EXPLORING THE EFFECT OF INTERGROUP RELATIONS ON PEOPLE’S ACCEPTANCE OF ROBOTS

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Abstract: People regard robots as social entities and apply social rules to the relations between people and robots. Robots, however, project an amount of product-ness and robot-ness as well as humanness. The objective of this study is to examine how people perceive robots as social objects by comparing with other objects. In order to investigate the effect of intergroup relations on people’s acceptance of robots by types of objects, social distance, especially intergroup relations, was applied to this study. In an experiment, participants watched pictures of in-group and out-group stimulus drawn from four types of objects (robots vs. humans vs. animals vs. products) and rated it in terms of preference and reliability. The results from the experiment showed that the difference of preference score between in-group and out-group in the case of robots was significantly greater than in the case of animals and products which are owned by people. In the case of reliability, intergroup relations had more of an influence on robots than humans. Based on the experiment results, we discussed the use of intergroup relations for designing robots.

Keywords: Robot acceptance, Social distance, Intergroup relations

1. Introduction

As socially interactive robots emerge in daily life [1], how people adopt robots as social partners should be explored. Fong and his colleagues defined socially interactive robots as the robots for which social interaction plays a key role [2]. Socially interactive robots express and/or perceive emotion, communicate with high-level dialogue, learn/recognize models of other agents, establish/maintain social relationships, use natural cues, exhibit distinctive personality and character, and may learn/develop social competencies. There have been various studies in regards to people’s acceptance of robots, such as the effect of the uncanny valley on people’s acceptance of robots’ appearance and personality [3], children’s acceptance of a teaching assistant robot [4], and cultural differences in the acceptance of robots between the West and Japan [5]. Most studies, however, are limited to covering aspects of robots’ physical attributes or people’s characteristics. The Computers As Social Actors (CASA) paradigm, however, suggests that people apply social rules to their interactions with computers and give mindlessly social responses to robots on how to treat people [6]. Therefore, when it comes to designing for Human-Robot Interaction (HRI), the robots’ social attributes with social psychological aspects of human relations need to be explored as well as their physical attributes. In addition, robots have three attributes, humanness, robot-ness, and product-ness [2]. Thus, the robots’ social position needs to be explored when people design robots in their daily life by comparing them with humans and products.

In sociology, Park applied a concept of distance which represents spatial relations between two places to human relations and suggested the term social distance representing a degree of familiarity between two people [7]. Social distance leads different interpretations in each different object and event [8]. Especially intergroup relations, one of various dimensions of social distance, explain how people differently show positive or negative distinctiveness to others through their and others’ social belongingness. Likewise, if people’s acceptance of robots is
affected by whether robots belong to their in-group or out-group, intergroup relations could be effectively applied to the design of HRI in order to increase the acceptance of robots as social partners.

The objective of this study is to explore the effect of social distance, especially intergroup relations, on people’s acceptance of robots and suggest effective ways to design robots for its harmonious coexistence with people in their social communities.

2. Social Distance and Intergroup Relations

2.1. Social Distance

Social distance, which has been generally observed in personal and social relations, has been used in social psychology as an index of intimacy between two [7]. Social distance is one of four different types of psychological distance such as temporal distance (e.g., next week vs. next year), spatial distance (e.g., next door vs. in another building), hypotheticality (e.g., likely vs. less likely), and social distance (e.g., self vs. others, friend vs. stranger) [9]. Social distance consists of multiple dimensions such as mutual sympathy and affectivity [10], belongingness [11, 12], the frequency and length of interaction [13, 14], similarity [12, 15, 16], interpersonal-physical distance [17], position [17], etc. For example, We tend to regard an object or other person as “socially near” when it has similarity in beliefs, customs, practices, appearances, and other characteristics that define their identity [18], while regard it as “socially distant” when it is detached from our direct experience [8].

2.2. Intergroup Relations

Intergroup relations is one form of social distance and refers to the way in which people in groups perceive, think about, feel about, and act toward people in other groups[19].

Intergroup relations first introduced as ethnocentrism by Sumner [20] describe the designation of one’s own group as human and the infra-humanization of “others.” People perceive those who have a shared similarity with them as in-group and those who don’t as out-group [21]. The factor of discrimination of in-group and out-group varies according to the situation. It can be an objective criterion such as race, gender, country, region or social position in human-human relationships and a subjective criterion such as attitudes, interests, traits, or physical appearance. For example, while criticisms of people who are from same country were tolerated surprisingly well, criticisms of people who are from different country were met with sensitivity and defensiveness [22]. According to the notion of intergroup relations, individuals become attached to their in-groups while they come to dislike or derogate out-groups [23]. Therefore, it is also called as intergroup discrimination or in-group favoritism.

