-cultural comparison of attitudes toward robots at a US and Japanese faculty using explicit and implicit measures. The results of this study indicate Japanese faculty had many more robot-related experiences than the US faculty. Although US participants reported a slightly stronger preference for people than the Japanese participants did, and Japanese participants reported slightly warmer feelings toward robots, implicit measures showed virtually no difference between the groups. Both groups had significantly more pleasant associations with humans than with robots. Both the Japanese and US faculty reported people as being more dangerous than robots but implicitly associated robots more strongly with weapons than people. This gap was bigger for the US faculty. It may indicate a conflict between rational fears of people and unconscious fears of robots. Given the higher prevalence of violent crime in the US, people are a known danger, but the danger of robots is harder to assess owing to a lack of experience with them.

1. INTRODUCTION

Among all human artifacts, perhaps robots share the most in common with their maker. Like computers, and in fact because they are controlled by computers, they can process huge amounts of information. Like powered equipment, they can manipulate their environment and move within it. And like dolls, mannequins, and other effigies, they can resemble us—either abstractly or down to the dimples on our cheeks. Nevertheless, the differences between machine and maker are profound. *Ancestry, life span, metabolism,* and *sexual reproduction* for now distinguish us from robots. Thus, the similarities and differences between us and them circumscribe a chasm that seems at once narrow and deep.

It should be unsurprising then that we view our creations with a certain ambivalence. This ambivalence seems to be strongest for robots designed with the goal of impersonating human beings in all respects (Harnad, 1989). The Japanese roboticist Mori (1970) noted this when he proposed that as we make machines more humanlike they would seem more familiar until they became so human as to seem eerie. *Bukimi no tani,* his graph of the relation between human likeness and familiarity, was translated into English as the *uncanny valley*—thus forging an unintended link with Freud's 1919 essay on the uncanny. Freud (1919/2003) argued that things that are very familiar but repressed are uncanny. Because the source of our feeling is not consciously accessible, we need a way to examine it that does not rely on introspection.

Mori's own hunch—which he did not elaborate—was that the uncanny valley relates to the human need for self-preservation. But that only raises the question, "What do we mean by self?" If by *self* we mean the human phenotype that must survive long enough to pass on its genes to the next generation and ensure their success, we are led to a biological explanation of negative feelings toward robots that must hold regardless of culture (e.g., the issues surrounding mate selection or pathogen avoidance discussed in MacDorman & Ishiguro, 2006). However, there is another way of understanding self: as the person a human body constructs from the social environment, with a biography and a narrative to justify both its words and deeds (MacDorman & Cowley, 2006; Ross & Dumouchel, 2004). To enjoy status and esteem, persons are strongly motivated to live up to the standards of their culture (Cowley & MacDorman, 2006), and their worldview and sense of identity reflect that purpose.

Solomon, Greenberg, and Pyszczynski (1998) have argued that, by living up to cultural standards, life becomes meaningful. Our cultural worldview explains our place in the universe and, in some religious contexts, can even offer us an afterlife. For these researchers self-preservation is about defending not just the body but the worldview that gives our lives meaning in the face of our physical mortality—defending that worldview against those who would transgress it. So the question remains whether our robotic creations are potential transgressors, trammeling our sense of identity and purpose.

Ramey (2005) argues that they are. There is something intrinsically disturbing about things that inhabit category boundaries: like the undead of the horror genre—neither dead nor alive. Douglas (1966) had discussed this in relation to the dietary laws of Leviticus. According to Douglas, restricted foods do not fit known categories. Eating pork is prohibited, for example, because pigs unlike other animals with cloven hooves do not chew their cud. The category boundary problem is particularly acute for robots, which are electromechanical, but share some human qualities (MacDorman & Cowley, 2006). From the standpoint of human perception, not only do they exist on a category boundary, but we are one of the categories—and in that sense, they could be seen as a threat to our personal and human identity. If a perfect human replica were ever created, how much room would that leave for our sense of human specialness? How would our "hoped for" immortality stand up against their ability to outlive us?

Nevertheless, the cognitive dissonance of things that lie on category boundaries may not be as universal as uncertainties about category boundaries imply. For example, although some cultures push intersex individuals to choose a male or female gender, other cultures afford room for a third gender (e.g., two-spirit people among the Native Americans). Although common category membership produced the strongest object association in US children and adults, Chinese children and adults were most sensitive to contextual and functional relations between objects (Ji, Peng, & Nisbett, 2000). This was attributed to a difference in cognitive style: The West may sanction an analytic cognitive style, whereas a cognitive style involving many relative comparisons may be more prevalent in Asia. Greek philosophy saw a separation of human and nonhuman phenomena into nature and ethics; Socrates considered sense experience (*phenomena*) to be a pale shadow of the true forms of objects (*noumena,* Plato, 360 BCE/1888; Woelfel, 1987). While Western philosophy sought absolute truth in perfect, unchanging knowledge, Eastern philosophy took a holistic view on the universe, which it saw as being in constant flux. The Western distinction between the whole and its parts was less pronounced. Indeed, the whole and its parts were seen as inseparable: "each 'one' defines the other, and indeed is the other" (Kincaid, 1987, p. 332). However, given the rapid modernization of Asia, the spread of Western-style education, and the globalization of information, there is a risk of overemphasizing these differences.

Nevertheless, many of the dualisms that are ingrained in Western thinking, such as the mind-body dualism, do not exist or are less pronounced in Asian cultures.[1] For example, Buddhism broke from its Hindu roots by introducing the concept of *anātman* (from Sanskrit, meaning *no soul*). As all things arise owing to causes and conditions, they are considered devoid of selfhood or intrinsic nature.[2] Mori (1982) even proposes that, just like people, robots could have Buddha-nature. *Shinto,* the

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[1] Ironically, Western philosophy has progressively backed away from substance dualism (MacDorman, 2004).

[2] Nevertheless, Buddhism does make a distinction between sentient and nonsentient beings, and prohibits the murder or the slaughter of sentient beings.

original religion of Japan, derives from animism: the belief that souls can inhabit objects. This affords a different sort of relationship, not only with nature, but with human creations like robots. Although almost no present-day Japanese believe in the literal truth of Shinto or Buddhism, they were part of the cultural background during Japan's modernization.

Yamamoto contrasts the creation story of Genesis with the neo-Confucian teachings of Zhu Xi. Zhu Xi mixes Confucian and Taoist elements with traditional Chinese views. Crucially, there is no God and no mind/matter distinction in neo-Confucianism. Zhu Xi's (1967) neo-Confucian views on the oneness of reality, which were especially popular among the samurai class during the Edo period (1603–1868), were seen as broadly compatible with the materialistic views of the architects of Japan's modernization during the Meiji era (1868–1912, e.g., Hiroyuki Katō's biological materialism, discussed in Yamamoto, 1983). Thus arose a kind of *scientism* in Japan, or heroic view of science and technology, that developed without resistance from Shinto or Buddhism. This contrasts with the West, where there are frequent conflicts between scientists and Christians on topics ranging from the origin of life to the ethics of stem cell research.

