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Exploratory Investigation of the Effects of Perspective Taking and Awareness of Vulnerability on Impressions of Robots

Shinnosuke Ikeda
Kanazawa University Kakuma-machi, Kanazawa, Ishikawa, Japan
ORCID: https://orcid.org/0000-0001-9128-5627, e-mail: odenshin@gmail.com

Objective. *This exploratory study investigated whether perspective-taking and awareness of vulnerability procedures could enhance impressions of robots.*

Background. *A society characterized by the harmonious coexistence of humans and robots is poised for realization in the imminent future. Nevertheless, numerous challenges must be confronted for the materialization of such a societal paradigm. One among them pertains to the prevailing tendency for humans to harbor adverse perceptions of robots, the amelioration of which proves to be a complex endeavor. The present study undertakes an exploratory investigation into strategies aimed at mitigating unfavorable impressions associated with robots.*

Study design. *Participants were randomly assigned to one of three groups: control group, perspective perception group, and robot vulnerability awareness group, and received different instructions.*

Participants. *Online experiments were conducted with 360 participants who were asked to imagine and describe a day in the life of a robot, and their impressions of the robot were measured using a questionnaire.*

Measurements. *Upon conjecturing and articulating the robot's daily routines, participants shared their perceptions of the robot through the application of three assessment tools: the Robot Anxiety Scale, the Mind Attribution Scale, and the Familiarity Rating Scale.*

Results. *The manipulation checks confirmed successful manipulation, but there was no evidence that perspective-taking or awareness of vulnerability influenced impressions of the robot.*

Conclusions. *The efficacy of perspective-taking, a technique established as beneficial in ameliorating adverse perceptions of humans, may exhibit diminished effectiveness in the context of alleviating negative impressions associated with robots.*

***Keywords*:** *social robot; perspective taking; awareness of vulnerability of the robot; empathy; human impression of the robot.*

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Экспериментальное исследование влияния децентрации и осознания уязвимости на восприятие человеком роботов

Икеда Ш.
Университет Канадзавы Какума-мачи, Канадзава, Исикава, Япония
ORCID: https://orcid.org/0000-0001-9128-5627, e-mail: odenshin@gmail.com

Цель. *Поиск ответа на вопрос о том, приведут ли децентрация (стремление понять опыт и точку зрения других) и повышение осведомленности об уязвимости робота к изменению восприятия человеком роботов.*

Контекст и актуальность. *Общество, характеризующееся гармоничным сосуществованием людей и роботов, готово к реализации важнейших задач, стоящих перед ближайшим будущим человечества. Тем не менее для материализации такой парадигмы необходимо решение множества проблем, одна из которых связана с преобладанием у людей негативного восприятия роботов. Настоящее исследование посвящено изучению стратегий, направленных на смягчение неблагоприятных впечатлений, возникающих у людей при взаимодействии с роботами.*

Дизайн исследования. *Участники были случайным образом распределены в одну из трех групп: контрольную группу, группу «децентрации» и группу осознания уязвимости роботов и получили различные инструкции. Участники должны были представить и описать один день из жизни робота, а их впечатления от робота измерялись с помощью анкеты.*

Участники. *В онлайн-эксперименте приняли участие 360 человек.*

Методы (инструменты). *Свободное описание распорядка дня робота; три оценочных инструмента: Шкалы тревожности робота, Шкалы атрибуции разума и Шкалы оценки знакомства.*

Результаты. *Проверка подтвердила успешность манипуляций, но не было обнаружено никаких доказательств того, что «децентрация», т.е. стремление понять опыт и точку зрения других, или осознание уязвимости повлияли на впечатления людей о роботах.*

Выводы. *Эффективность метода «децентрации», признанного полезным для смягчения негативных представлений о людях, демонстрирует меньшую эффективность при смягчении негативных впечатлений, связанных с роботами.*

***Ключевые слова*:** *социальный робот; децентрация; осознание уязвимости робота; эмпатия; восприятие человеком роботов.*

Финансирование. Данная работа выполнена при поддержке Программы определения тем для продвижения передовых исследований в области гуманитарных и социальных наук, № JPJS00122674991.