Because a robot is a social partner that communicates with humans as an “other”, many researchers have tried to apply the concept of intergroup relations to the field of Human-Computer Interaction (HCI) and HRI [24, 25, 26, 27]. In particular, being able to cooperate with robots has been studied related to the concept of intergroup relations.

In Nass’s study [24], he investigated people’s team relationships with computers. In the results, people who are told they are affiliate with the computer as a team perceived the computer to be more similar to themselves, showed higher receptivity to the computer’s suggestions, and perceived the computer’s information more helpful.

Furthermore, Mutlu and his colleagues compared people’s perception when they cooperate and compete with ASIMO [25]. The results showed that participants in the cooperative interaction perceived the robot more sociable and more intellectual than participants in the competitive interaction, while they were less involved in the task in the co-operative condition than in the competitive condition. However, this effect was significant only for male participants.

Findings from previous studies suggest that the intergroup relations could affect people’s perception of robots. This is why we expected that intergroup relations can be an effective way to design robots to be more acceptable. Those previous studies, however, had the people collaborate with the robot as a teammate or compete with the robot as a counterpart. Therefore it is hard to suggest general design implications of robots’ social characters from those findings. In addition, because a teammate and a counterpart are completely opposite more than difference, it doesn’t convey that different social belongingness makes people accept robots differently in human robot relations. This paper explores whether people’s acceptance of robots can be different depending on whether the robots are perceived as one’s in-group or out-group.

3. Acceptance of Robots

3.1. Acceptance of Robots in HRI Research

Although the general public, as well as robot researchers, have begun to pay attention to robots, the robots are not still deployed on a commercial scale. It may be because robots
have been developed for technological advancement based on engineering science. There is little research in the acceptability of robots to people in daily lives and most existing studies related to people's acceptance of robots are limited to the effect of aspects of robots' physical attributes.

Moreover, some studies dealing with robot's social attributes were already based upon a premise that people treat robots socially like other people. However, because robots have not only robot-ness but both humanness and product-ness, how people distinctively accept robots in their communities need to be explored by comparing them with humans and products.

3.2. Acceptance of Robots Comparing with Other Objects

As people perceive robots as social partners [6], we need to explore people's acceptance of robots compared to other objects that they communicate with.

Many researchers have compared robots with other social entities such as human, animal, toys, 2-D character agent, etc [28, 29, 30]. Kim and her colleagues explored how people treat humanoid social robots targets by comparing with human targets [29]. To compare humanoid robot and human, social-oriented constraints, such as feelings, non-imposition, and disapproval, and task-oriented constraints, including clarity and effectiveness, were applied. In the case of human, people were more concerned with social-oriented constraints, such as avoiding hurting the other's feelings, avoiding inconveniencing the human interactive partner, and avoiding being disliked by the human, while people were less concerned about social-oriented constraints in the case of robot.

As reflected in Kim's study, acceptance of robots is different from that of humans, even though both robots and humans are social entities. Therefore, it is important to analyze the effect of intergroup relations by initiating a comparison with other objects.

Of particular relevance to the current research is how intergroup relations influence how robots are accepted as social agents. In social psychology, intergroup relations are an index of relationships between people. Applying the concept of intergroup relations to human-robot relationships could be an effective way of designing appropriate robots in our daily lives. Robots, however, have a product-ness aspect, as well as humanness aspect [2]. Thus, the effect of intergroup relations on robots needs to be compared with other social entities in order to find common points and differences between robots and humans. Then, it would make it possible to suggest various design implications in order to increase people's acceptance of robots as social partners.

4. Study Design

The experiment used a 4 within-groups factorial design. The within-groups factors were the four object types (robots vs. people vs. animals vs. products). Preference and reliability were evaluated through questionnaires. Score difference between an in-group stimulus and an out-group stimulus in preference and reliability were compared by types of objects.

As there would be an intergroup relations effect on objects, we expect that people's perception of in-group objects would be different from that of out-group objects.

Moreover, we were interested in examining how the effect of intergroup relations would be different by object types. NEC personal robot center conducted a survey to examine how people perceive a robot by comparing it with other types of objects, such as people, animals, inanimate objects including rocks and computers [30]. The survey results showed that the stimuli were classified into the "Human-Animal" group, "Machine-Inanimate Object" group, and the "Robot" group, and people perceived the Robot group as objects in between the other two groups. In addition, as people communicate with robots as social actors [6], we believed that people's perception of robots would be distinguished from their perception of other types of objects (e.g., product).