For a Jew, Christian, or Moslem, what does it mean to build a humanlike robot? All of these religions have prohibitions against idolatry and the usurpation of God's role: "You shall not make for yourself an idol in the form of anything in heaven above or on the earth beneath or in the waters below" (NIV, Exodus 20:4). Islam bans all icons from mosques, just as the Puritans banned icons from their churches. The Amish do not take photographs. The Taliban went so far as to destroy any art that depicts a human form. The Bible states, "God created man in his own image" (NIV, Genesis 1:27). Thus, to build machines in man's image, that is, with human qualities, would be to usurp God's role. An Arab journalist has gone so far as to describe the creation of robots as a "God-crushing act" (Yamamoto, 1983). This view contrasts with the sentiment expressed in 1928 by Makoto Nishimura, an early Japanese robotics pioneer, "If one considers humans as the children of nature, artificial humans created by the hand of man are thus nature's grandchildren" (cited in Hornyak, 2006, p. 38).

These examples indicate differences in how East Asian and other cultures confront ambiguities in general and humanlike machines in particular. Thus, rather than concluding that human perception of robots is biologically determined, it seems reasonable to assume that individual, social, and cultural factors also come into play.

One important issue then is how to measure these factors. When people do not understand the reasons behind their own attitudes, they may fall back on whatever explanation happens to be popular. Japanese, for example, see themselves collectively as a robot-friendly culture. But being on the front lines of robot adoption, individual Japanese may feel anxiety and misgivings about robots, say, when it is their grandmother being turned over by a robot in her hospital bed. People of all cultures are incentivized to align to the feelings of others, but that tendency may be especially strong in Japan. It would be exciting to measure people's positive or negative associations with robots, setting aside how they think they are supposed to present themselves.

The implicit association test (IAT) offers one possible solution (Banaji, 2001; Greenwald, McGhee, & Schwartz, 1998). The IAT is intended to measure automatic evaluations that may differ from self-reported preferences. This study compares the IAT results and self-reports of faculty members at a Japanese and US university to determine whether there are cultural differences with respect to robots in either implicit associations or questionnaire responses. Specifically, it uses explicit and implicit measures to compare attitudes toward robots relative to human beings along two dimensions: pleasant–unpleasant and safe–threatening. It is hoped that the results might shed some light on cultural differences between Japan and the United States.

2. LITERATURE REVIEW

2.1 Robots and Culture

People around the world have different levels of exposure to robots, because of where they live, what is covered in the media, and their personal experiences. The structure of a country's economy, its technological development, national funding priorities, and historical and religious context affect the social and cultural significance of robots, and these factors in turn shape individual attitudes. Since Capek (1921/2004) first coined the term robot (from Czech *robata*, meaning *serf labor, drudgery*) in the science fiction play *R.U.R.* premiering in 1921, robots have frequently been depicted in a negative light in the West. The scenario in Capek's play of robots bent on revolt or world domination has been echoed in countless films and novels, such as the Hollywood blockbusters *Blade Runner, Terminator*, and *I, Robot.* Nevertheless, other American films like *Short Circuit* and *Bicentennial Man* present robots as heroes.

Robots have had their greatest impact in Japan, where cultural perspectives on robots have developed rather differently from in the West. From Japan's early Edo period, the elaborate performances of clockwork *karakuri* puppets have left audiences awestruck, and this tradition of craftsmanship and artistry has continued to create and animate human-looking machines for the past 400 years (Hornyak, 2006). *Karakuri* automata, for example, served tea, plucked and shot arrows, and drew Chinese characters with brush and ink—all without human control. Perhaps the most famous hero of Japanese manga(Japanese word for comics) is not human but the fictional robot Astro Boy, serialized by Osamu Tezuka from 1951 to 1981 and also adapted to film and television. Astro Boy fought crime, injustice, and evil and could experience human emotion. In 1956 Ironman appeared in manga as the remote-controlled, crime-fighting robot of the boy detective Shotaro Kaneda. Another action hero, Amuro Ray, pilots Gundam, his giant robotic suit of armor. A similar man-machine symbiosis earlier appeared in the Go Nagai series, Mazinger Z. These examples show that mass audience fictional portrayals of robots in Japan have generally been positive.

Industrial robots also play an important role in the Japanese economy. Japan's postwar economic growth has been fueled by exports in the automotive and electronics industries, which enjoyed efficiency gains in part through increased automation. During the 1970s and 1980s, Japan maintained its manufacturing sector while most other developed economies were shifting to services (Castells, 2000). By 2000 Japan had ten times as many industrial robots per capita as the United States.[1] Automation was not seen as a threat to jobs, because Japanese companies would retrain workers for other jobs rather than dismiss them as is typical in the US (Hornyak, 2006).

In addition, Japan has promoted new applications for robots that support human interaction. Japanese companies have pioneered entertainment, pet companion, and humanoid robots, such as Sony's robot dog Aibo and humanoid Qrio, Honda's Asimo, AIST's therapeutic robot seal *Paro.* Social robots frequently appear at public events, expositions and conventions, and on television. Robots have even been an integral part of the Japanese government's plans for addressing the country's demographic crisis: the combination of an aging population and low birthrate (Barry, 2005).

There have been a few cross-cultural surveys examining how people perceive robots. Shibata, Wada, and Tanie (2004) studied human's subjective evaluations of Paro in Italy, Japan, Korea, Sweden, and the UK. Their results found differences according to gender, age, and nationality. British and Italian participants were concerned about the necessity of Paro; Italian and Swedish participants focussed on its animal-like qualities; and Japanese participants noted its visual and tactile impression. Another study on social interaction with the communication robot *Robovie-II* and *Robovie-M* suggesting that in Japan, younger generations do not necessarily prefer robots to older generations (Nomura et al., 2007). However, the study was conducted

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[1] *The Economist,* December 1, 2001, p. 96.

at a robotics exhibition. This kind of event is more likely to attract robot enthusiasts belonging to any generation.

While these studies focused on specific robots, other studies examined attitudes toward robots in general, employing various methods. Suzuki, Kashibuchi, Sakamoto, and Nagata (2002) developed a psychological scale for measuring people's mental images about robots. Kashibuchi, Suzuki, Sakamoto, and Nagata (2002) conducted a study using this scale and found that these mental image can be depicted using a one-dimensional scale where one end corresponds to robots and the other end corresponds to artificial objects and that the results were mostly in the middle.

In another study, photographs and a questionnaire were used to study the difference in how robot appearances influence the emotions of children and adults (Woods & Dautenhahn, 2005). A Robot Pictures Questionnaire was completed by groups of children from various primary schools. Five adults independently rated the overall appearance of 40 robot images. The results of this study indicate that children's ratings of robot personality and emotions were different from the adults' ratings of the robot appearances. The results also indicated that children and adults may have similar views on the link between a robot's appearance and its ability to communicate.