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Introduction

Empathy, a crucial ability for group living [23; 25], is multidimensional in nature [4] and has been defined as the capacity to recognize the emotions of others with minimal discrimination between self and others [8]. While empathy is observed in various animal species, humans are believed to possess more advanced forms of empathy as a result of evolution [6; 7; 15].

Empathy is often associated with the ability to adopt the perspective of others [5; 13]. In fact, research has suggested that empathy can be augmented through the practice of perspective-taking, where individuals strive to understand the experiences and viewpoints of others [10; 12]. For instance, taking the perspective of individuals belonging to a certain category has been shown to decrease prejudice based on age and race [9; 11].

However, recent research has highlighted that perspective-taking may not be effective in reducing prejudice towards robots [26]. Studies have reported that humans struggle to empathize with robots [3; 24], and that traditional perspective-taking procedures employed in previous studies do not improve negative impressions of robots [26]. In fact, it has been demonstrated that humans encounter difficulties in adopting the perspective of robots [27].

Given the increasing likelihood of further development in the coexistence with robots in the future, how can we recognize robots as social partners? This study investigates, in an exploratory manner, the effects of awareness of the vulnerability of robots. For instance, research has shown that humans can deliver electric shocks to a moving, talking LEGO robot at a higher intensity than to a human, upon command [1]. If humans are made aware of the fact that robots, like humans, are unable to recover from fatal injuries, they may be more likely to treat robots with a similar level of consideration as they would humans.

This study aims to investigate whether altering the perspective-taking procedure and raising awareness of the vulnerability of the robot would result in changes in impressions of the robot. Although previous research has shown that perspective-taking does not significantly impact impressions of robots [26], it is hypothesized that awareness of vulnerability may positively influence these impressions. To test this hypothesis, participants were randomly assigned to one of four experimental conditions: (1) perspective-taking group, (2) awareness of vulnerability group, (3) combined perspective-taking and awareness of vulnerability group, and (4) control group. Impressions of the robot were assessed after the experimental manipulation in each condition.

Method

Participants

The study was conducted using an online survey, with a total of 360 participants (136 female, 223 male, 1 non-response, Mean age = 51,01 years, *SD* = 10,53, range = 18—60) recruited through GMO Research (https://gmo-research.com/). The procedures for this study were approved by the Ethical Review Board of the author's institution (approval number 22H11).

Materials

In this study, the following three questionnaires were used to measure impressions of robots: The first is the Robot Anxiety Scale (RAS) [20]. This scale measures anxiety about robots in general with items such as "I would be nervous if I had to operate a robot in front of other people". The scale consisted of 11 items answered on a 5-point scale. The second is the Mind Attribution Scale (MAS) [14]. This scale measures the degree of mind attribution to robots through items such as "To what extent are robots able to experience joy?" The scale consisted of 18 items answered on a 7-point scale. The third is the Familiarity Rating Scale (FRS) [17]. This scale measures familiarity with the robot, and 11 adjective pairs such as "unfriendly-friendly" are presented, and the participants answer on a 7-point scale (the higher the number, the stronger their familiarity with the robot).

Procedure

The study was conducted on GORILLA Experiment Builder, an online experimental program. Participants accessed Gorilla from the URL provided in the GMO Research survey request and participated in the experiment. Four conditions were set for this study, and participants were randomly delivered a link that allowed them to access one of the four conditions.

The study consisted of six phases: an age and gender response phase, a free writing phase, a computational task phase, a RAS phase, a MAS phase, and an FRS phase. In each phase, participants were provided with instructions on what they were required to do, and they initiated the phase by pressing the “Start” button. There was no time limit set for each phase, unless otherwise noted. However, if the total duration of a phase exceeded 30 minutes, the phase was forcibly terminated, as there was no intention to continue beyond that point.