As such, we anticipated that the effect of intergroup relations on robots would be greater than on animals or inanimate objects while smaller than on people.

This analysis led to the following research hypotheses:

H1. The preference score of in-group and out-group will vary in each object.

H2. The reliability score of in-group and out-group will vary in each object.

H3. The differences in preference score between in-group and out-group will vary by robots, humans, animals, and products.

H4. The differences in reliability score between in-group and out-group will vary by robots, humans, animals, and products.

4.1. Participants

In order to divide the stimuli into in-group and out-group with criteria such as country, school, and generation, we recruited participants who are of the same
nationality and generation and belong to the same university, KAIST. Korean students in their twenties from the same engineering college (Male: 14, Female: 16) participated in the experiment.

4.2. Materials

Referring to the aforementioned NEC research [30], we selected stimuli according to four types of object, such as robots, humans, animals, and products, and for each object type we chose in-group and out-group stimuli.

For humans, we chose one of the well-known students at KAIST where participants attend, the first cosmonaut in Korea, as an in-group stimulus. As an out-group member, one woman who is not in the same engineering college was selected.

For animals, a representative Korean dog, the Jindodog, was selected as an in-group stimulus while a Western dog, a type of hound, was provided as an out-group stimulus. Both dogs are similar in size and characteristics.

In the case of the robots, HUBO, a well-known humanoid developed by KAIST, was an in-group stimulus while an unknown humanoid robot used in a specific public institution was chosen as an out-group.

For products, a laptop was chosen as an in-group stimulus while a typewriter was selected as an out-group stimulus, because the former is a popular product among the participants' generation whereas the typewriter is an out-of-date product.

Table 1. Experiment Materials

<table>
<thead>
<tr>
<th>Robot</th>
<th>Human</th>
<th>Animal</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="In-group Robot" /></td>
<td><img src="image" alt="In-group Human" /></td>
<td><img src="image" alt="In-group Animal" /></td>
<td><img src="image" alt="In-group Product" /></td>
</tr>
<tr>
<td><img src="image" alt="Out-group Robot" /></td>
<td><img src="image" alt="Out-group Human" /></td>
<td><img src="image" alt="Out-group Animal" /></td>
<td><img src="image" alt="Out-group Product" /></td>
</tr>
</tbody>
</table>

4.3. Procedures

At the beginning of the experiment, an experimenter explained the experiment and asked the participants to complete a written consent. The participants were then asked to take a seat in front of a computer. On the computer screen, the still image and the name of each stimulus were displayed, and the participant was asked to rate each stimulus in terms of Preference and reliability. Participants watched all of the eight stimuli, and the stimuli were randomized by types of object and types of intergroup relations.

4.4. Experimental Manipulations

In in-group condition, each objects had same affiliation, nationality, or generation with participants, while out-group objects had different ones from participants. To check on the validity of the in-group and out-group division of each material, we measured people's familiarity to each object. It is because familiarity is an index of social distance [7] and if we have significantly different familiarity to in-group object and out-group object, it means these two objects have different social distance from people. Eleven items to evaluate familiarity were adapted from previous research, such as Kanda, Ishiguro, and Ishida's study [31]. The 11 items were such as “kind, friendly, safe, warm, frank, pretty, distinct, accessible, light, altruistic, and favorable.” Among 11 items of the familiarity scale, 10 items except “favorable” were used. “Favorable” which is often used in marketing research to measure consumer’s preference was used as one item for evaluating preference in this study. All items were assessed on seven-point Likert scales ranging from “Describes Very Poorly” to “Describes Very Well”.

4.5. Measures

There are some criteria to evaluate the acceptance of robot in the field of HRI, such as the degree of enjoyment [31, 32], usefulness [32], sociability [32], ease of use [32, 33], accessibility [33], reliability [34], comfort level [35], etc. Among these, because robots are being applied in situations which require robot’s delicacy and precision, such as medical applications, robot reliability is becoming ever more important in the field, the complex and unstructured environments [34]. Preference is a typical index to measure the people’s acceptance of events, objects and even other people.

Thus, we measured participant’s acceptance: preference and reliability. Preference was measured by “good” and “favorable” to measure user’s overall satisfaction of each object [36]. Reliability was an index of two items “trustworthy” and “reliable,” which was used for intergroup relation research in social psychology [23]. All items were assessed on seven-point Likert scales ranging from “Describes Very Poorly” to “Describes Very Well”.