Nomura, Kanda, and Suzuki (2006) developed a psychological scale to measure negative attitude toward robots: the Negative Attitude toward Robots Scale (NARS). A study was conducted using this scale to verify the influence of negative attitudes toward robots on humans' behaviors towards them (Nomura et al., 2006). In the study participants interacted with *Robovie*. The results indicated gender differences in relations between negative attitudes and behaviors toward robots. The researchers also noticed a possibility of a link between the individuals' experiences of real robots and negative attitudes toward robots.

A cross-cultural study on attitudes toward robots was conducted (Bartneck, Nomura, Kanda, Suzuki, & Kato, 2005). In the study a questionnaire was presented to Chinese, Dutch, and Japanese participants based on NARS. The questionnaire consisted of three parts: attitude towards the interaction with robots; attitude towards social influence on robots; and attitude towards emotions in interaction with robots.

The study found that only nationality had a significant influence on the social dimension and that Japanese participants rated social influence significantly higher than Chinese and Dutch participants. Other variables like gender did not have any significant influence on the measurements. This study was followed up by another study of negative attitude towards robots (Bartneck, Suzuki, Kanda, & Nomura, 2007). Mexican and American participants were included with Chinese, Dutch, German, and Japanese participants in the study and the same questionnaire was used. The results indicate that participants from the USA were least negative about interaction with robots, and participants from Mexico were most negative towards robots. The results for Japan were unexpected:

> In contrast to the popular belief that the Japanese love robots, our results indicate that the Japanese are concerned about the impact that robots might have on society and that they are particularly concerned about the emotional aspects of interacting with robots. A possible explanation could relate to their higher exposure to robots in real life, particularly through the Japanese media. The Japanese could be more aware of the robots abilities and also their shortcomings. (Bartneck et al., 2007, p. 225)

Most of these studies use surveys and questionnaires. However, these research methods are susceptible to self-presentational bias: how participants choose to present themselves to others (or to themselves) may not accurately reflect their attitudes and dispositions (Goffman, 1959; Greenwald et al., 1998; Ashburn-Nardo, Knowles, & Monteith, 2003). In addition, some attitudes may not be accessible to conscious introspection. One method to overcome these kinds of biases is to measure a participant's underlying automatic evaluation by means of an implicit measure. Implicit measures are measurement outcomes that indicate a construct by means of processes that are uncontrolled, unintentional, unconscious, efficient, effortless, fast, goal-independent, autonomous, or driven solely by the stimulus (De Houwer & Moors, 2007). Implicit measures include the implicit association test (Greenwald et al., 1998), go/no-go association task (GNAT, Nosek & Banaji, 2001), and cognitive priming procedures (Bargh, Chaiken, Govender, & Pratto, 1992; see Fazio & Olson, 2003 for a review).

2.2 Implicit Association Test and Its New Algorithm

The IAT measures automatic evaluative associations (Greenwald et al., 1998), namely, the differential associations of two target concepts (e.g., robot and human) along an attribute dimension (e.g., *weapon–nonweapon*) based on response latencies during a combined categorization task. "IAT responses are considered automatic because they are expressed without intention or control" (Dasgupta, McGhee, Greenwald, & Banaji, 2000, p. 317). Indeed, the participant may not be aware of the causal processes responsible for the evaluation (Greenwald & Banaji, 1995). Performance is faster if a more strongly associated attribute-concept pair has the same response key than if a less strongly associated attribute-concept pair does. For example, if we gave someone the task of pressing *E* when a robot or weapon appeared and pressing *I* when a human or nonweapon appeared, we might expect them to perform this task faster if they associated robots with weapons more than they associated humans with weapons.

The IAT consists of several blocks. In the first block, the task is to discriminate among a set of items according to their target concept membership (e.g., either robot or human). In the second block, the task is to discriminate among a different set of items according to their value on an attribute dimension (e.g., either pleasant or unpleasant). In the third block, the tasks of the first and second block are interspersed. (The order is shuffled.) The fourth block is the same as the first block except that the response keys for the target concepts are reversed. In the fifth block, the tasks of the second and fourth blocks are interspersed. The third and fifth blocks are used in scoring. (In the original IAT they were subdivided into practice and test blocks.)

The basic assumption behind the design of the IAT is that the participant should be able to perform either the third block or the fifth block faster depending on how the target concepts and attribute dimension are differentially associated.

To test this method, Experiment 1 of Greenwald et al. (1998) presented on a computer screen names of flowers, names of insects, pleasant words, and unpleasant words. Participants were asked to categorize these words by pressing one of two keys. It can be assumed on a priori grounds that while the target concept *flower* and *pleasant* are automatically associated, the target concept *insect* and *unpleasant* are also automatically associated. Therefore, responses should be faster when *flower* and *positive* are both assigned to the one key and *insect* and *negative* are both assigned to another key, because the assignments are compatible with existing associations. And the response should be slower for the reverse. The results clearly confirmed that the reaction times were faster with compatible assignments.

Experiments were conducted to assess the usefulness and efficiency of the IAT in measuring automatic evaluative associations (Greenwald et al., 1998). Explicit self-report measures of attitude were compared with IAT measures. Researchers found that the IAT is more resistant to self-presentational bias than explicit measures. When researchers introduced a more sensitive domain of social attitudes (e.g., racial bias), the effect size of explicit measure dropped very low even though the IAT measure was still high. Researchers were also able to establish the validity of IAT measure. This accounts for the popularity of the IAT is social psychology research (e.g., Ashburn-Nardo et al., 2003).

De Houwer (2001) conducted a structural and process analysis of the IAT to compare it with stimulus-response compatibility tasks. He found that while in the stimulus-response tasks, the relation between the response and stimulus vary as a function of their long-term association, only the target concepts and attribute dimension affected the performance of the IAT. Other studies, however, indicate that the valence of stimuli can affect results (e.g., Govan & Williams, 2004).

Studies were conducted to examine the relations between the IAT and explicit self-report measures (Karpinski & Hilton, 2001). In the Greenwald et al. (1998) study, the correlations between the IAT and explicit measures ranged from .04 to .64 with only 2 out of the 16 being significance. Karpinski and Hilton (2001) suggested that social desirability concerns in Experiments 2 and 3 measuring attitudes toward racial or ethnic groups is the reason for the lack of significance. In their first two studies, two types of self-reports followed the IATs. These studies indicated that for sensitive topics self-reports and the IAT were independent. This result was replicated in two independent samples and in subsequent studies.

Demonstration IATs were posted on the Internet, which resulted in large data sets. These data sets were used to evaluate alternative scoring procedures (Greenwald, Nosek, & Banaji, 2003). It was found that the data from practice trials, which was thrown out in the conventional algorithm, actually provided a better IAT measure. It was also found that including error latencies improved the IAT measure. In the next study, Greenwald et al. (2003) found that among all the six available latency transformations, the *D* measure performed best. His team also proposed to improve the *D* measure by including error latencies. Based on the findings of this study, Greenwald et al. (2003) developed a new scoring algorithm for the IAT and suggested that

> compared with the conventional algorithm, the new IAT algorithm should generally (a) better reflect underlying association strengths, (b) more powerfully assess relations between association strengths and other variables of interest, (c) provide increased power to observe the experimental manipulations on association strengths, and (d) better reveal individual differences that are due to association strengths rather than other variables. (p. 215)

This study uses the new IAT scoring algorithm.