In the free writing phase, a picture of NAO, a bipedal humanoid robot, was presented to all conditions with different instructions for each of the four conditions. The instructions were as follows: Control group: Participants were instructed to imagine and describe a typical day in the life of the robot shown in the picture, which can talk to humans and perform simple household chores. Perspective-taking group: Participants were instructed to imagine and describe a day in the life of the robot from its point of view, as if they were the robot, which can talk to humans and perform simple household chores. Awareness of vulnerability group: Participants were instructed to imagine a day in the life of the robot and describe it in detail, while noting that the robot is fragile and cannot be restored to its original state if severely damaged. The robot shown in the picture can talk to humans and perform simple household chores. Perspective-taking x Awareness of vulnerability group: Participants were instructed to imagine a day in the life of the robot as if they were the robot, and describe it in detail from the robot’s point of view. They were also instructed to note that the robot is fragile and cannot be restored to its original state if severely damaged. The robot shown in the picture can talk to humans and perform simple household chores. Participants were informed that they had 5,5 minutes to write the description, and a countdown was displayed on the screen 30 seconds before the end. In the calculation task phase, 20 one-digit addition questions were performed as fillers.

In the RAS, MAS, and FRS phases, all questions were presented on the screen in a random order. The user could not move to the next screen until all items in each phase were answered.

Coding

For each of the three scales, the mean of the rating values for each item was calculated for each individual and used as the score. The RAS score ranged from 1 to 5, with higher scores indicating greater anxiety toward the robot; the MAS score ranged from 1 to 7, with higher scores indicating greater mind attribution to the robot; and the FRS score ranged from 1 to 7, with higher scores indicating greater familiarity with the robot.

Results

Manipulation check of free writing procedures

The study examined whether there were differences in the content of the descriptions provided in the free writing phase based on the instructions given in each of the four conditions. Since the criterion of changes in the frequency of first person, often used in perspective-taking studies in Western countries, may not be applicable in Japanese language where first person is often omitted, text mining was conducted to analyze the words used in the descriptions. Correspondence analysis was performed using KH Coder version 3.Beta.07b [16], including all parts-of-speech, and the top 60 words with significant differences were used in the analysis. The results were shown in Figure, which displayed the words that were salient in each of the four conditions, arranged in the direction of the name of each condition.

The findings from Figure showed that the word "壊れる" (meaning "break" in Japanese) appeared characteristically in the group that underwent the awareness of vulnerability condition. On the other hand, the words "主人" (meaning "master" in Japanese) and "人間" (meaning "human" in Japanese) appeared characteristically in the group that underwent the perspective-taking condition. This suggests that participants in the perspective-taking group considered themselves as robots and viewed humans relatively. Additionally, the words "掃除" (meaning "cleaning" in Japanese) and "掃除" (meaning "preparation" in Japanese) were common words across all groups. Given the prevalent omission of the subject in Japanese sentences, the frequent utilization of first-person pronouns, a conventional metric employed for manipulation check in Western contexts, was deemed unsuitable. Additionally, the pioneering nature of the methodology employed in this study precluded the preselection of standard words. Consequently, the operational checks implemented in this study, while not furnishing robust evidence, based on these results, it can be concluded that the manipulation of the free writing procedure was successful in eliciting different content in the descriptions based on the instructions given in each condition.

Impression Rating of the Robot

The study conducted a one-factor, four-level between-participants analysis of variance (ANOVA) to examine the effects of perspective-taking and awareness of vulnerability on impressions of the robot, using the RAS, MAS, and FRS scale scores as dependent variables (see Table). The results showed that the main effect of condition was not significant for any of the scales: RAS (F(3, 356) = 0,446, p = 0,720, η_p^2 = 0,004), MAS (F(3, 356) = 0,587, p = 0,624, η_p^2 = 0,005), or FRS (F(3, 356) = 0,916, p = 0,433, η_p^2 = 0,008). This indicates that neither perspective-taking nor awareness of vulnerability had a significant effect on impressions of the robot, as measured by the RAS, MAS, and FRS scores.