5. Results
5.1. Manipulation Check
The experiment used one-way within-groups analysis of variance (ANOVA) in each object to check on the validity of the in-group and out-group division of each object. We asked participants how much familiar each material was with 10 items. There was a significant difference of familiarity between in-group stimuli and out-group stimuli for all four types of object as described in Table 2: robot (in-group: $M=4.73$, $SD=1.32$ vs. out-group: $M=3.91$, $SD=1.45$, $F(1, 558)=48.68$, $p<.001$), human (in-group: $M=5.09$, $SD=1.32$ vs. out-group: $M=3.93$, $SD=1.43$, $F(1, 558)=100.45$, $p<.001$), animal (in-group: $M=5.40$, $SD=1.28$ vs. out-group: $M=4.63$, $SD=1.30$, $F(1, 558)=49.51$, $p<.001$) and product (in-group: $M=4.68$, $SD=1.40$ vs. out-group: $M=4.44$, $SD=1.41$, $F(1, 558)=4.2$, $p<.05$).

### Table 2. Manipulation Check

<table>
<thead>
<tr>
<th>Object</th>
<th>In-group</th>
<th>Out-group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot</td>
<td>4.73 [1.32]</td>
<td>3.91 [1.45]</td>
</tr>
<tr>
<td>Human</td>
<td>5.09 [1.32]</td>
<td>4.63 [1.30]</td>
</tr>
<tr>
<td>Animal</td>
<td>5.40 [1.28]</td>
<td>4.44 [1.41]</td>
</tr>
<tr>
<td>Product</td>
<td>4.68 [1.40]</td>
<td>4.44 [1.41]</td>
</tr>
</tbody>
</table>

Note: The numbers show the means and the standard deviation in brackets. Significance tests compare in-group with out-group in each object.

* $p < .05$, ** $p < .01$, *** $p < .001$

### 5.2. The Effect of Intergroup Relations on People’s Acceptance

The experiment used one-way within-groups ANOVA in each object to examine the effect of intergroup relations on peoples’ acceptance in each object. We analyzed the people’s preference and reliability score of in-group stimuli and out-group stimuli for each object.

As predicted by H1, participants reported they would prefer the in-group robot, $M=4.95$, $SD=1.34$ to the out-group robot, $M=3.39$, $SD=1.46$, $F(1,110)=34.39$, $p<.001$. It was same with in the case of human(in-group: $M=5.18$, $SD=1.05$ vs. out-group: $M=3.63$, $SD=1.30$, $F(1,110)=48.48$, $p<.001$), animal(in-group: $M=5.91$, $SD=1.00$ vs. out-group: $M=5.30$, $SD=1.00$, $F(1,110)=10.47$, $p<.05$), and product(in-group: $M=5.38$, $SD=1.10$ vs. out-group: $M=4.88$, $SD=1.32$, $F(1,110)=4.72$, $p<.05$) as shown in Table 3.

H2 was also supported by the data. Participants rated that the in-group robot, $M=4.89$, $SD=1.42$, is more reliable than out-group robot, $M=3.57$, $SD=1.48$, $F(1,110)=23.28$, $p<.001$. It was same with in the case of human(in-group: $M=5.21$, $SD=1.37$ vs. out-group: $M=3.21$, $SD=1.34$, $F(1,110)=60.73$, $p<.001$), animal(in-group: $M=6.02$, $SD=.84$ vs. out-group: $M=5.00$, $SD=1.19$, $F(1,110)=27.28$, $p<.001$), and product(in-group: $M=5.04$, $SD=1.25$ vs. out-group: $M=4.04$, $SD=1.13$, $F(1,110)=19.76$, $p<.001$) as shown in Table 3.

### Table 3. The Acceptance Score of In-group and Out-group

<table>
<thead>
<tr>
<th>Object</th>
<th>In-group</th>
<th>Out-group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>4.95 [1.34]</td>
<td>3.99 [1.46]</td>
</tr>
<tr>
<td>Reliability</td>
<td>4.89 [1.42]</td>
<td>3.57 [1.48]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object</th>
<th>In-group</th>
<th>Out-group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>5.91 [1.00]</td>
<td>5.30 [1.00]</td>
</tr>
<tr>
<td>Reliability</td>
<td>6.02 [1.84]</td>
<td>5.00 [1.19]</td>
</tr>
</tbody>
</table>

### 5.3. The Effect of Object Type on the Differences in Peoples’ Acceptance by Intergroup Relations

The experiment used one-way within-groups ANOVA to compare the effect of intergroup relations on robot and other objects. The difference of preference score between in-group stimuli and out-group stimuli on robot was compared independently with on human, animal, and object. The statistical method in the case of reliability score was same with the preference score.