2.3 Hypotheses

The following hypotheses are meant to examine Japanese and US attitudes toward robots using implicit and explicit measures and their relative familiarity with robots. They follow the trend of stereotypes promulgated by the international news media, which identifies Japan with enthusiasm for robots (Schodt, 1988).

H1. Japanese faculty have more robot-related experiences than US faculty.

H2. Japanese faculty report a stronger preference for robots and warmer feelings toward robots than US faculty.

H3. US faculty rate robots as more threatening than Japanese faculty.

H4. Implicit measures indicate Japanese faculty more strongly associate robots with pleasant words than US faculty.

H5. Implicit measures indicate US faculty more strongly associate robots with weapons than Japanese faculty.

3. METHOD

3.1 Participants

There were 731 participants who completed at least one of the two IATs, or the questionnaire on attitude toward robots. Participants were recruited by email from a random sample of faculty members at Indiana University, USA (Bloomington and Indianapolis campuses) and Osaka University, Japan (Suita and Toyonaka campuses). A follow-up email was sent to nonresponders. 74.8% of participants completed both IATs and the questionnaire.

There were 479 US participants and 237 Japanese participants (see Table 3.1). 66.4% of participants were male. In the US group, gender was almost equally distributed with 52.1% of participants being male. In the Japanese group, 95.2% of participants were male. The average age among the participants was 43.9, and the average years of education was 20.5. Only 22 participants chose not to provide their demographic information.

Table 3.1
Participants by Nationality and Gender

		N	Percentage(%)
Japan	Male	226	4.8
	Female	11	95.2
	Total	237	100.0
USA	Male	250	52.1
	Female	229	47.9
	Total	479	100.0

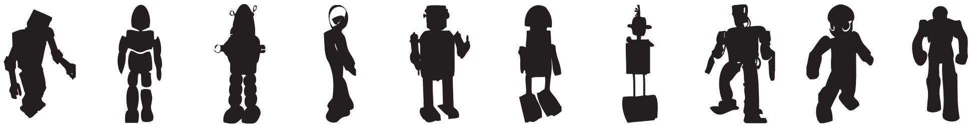
3.2 Materials

The following silhouettes and words were used in the robots pleasant IAT and the robots threatening IAT (Fig. 3.1). Both IATs used 10 silhouettes of humanoid robots to represent instances of the target concept *robot* (Fig. 3.1(a)) and 10 silhouettes of people to represent instances of the target concept *human* (Fig. 3.1(b)). The robots pleasant IAT used 8 pleasant and 8 unpleasant words for the attribute dimension (Fig. 3.1(c)). The robots threatening IAT used 10 silhouettes of weapons and 10 of silhouettes of nonweapon artifacts for the attribute dimension (Fig. 3.1(d)). The IATs used silhouettes instead of photographs to make it impossible to identify the race of human stimuli. This was intended to eliminate any possible cultural effect, so that silhouettes of the same people could be used in both Japan and the USA.

In addition to the two IATs, there was a questionnaire on which participants indicated for robots and people their relative preference, how warm or cold they felt for them, their relative threat, and how safe or threatened they felt they were. Participants also indicated their level of interest and familiarity with robots, and the frequency with which they read material, watched media, and attended events that were robot-related, had physical contact with robots, and built or programmed robots. The list of questions is provided in Appendix A.

3.3 Procedure

The robots pleasant IAT, the robots threatening IAT, and the questionnaire on attitudes toward robots and robot-related experiences were conducted at an Internet-accessible website. Each participant was able to register at the website, provide demographic data (or skip that step), and give consent. The presentation order of the IATs and the questionnaire was counterbalanced. The presentation order of the attribute-concept pairings within each IATs was also counterbalanced. For example, for half the participants in the robots pleasant IAT, *robots* was assigned to the same response key as *pleasant words* (vs. *human* and *unpleasant words*) and then, in the



(a) Target Concept: Robot

(b) Target Concept: Human

Wonderful Love Glorious Joy Pleasure Peace Laughter Happy

Agony Terrible Horrible Nasty Evil Awful Failure Hurt

(c) Attribute Dimension: Pleasant–Unpleasant (Robots Pleasant IAT)

(d) Attribute Dimension: Weapon–Nonweapon (Robots Threatening IAT)

Fig. 3.1. Images and words used in the IATs

reverse combination task, *robots* was assigned to the same response key as *unpleasant* words (vs. *human* and *pleasant* words). For the other half of the participants, the presentation order of the combination tasks was reversed.

3.4 Data Analysis

Factor analysis by principal components analysis and reliability were used to validate a robot-related experiences index. A robots preference self-report index was calculated by the method proposed by Greenwald et al. (2003). The 11-point people warm/cold thermometer item was subtracted from the 11-point robot/warm cold thermometer item. The result was converted to z-scores and averaged with, after z-score conversion, the 7-point relative preference item. A robots threatening self-report index was calculated by the same method.

Response times during the combined tasks of the robots pleasant IAT and robots threatening IAT (i.e., block 3 and 5) were used to calculate the D measure for each participant using the improved IAT scoring algorithm (Greenwald et al., 2003). This D measure indicates the differential automatic evaluative association between robots and people and the attribute dimension (i.e., *pleasant–unpleasant* in the robots pleasant IAT or *weapon–nonweapon* in the robots threatening IAT).

In addition to basic descriptive statistics, such as the mean and standard deviation, the analysis of variance (ANOVA) was used to test statistical significance in comparing means by group (e.g., gender, age, education, nationality, familiarity, and interest). The F-value, degrees of freedom, p-value, and Pearson's correlation were also calculated. Pearson's correlation was calculated between implicit and explicit measures.

4. RESULTS

4.1 Frequency of Robot-related Experiences

Table 4.1 shows the mean number of experiences participants had with robots by question, the standard deviation, and the standardized factor loading, performing factor analysis by principal components analysis. Participants were divided into groups for further analysis. Because the ratio of male-to-female faculty at the Japanese university was so much higher than at the US university, participants were divided into groups by nationality and gender. In addition, the entire sample was divided into groups by age, education, familiarity with robots, and interest in robots. The group labeled *Below 43.9* is below the average age, and the group labeled *Below 20.5* is below the average years of education. The group labeled *Not Familiar* identified itself as not at all familiar with robots, and the group labeled *Familiar* identified itself as slightly, somewhat, moderately, or completely familiar with robots. *Not Interested* and *Interested* were divided similarly.

Japanese participants had many more experiences with reading robot-related material, watching robot-related media, having physical contact with robots, attending robot-related events, or building or programming robots than US participants (Table 4.2). Male participants had more robot-related experiences than female participants. Younger participants had more robot-related experiences than older participants.

Factor analysis resulted in only one component which explained, 58.73% of the variance. The standardized factor loadings ranged from 0.82 to 0.67 (Table 4.1). Cronbach's α was .82, indicating sufficient reliability. Adding the self-assessed question "How familiar are you with robots?" slightly decreased the variance explained and Cronbach's α; the question was therefore excluded.

Table 4.1
Frequency of Robot-Related Experiences

	M	SD	Factor Loading
How many times in the past one year have you read robot-related stories, comics, news articles, product descriptions, conference papers, journal papers, blogs, or other material?	1.98	1.31	0.82
How many times in the past one year have you watched robot-related programs on film, television, DVD, the Internet, or other media?	2.48	1.89	0.76
How many times in the past ten years have you had physical contact with a robot?	2.29	1.82	0.77
How many times in the past ten years have you attended robot-related lectures, exhibitions, trade shows, competitions, or other events?	1.86	1.99	0.80
How many times in your life have you built or programmed a robot?	0.87	1.51	0.67

The results indicate that simply summing the number of robot-related experiences for each question could produce a reasonable index of robot-related experiences. This robot experiences index appears as *Total* in Table 4.2. It shows highly significant differences in all groups (p=.000) except years of education. The robots experiences index is employed later in the correlation analysis.

4.2 Self-reported Attitudes toward Robots

Table 4.3 shows the questionnaire items at the extremes with their scale directions and the overall mean and standard deviation for each item. The full list of items is provided in Appendix A. On average participants moderately preferred people to robots and felt slightly warm toward robots but a little warmer toward people.

Table 4.2
Frequency of Robot-Related Experiences by Group

		Reading Material	Watching Media	Physical Contact	Attending Events	Built or Programmed	Total
Nationality	Japan	3.63***	3.13***	2.50***	1.57***	1.00***	11.82***
Male Only	USA	2.23	2.07	1.73	0.63	0.63	6.98
Nationality	Japan	3.82***	3.00*	2.55*	1.45**	0.45	11.27***
Female Only	USA	1.64	1.68	1.37	0.44	0.25	5.37
Age	Below 43.9	2.69**	2.59***	2.14***	1.04**	0.61*	9.06***
	43.9 and Above	2.26	1.94	1.56	0.68	0.38	6.82
Education	Below 20.5	2.45	2.29	1.79	0.80	0.45	7.94
	20.5 and Above	2.45	2.23	1.89	0.88	0.52	7.96
Robot	Not Familiar	0.79***	1.18***	0.62***	0.20***	0.12***	2.91***
Familiarity	Familiar	2.81	2.51	2.10	1.01	0.58	9.01
Robot	Not Interested	0.62***	0.87***	0.62***	0.03***	0.01***	2.14***
Interest	Interested	2.70	2.46	2.01	0.98	0.56	8.70

$^{\Delta}p<.1$ $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

Among all participants there was the least agreement on how warm or cold they felt toward people (SD=2.82).

Table 4.4 shows the mean preference and warmth ratings by group. Although both Japanese and US participants preferred people to robots, US participants preferred people more than Japanese participants (F(458)=16.19, p=.000, r=.79). Older participants preferred people more than younger participants (F(705)=11.54, p=.001, r=.40), and preference for people increased slightly for those who were more familiar with robots or interested in them (F(725)=9.90, p=.002, r=.34). Japanese participants felt somewhat warmer toward robots than US participants (F(457)=9.13, p=.003, r=.39). Participants who were not familiar with robots or not interested in them felt slightly warmer toward robots than those who were more interested in them or more familiar with them (F(724)=33.83, p=.000, r=.78 and F(724)=29.51, p=.000, r=.74, respectively). There was no significant difference in warm feelings toward people by nationality, age, education level, or familiarity.

Table 4.5 shows the mean relative threatening ratings and safe ratings for robots and people by group. On average participants and especially Japanese participants felt people were slightly more threatening than robots. However, the difference was small but significant (e.g., F(458)=8.77, p=.003, r=.38 for males). US participants also rated robots as being slightly unsafe (e.g., F(457)=8.79, p=.003, r=.38 for males), while Japanese participants were neutral (F(457)=8.79, p=.003, r=.38).

It is typical of IAT studies that the relative preference scale and warm/cold thermometer scale are combined by the method described in the Data Analysis section (e.g., Greenwald et al., 2003). However, the Cronbach's α for the three variables *prefer robots, robots warm,* and *people warm* after z-score conversion was only 0.04, and the Cronbach's α for *robots more threatening, robot safe,* and *people safe* was -0.88. For US participants the values were 0.16 and -1.08, respectively; and for Japanese participants 0.10 and -1.06, respectively. Other combinations were attempted, but they all showed low reliability. Many researchers will not use an index that has a Cronbach's α below 0.70. Factor analysis confirmed that each of the two groups of

Table 4.3
Summary Results for the Attitudes toward Robots Questionnaire

	Mean	SD
I strongly prefer robots to people. (+3) I strongly prefer people to robots. (-3)	-2.10	1.22
Rate how warm or cold you feel toward robots. (+5=very warm, -5=very cold)	0.63	1.89
Rate how warm or cold you feel toward people. (+5=very warm, -5=very cold)	1.22	2.82
Robots are much more threatening than people. (+3) People are much more threatening than robots. (-3)	-0.56	1.57
Rate how safe or threatening you feel robots are. (+5=very safe, -5=very threatening)	-0.27	1.92
Rate how safe or threatening you feel people are. (+5=very safe, -5=very threatening)	0.28	1.97

variables would not load on a single factor. The first factor explained very little of the variance.

4.3 Implicit Measures of Attitudes toward Robots

In the robots pleasant IAT, the average *D* measure was -.41 with an effect size of .22. This *D* measure indicates that participants had more pleasant associations with humans than with robots. There was no significant difference in the *D* measure by nationality, gender, age, educational level, or robot familiarity or interest (Table 4.6). The differences that appeared in the self-report did not appear in the IAT.