H3 predicted that intergroup relations would show different degree of effect on preference according to types of object. The score difference analyses showed that, intergroup relations on robots, $M=1.59$, $SD=1.83$, were much more effective than on animals, $M=0.61$, $SD=1.47$, $F(1,110)=9.81$, $p<.01$, and products, $M=0.50$, $SD=1.55$, $F(1,110)=11.58$, $p<.01$, while it had similar effect on people’s acceptance to intergroup relations on humans, $M=1.55$, $SD=1.59$, $F(1,110)=.01$, $p<.01$, as shown in Table 4 and Figure 1.

### Table 4. The Difference of Acceptance Score between In-group and Out-group

<table>
<thead>
<tr>
<th>Object</th>
<th>In-group</th>
<th>Out-group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>1.59 [1.83]</td>
<td>0.61 [1.47]</td>
</tr>
<tr>
<td>Reliability</td>
<td>1.32 [1.94]</td>
<td>1.02 [1.14]</td>
</tr>
</tbody>
</table>

Note: The numbers show the means and the standard deviation in brackets. Significance tests compare robot with other objects such as human, animal, and product.

* $p < .10$, ** $p < .05$, *** $p < .01$
This finding provides further evidence that people unconsciously try to find the common points from the object and if he/she has the same affiliation with the object or owns the object, they will have a positive perception of the object.

As predicted by H3, people showed different effects of intergroup relations in preference by types of objects. The differences between in-group stimuli and out-group stimuli of robots was higher than that of product and animal. Animals and products may be distinguished by whether or not people possess it rather than whether or not it is in the same group with them. In addition, even though intergroup relations affected people's preference of robots significantly, the effect of people's tastes on people's preference may be larger than the effect of affiliation of animals or products. In this experiment, in an interview conducted after a questionnaire, for example, only three among thirty participants described animals with its nationality, such as "The reason why I feel close to Jindodog may be that Jindodog is a Korean dog," "When I see a hound, I feel like looking foreigner." In most cases, participants described animals' characteristics and attributions were judged by appearance like "It(hound) is a mean-looking dog." "Jindodog seems to take care of a house well." In the case of robots, most of the participants first described the in-group robot with the word "HUBO, our (university) robot," while they only mentioned the out-group robot's appearance without any word related to an affiliation. This is because the out-group robot has no relation to the participants and may just be a stranger to them. This finding provides further evidence that people perceive robots as social entities, which can be a member of our group or another group, instead of possessions.

In the case of reliability, as predicted by H4, the difference between in-group stimuli and out-group stimuli in the robot was significantly lower than in humans. Humans are individuals and not owned by other people like products or animals, even though they are really close. Therefore, people need enough time and effort to figure out and trust others. It can be inferred that the lower grades of difference between an in-group robot and an out-group robot on reliability originates from robots' product-ness.

6. Discussion

6.1. Summary and Interpretation of Results

As predicted by H1, people preferred in-group to out-group in all four objects. Consistent with H2, a significant intergroup effect on all four objects was found.
an effect on people's acceptance of robots in a similar way to that in which intergroup relations do on people's acceptance of other people.

The results suggest that an in-group concept can be effective way to increase reliability. For example, attaching a local mark on the front of the robot, having robots exposed to people, and giving humans a chance to interact with robots is recommended in order to increase people's acceptance of the robot, especially when designing a robot for which reliability should be emphasized, such as a rescue robot or a teaching assistant robot.

6.3. Limitations

There are several limitations in this experiment.

First, the criteria for dividing in-group and out-group were slightly different according to types of object. The criterion in animals, such as country, was a bigger notion than school which is a criterion in humans and robots, although participants distinguished in-group stimulus from out-group stimulus.

Second, we recruited only university students in their twenties who might be unfamiliar with a typewriter. However, because some participants in their late twenties might have experienced a typewriter when they were young, there was a possibility that a typewriter is perceived as an in-group object rather than an out-group one, although participants rated typewriter as out-group stimuli on the comparing with laptop.

Third, the experiment was conducted with only one pair of robot samples. The effect of intergroup relations on robots should be further explored with various robot samples such as anthropomorphic, zoomorphic, caricatured, and functional robots [2].

7. Conclusion

As robots' purpose in human daily life transfers from working instead of humans to being friends or social partners, people's adoption and acceptance of robots is an important issue to explore in the field of HRI. This study represents an initial attempt to demonstrate the effect of intergroup relations in HRI by comparing with humans, animals, and products. From this study, the results suggest that designing robots with the notion of in-group can increase people's acceptance of robots, especially in the case of robots required reliability for their work.

References