In the robots threatening IAT, the average *D* measure was .20 with an effect size of .07. This *D* measure shows that overall participants felt somewhat threatened by robots. However, the *D* measure showed significant differences by age and nationality (Table 4.6). US participants associated robots with weapons to a great extent than Japanese participants, and older participants associated robots with weapons to a

Table 4.4
Mean Self-Reported *Prefer Robots* and *Warm* Ratings by Group

		Prefer Robots	Robots Warm	People Warm
Nationality Male Only	Japan	-1.76***	0.94**	1.22
	USA	-2.23	0.42	1.23
Nationality Female Only	Japan	-1.00***	1.00	2.18
	USA	-2.41	0.60	1.12
Age	Below 43.9	-1.97**	0.65	1.31
	43.9 and Above	-2.28	0.64	1.09
Education	Below 20.5	-2.18	0.65	1.04
	20.5 and Above	-2.09	0.61	1.35
Robot Familiarity	Not Familiar	-2.42**	1.53***	1.13
	Familiar	-2.04	0.45	1.23
Robot Interest	Not Interested	-2.45**	1.71***	0.44*
	Interested	-2.06	0.50	1.31

$^{\Delta}$p<.1 *p<.05 **p<.01 ***p<.001

Table 4.5
Mean Self-Reported *Robots More Threatening* and *Safe* Ratings by Group

		Robots More Threatening	Robots Safe	People Safe
Nationality Male Only	Japan	-0.43**	0.02**	0.38
	USA	-0.86	-0.51	0.21
Nationality Female Only	Japan	-0.36	-0.36	-0.27
	USA	-0.41	-0.29	0.34
Age	Below 43.9	-0.57	-0.33	0.11*
	43.9 and Above	-0.57	-0.19	0.48
Education	Below 20.5	-0.46	-0.04*	0.29
	20.5 and Above	-0.69	-0.52	0.29
Robot Familiarity	Not Familiar	-0.43	0.01	0.08
	Familiar	-0.59	-0.32	0.32
Robot Interest	Not Interested	-0.41	0.12	0.14
	Interested	-0.58	-0.31	0.30

$^{\Delta}p<.1$ $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

Table 4.6
Mean Self-Reported and Implicit Measures by Group

		Prefer Robots		Robots More Threatening	
		Self-report	IAT *D*	Self-report	IAT *D*
Nationality Male Only	Japan	-1.76***	-.40	-0.43**	.15*
	USA	-2.23	-.40	-0.86	.23
Nationality Female Only	Japan	-1.00***	-.31	-0.36	.02$^{\Delta}$
	USA	-2.41	-.42	-0.41	.21
Age	Below 43.9	-1.97**	-.41	-0.57	.14***
	43.9 and Above	-2.28	-.40	-0.57	.26
Education	Below 20.5	-2.18	-.39	-0.46	.19
	20.5 and Above	-2.09	-.42	-0.69	.21
Robot Familiarity	Not Familiar	-2.42**	-.42	-0.43	.25
	Familiar	-2.04	-.41	-0.59	.19
Robot Interest	Not Interested	-2.45**	-.41	-0.41	.23
	Interested	-2.06	-.41	-0.58	.20

$^{\Delta}$p<.1 *p<.05 **p<.01 ***p<.001

great extent than younger participants. Although participants reported that people were more threatening than robots, the *D* measure shows that they more strongly associated robots and weapons than people and weapons. These gaps were more pronounced for US participants than Japanese participants (F(404)=4.47, p=.035, r=.22). The *D* measure shows that older people more strongly associate robots with weapons than younger people (F(625)=19.20, p=.000, r=.61).

4.4 Correlations among Self-Reported and Implicit Measures

Table 4.7 and 4.8 show the relation between the number of robot-related experiences, questionnaire results, and IAT *D* measures for Japanese and US participants, respectively. The number of robot-related experiences and self-report "I prefer robots

Table 4.7
Correlation for Japanese Participants

		Robot	Prefer Robots		Robots More Threat.	
		Experiences	Self-report	IAT D	Self-report	IAT D
Robot Experiences		–				
Prefer Robots	Self-report	.15*	–			
	IAT D	-.05	-.05	–		
Robots Threat.	Self-report	.04	-.06	-.08	–	
	IAT D	-.14*	-.22**	-.08	-.09	–

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

to people" (*Prefer Robots*) were correlated for both Japanese (r=.15, p=.027, two-tailed) and US (r=.13, p=.003, two-tailed) participants.

The number of robot-related experiences and differential association between robots and weapons (*Robots More Threatening* IAT D) were negatively correlated for Japanese participants (r=-.14, p=.042, two-tailed). The *Robots More Threatening* IAT D and *Prefer Robots* self-report were negatively correlated for Japanese participants (r=-.22, p=.001, two-tailed). The number of robot-related experiences and the self-report "Robots are more threatening than people" were negatively correlated (r=-.19, p=.000, two-tailed) for US participants. The *Robots More Threatening* self-report was also negatively correlated with the *Prefer Robots* self-report for US participants.

4.5 The Effect of Presentation Order

An independent t-test was applied to the IAT and questionnaire sequence to check for any order effect on the IAT scores and questionnaire results. For the robots pleasant IAT, participants who took the IAT before (D_{mean}=$-$.41, SE=.26) the questionnaire had about the same results as those who took it after (D_{mean}=$-$.40, SE=.28).

Table 4.8
Correlation for US Participants

		Robot	Prefer Robots		Robots More Threat.	
		Experiences	Self-report	IAT *D*	Self-report	IAT *D*
Robot Experiences		–				
Prefer	Self-report	.13**	–			
Robots	IAT *D*	-.02	.05	–		
Robots	Self-report	-.19**	-.14**	-.01	–	
Threat.	IAT *D*	.01	-.00	-.08	.06	–

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

In the robot threatening IAT, participants who took the IAT before (D_{mean}=.24, SE=.32) the questionnaire felt slightly more threatened by robots than those who took the IAT after (D_{mean}=.18, SE=.35). But the difference was not significant ($t(628)=-2.03$, $p>.05$). These results show that there was no significant order effect on the robots pleasant and robots threatening IAT or the IATs and the questionnaire.

5. DISCUSSION

On average female faculty members of the Japanese university had 110% more robot-related experiences than female faculty member of the US university (Table 4.2). Male faculty members of the Japanese university had 69% more robot-related experiences. The heightened prevalence of robot-related experiences at the Japanese university was consistent across all five questions. This supports H1.

Although the Global Gender Gap Report 2007 ranks the US as having less gender inequality than Japan,[1] and only 4.5% of the participants from the Japanese university were female, among the Japanese faculty, there is not much of a gender gap except with respect to building and programming robots. However, there was a consistent gender gap among US participants. Male participants had on average 30% more robot-related experiences overall and 152% more experiences with building or programming robots than female participants. In both the US and Japan, younger people had more robot-related experiences.

H2 predicts Japanese faculty prefer robots and feel warmer towards robots than US faculty. While the self-report results indicate this is literally true, on average both Japanese and US participants moderately prefer people to robots (Table 4.4). The difference between Japanese and US male participants is only 0.47 on a 7-point relative preference scale and 0.42 on an 11-point warm/cold thermometer scale. In addition, Japanese felt warmer toward people than toward robots, though not as warm toward people as their US counterparts. These small differences hardly indicate Japan is a culture in the throes of “robot mania.”

H3 predicts US faculty rate robots as more threatening than Japanese faculty. The results do not support H3. On average both Japanese and US participants reported that people are more threatening than robots. This opinion was stronger for US

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[1] The US ranks 31 of 128 countries compared to Japan at 91, cf. Hausmann, Tyson, & Zahidi, 2007.

participants. However, on the safe/threatening thermometer scale, US participants rated robots as slightly dangerous, while Japanese participants rated them as neutral.

These anomalous results can be partly explained. The participants came from a highly educated demographic, so they probably understand that robots are controllable but people are not and insofar as robots are a threat it is because of how people use them (e.g., as weapons). The negative rating for the self-report *Robots Safe* in the United States might also be explained by a higher prevalence of technophobia; however, empirical studies do not support that stereotype (Weil & Rosen, 1995).

The view that robots are threatening but people are even more threatening among US participants may be a result of the higher crime rate in the US and the media's obsession with crime. Japan is a society that is relatively free of crime—especially violent crime—compared to the United States. Japanese police enjoy a close relationship with the local community. There is a *koban* (police box) in almost every neighborhood. Police walk the beat and make home visit to learn about people's lives (Reubenfien, January 13-14, 1989). Forced confessions are commonplace, there is no plea bargaining or jury system, and even guilty pleas must go to trial. The end result is a conviction rate approaching 99.9% (Scanlon, March 12, 2003).

In a cultural study of Japan's low crime rate, Komiya (1999) concludes

> In Japan, the locality-based group formation causes both a sense of security and an infinite number of repressive rules; these two elements are bound together to produce high self-control which acts as a strong force restraining people from committing crime. (p. 369)

In Japan there were 1.09 murders, 4.69 robberies, 1.62 rapes, and 20.21 acts of violence per 100,000 people in 2005.[2] To put that in perspective, in the USA there were 5.65 murders, 140.79 robberies, 31.82 rapes, and 469.04 acts of violence per

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[2] In 2005 Japan's population was 127,756,000, and there were 1,392 murders, 5,988 robberies, 2,076 rapes, and 25,815 acts of violence (*Japan Statistical Yearbook 2008* (Chapter 25, Justice and police, p. 773). Statistics Bureau, Ministry of Internal Affairs and Communications). In 2005 the USA's population was 296,507,061 and there were 16,740 murders, 417,438 robberies, 94,347 rapes, and 1,390,745 acts of violence (*2006 Crime in the United States.* Federal Bureau of Investigations, Department of Justice).

100,000 people in 2005. Clearly, the US has much more violent crime than Japan despite Japan's much higher population density. Thus, even though US participants felt robots were slightly threatening, they could still feel that people were more threatening than robots.

H4 predicts Japanese faculty more strongly associate robots with pleasant words than US faculty as indicated by the IAT D measure. This hypothesis is not supported. All groups had about the same association. They uniformly associated humans more strongly with pleasant words than robots. Japanese and US participants also more strongly associated robots with weapons than humans. However, the strength of this association was slightly stronger for US participants, so H5 is partially supported. On average why do participants, and especially US participants, say people are slightly more threatening than robots but associate robots with weapons more than humans? US participants may have some unconscious fears concerning robots—perhaps stemming from a lack of knowledge or familiarity.

Nevertheless, the more fundamental issue is that the self-reported and IAT results do not indicate a large difference between Japan and the US in terms of attitudes toward robots. One possibility is that faculty members of the chosen universities are not representative of their cultures as a whole. Another possibility is that Japan's robot culture is mainly built on factors other than feelings concerning preference, warmth, and safety with robots. These factors include Japan's historical development, economic structure, professional specialization, and government planning and policy. Japan's manufacturing sector has maintained its strength (Castells, 2000) in part through robotic automation; Japan's universities graduate a high percentage of native-born engineers, especially when compared to the US; Japan's government has envisioned robots as a possible solution to the demographic crisis; and given Japan's unique, tight-knit culture with many social rules and complexities, simply importing labor has long been considered problematic.

Sara Kiesler proposed that Japan is experiencing a positive feedback loop in robotics related to how commitment and expertise function in organizations and economies.[3] Once Japan acquired expertise in robotics, developed robots for factory automation, and trained a substantial number of robotics engineers, these experts began to create additional markets for their skills.

In the United States, this pattern is well-known in the legal profession as exemplified by the explosive growth not only in the supply of lawyers during the past 40 years but also in the demand for their skills. According to Kagan (1994), lawyers have advocated a progressive expansion of their role in society:

> Lawyers, law professors, and judges generate a legal culture that supports adversarial legalism as an essential aspect of governance. Organized groups of lawyers systematically lobby courts and legislatures to extend the realm of adversarial legalism and to block reforms that would reduce it. (p. 60)

In addition, lawyers have helped to foment an explosion in litigation. Elite firms encourage corporate clients to adopt a “rent seeking” strategy by investing heavily in law suits:

> As litigants become more accustomed to launching large legal battles, their opponents are compelled to follow suit. The big lawyer teams produce increasingly complex and sophisticated legal strategies, making legal battles more like a lottery—more dependent on big investments for successful outcomes. (Sander & Williams, 1989, p. 473)

The end result is spiraling demand for lawyers that to some extent is generated by the profession itself. Could the same be true of robot engineers in Japan?

5.1 Lessons Learned

The standard method of creating a self-reported preference index by combining relative preferences and warm/cold thermometer items (Greenwald et al., 2003) was

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[3] Personal communication

unsuccessful for robots. The reliability of the combined index was low, and the questionnaire items did not load on a single factor. Typically, in evaluating various forms of bias, people who report preferring group A to group B will also have warmer feelings toward group A than towards group B. However, this tendency is violated when robots and people are being compared.

One possible explanation is that many faculty members, especially in Japan, may not conceive of the robot as a social or personified entity with independent agency. Several researchers from Japan, including those working in the life sciences, reported that they use robots for laboratory experiments. So when they were asked about their views on robots, they at first imagined the kinds of robots they use every day. These robots they understood as a kind of programmable mechanism that is in no way personified or sociable. It is easy to understand that someone might feel cold toward such a device, but nevertheless prefer it to human beings—for example, because of its controllability, compliance, or productivity. A person might enjoy programming a robot for the satisfaction of solving a problem or creative expression without having “warm and fuzzy” feelings for it.

This might also explain why those who were not familiar with robots or not interested in them actually felt warmer toward robots. When they think of robot, they may be thinking about the personified robots of popular culture. These robots have more humanlike characteristics that elicit anthropomorphism, especially among those who have no experience building or programming robots. Also, because people who lack these kinds of experiences with robots understand less about the internal mechanisms of the robot, they may be more likely to treat it as an agent, to anthropomorphize.

From this discussion we might conclude the following: (1) Faculty members may not have one concept of robot but many: laboratory robot, industrial robot, humanoid robot, human double, and so on. The active concept is influenced by personal experience and how the questionnaire and IAT are presented. (2) Self-report indices and scales that work for racial, gender, and other groups may not work for certain concepts of robot. Once solution might be to give the participant a clear idea of the kind of robot the questionnaire is asking about. For example, if the questionnaire is about *humanoid robots*, a definition of humanoid robot could be provided with short video clips demonstrating well-known humanoid robots (e.g., Honda's ASIMO, MIT's Cog, KAIST's Hubo KHR-2). In addition, a validated self-report scale could be developed specifically for attitudes toward humanoid robots. It may also be a mistake to use people as a benchmark for judging attitudes toward robots—instead of, say, cars or animals—because there was such a wide variance in participants attitudes toward people (Table 4.3). A more stable or neutral object might be more appropriate.

Another alternative is to simply eliminate the second target concept. This is the approach of the single target IAT (ST-IAT cited in Penke, Eichstaedt, & Asendorpf, 2006). For example, if the attribute dimension is *pleasant–unpleasant*, the target concept and *pleasant* are paired with one response key and *unpleasant* is paired with the other response key in one of the combined blocks. In the other combined block, *pleasant* is paired with one response key and the target concept and *unpleasant* are paired with the other response key. The go/no-go association task (GNAT, Nosek & Banaji, 2001) also requires just a single target concept. In one of the combination tasks, participants must respond with a single key to instances of either the target concept or the *pleasant* attribute within, say, 700 ms. Instances of the *unpleasant* attribute appear as distracters. In the other combination task, the roles of *pleasant* and *unpleasant* are reversed. Both the ST-IAT and the GNAT are recommended when the target concept has no clear opposite or when the focus is on one target concept only. This avoids the introduction of a second target concept, which could be a source of unexplained variance in the result.

As an implicit measure of association, the IAT does not distinguish associations rooted in personal preferences from those rooted in extrapersonal information, such as cultural norms, educational training and material, the news media, or other people's opinions (Karpinski & Hilton, 2001; Olson & Fazio, 2004). Although this distinction is not crucial to this cross-cultural study, because it concerns general attitudes that are prevalent in Japan or the US, it can be relevant to studies on behavioral choices.

Olson and Fazio (2004) developed a personal IAT to handle these cases. Participants select items they like and dislike from a list of items that have on average a neutral valence. (In other words, there are roughly equal numbers of people who like them as dislike in among the general population.) Thus, the target concepts *I like* and *I dislike* are based on each participants own personal preferences. Houben and Wiers (2007) have successfully applied the personal IAT to the study of alcohol consumption. While studies based on the IAT showed that heavy drinkers had negative associations with alcohol, perhaps resulting from the prevalence of negative attitudes in society, the personal IAT showed that they had positive associations. In future research the personal IAT could be used to separate personal and extrapersonal associations with robots. This could address the issue, raised in the introduction, about differentiating between how Japanese think they are supposed to feel about robots from how they actually feel about them.

6. CONCLUSION

On average the Japanese faculty had many more robot-related experiences than the US faculty (110% for female, 69% for male). According to their self-reports, the Japanese faculty moderately preferred people to robots, and the US faculty preferred people slightly more. The Japanese faculty felt slightly warm toward robots, a bit warmer than the US faculty. Implicit measures showed that both Japanese and US faculty associated people with pleasant words more than robots. There was almost no difference among the groups. So implicit and explicit measures show a similar trend toward a preference for people among both faculties.

Both the Japanese and US faculty rated people as more threatening than robots, but the effect was slightly stronger for the US, which may reflect safety concerns. However, implicit measures also showed that both Japanese and US faculty associated robots with weapons more than people. The effect was slightly larger for the US faculty. This implies that both faculties and especially the US faculty might have some unconscious fears about robots that are not appearing on the self-reports.

The differences between the Japanese and US faculty were not sufficient to substantiate the view that Japan as a culture loves robots and views them as safe. This may indicate that the Japanese and US faculty were not representative of the wider culture, or that factors other than attitude play a greater role on Japan's development as a robot-oriented culture—for instance, Japan's historical development, economic structure, professional specialization, and government planning and policy. In addition, increased familiarity with robots may imply a deeper understanding of robots as a mechanism, and therefore a lessened tendency to anthropomorphize.

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APPENDIX

A. QUESTIONNAIRE

A.1 Robot-related Experiences

1. How many times in the past one (1) year have you read robot-related stories, comics, news articles, product descriptions, conference papers, journal papers, blogs, or other material?

   0, 1, 2, 3, 4, 5 or more

2. How many times in the past one (1) year have you watched robot-related programs on film, television, DVD, the Internet, or other media?

   0, 1, 2, 3, 4, 5 or more

3. How many times in the past ten (10) years have you had physical contact with a robot?

   0, 1, 2, 3, 4, 5 or more

4. How many times in the past ten (10) years have you attended robot-related lectures, exhibitions, trade shows, competitions, or other events?

   0, 1, 2, 3, 4, 5 or more

5. How many times in your life have you built or programmed a robot?

   0, 1, 2, 3, 4, 5 or more

A.2 Attitudes toward Robots

1. Select the statement that best describes your opinion.
   - I strongly prefer robots to people. (+3)
   - I moderately prefer robots to people.
   - I slightly prefer robots to people.

  - I like robots and people equally.
  - I slightly prefer people to robots.
  - I moderately prefer people to robots.
  - I strongly prefer people to robots. (-3)

2. Rate how warm or cold you feel toward robots. (11 point scale)
   - Very cold (-5)
   - Neutral
   - Very warm ($+5$)
3. Rate how warm or cold you feel toward people.
   - Very cold (-5)
   - Neutral
   - Very warm ($+5$)
4. Select the statement that best describes your opinion.
   - Robots are much more threatening than people. ($+3$)
   - Robots are somewhat more threatening than people.
   - Robots are slightly more threatening than people.
   - Robots and people are equally threatening.
   - People are slightly more threatening than robots.
   - People are somewhat more threatening than robots.
   - People are much more threatening than robots. (-3)
5. Rate how safe or threatening you feel robots are.
   - Very threatening (-5)
   - Neutral
   - Very safe ($+5$)
6. Rate how safe or threatening you feel people are.
   - Very threatening (-5)

  - Neutral
  - Very safe (+5)

7. How familiar are you with robots?
   - Not at all familiar (0)
   - Slightly familiar
   - Somewhat familiar
   - Moderately familiar
   - Very familiar
   - Completely familiar (+5)

8. How interested are you in robots?
   - Not at all interested (0)
   - Slightly interested
   - Somewhat interested
   - Moderately interested
   - Very interested
   - Completely interested (+5)

VITA

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Sandosh K. Vasudevan

1350 N. Meridian St.
Indianapolis, IN 46202
(317) 224-4309
sanvasud@iupui.edu

Education

Master of Science, Human-Computer Interaction

Indiana University Purdue University at Indianapolis, US, May 2008

Bachelor of Technology, Electrical Engineering

Indian Institute of Technology Madras, India, May 2006

Professional

08/2006–Present, School of Informatics, IUPUI, Indianapolis, IN

Research Assistant.

Collaborated with a group of researchers to create multilingual interfaces to conduct online experiments in the field of Human-Computer Interaction.

06/2007–08/2007, Yahoo! Inc., Sunnyvale, CA

Software Applications Developer Intern.

Designed and Developed a firefox extension to visualize data at Yahoo. Won ‘Must ship with Award’ at Yahoo! Widgets Intern Contest.

Skills

Programming: PHP, MySQL, JavaScript, CSS, (X)HTML, Actionscript, XML, Python, C/C++, Java, XUL

Frameworks/APIs: Ajax, Django, Ruby on Rails, Firefox