Discussion

The findings of the study suggest that perspective-taking and awareness of vulnerability, as manipulated in the study, did not have a significant effect on impressions of the robot. This is consistent with previous research that showed perspective-taking did not reduce robot anxiety [26]. However, it is noteworthy that the lack of effect of awareness of vulnerability on impressions of the robot was contrary to the predictions of the study. This finding may suggest that other factors, beyond perspective-taking and awareness of vulnerability, may play a more significant role in shaping impressions of robots. Further research may be needed to explore and understand the complex re-

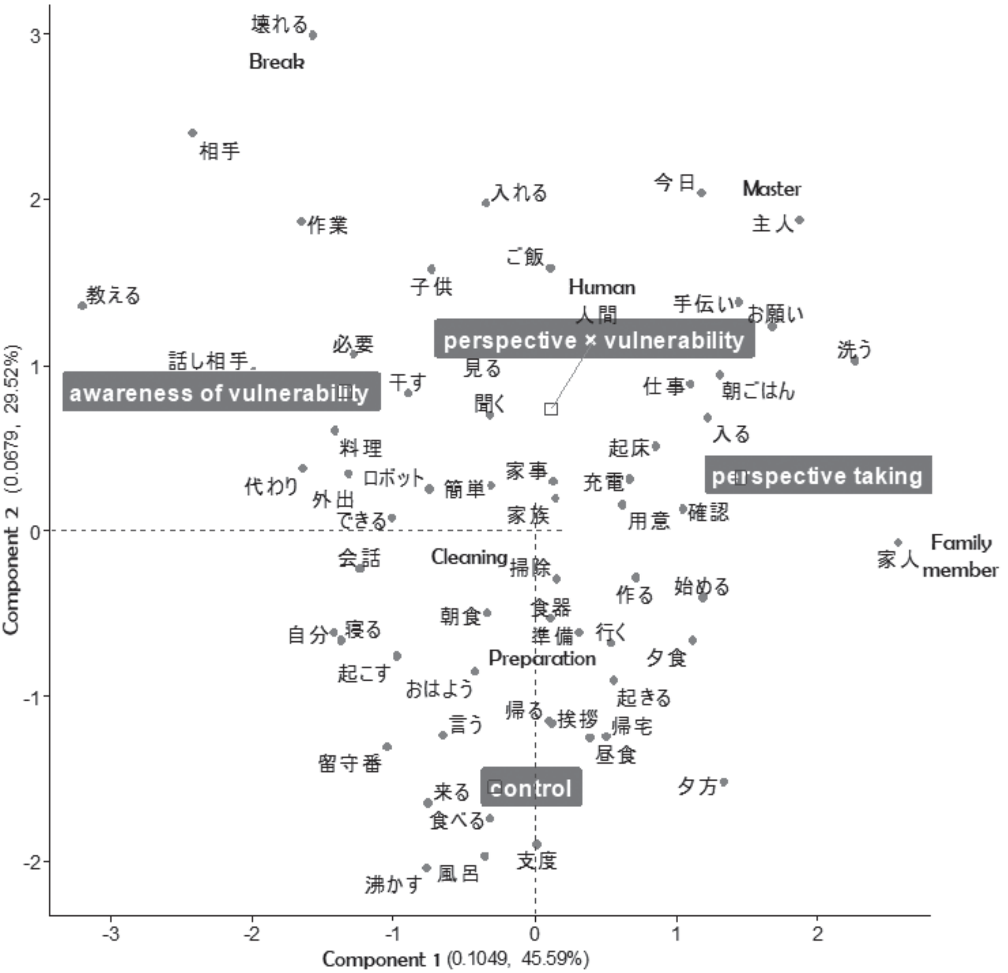

Fig. Results of correspondence analysis of free writing content

Table

Average of impression ratings for robots in each condition

Variables	Control	Perspective taking	Awareness of vulnerability	Perspective x vulnerability
RAS	3,369 (0,987)	3,445 (0,820)	3,445 (0,946)	3,524 (0,846)
MAS	3,456 (1,006)	3,551 (0,874)	3,454 (0,927)	3,361 (1,031)
FRS	4,253 (1,010)	4,370 (0,891)	4,463 (0,897)	4,257 (1,171)

Note: Values in parentheses indicate standard deviations.

lationship between human cognition and impressions of robots.

One possible explanation for the lack of significant effects of perspective-taking and awareness of vulnerability on impressions of the robot despite successful manipulations could be related to the uncanny valley phenomenon. The uncanny valley refers to the discomfort or eeriness that humans may experience when interacting with robots or other artificial agents that closely resemble humans but are not quite identical [14; 19]. Perspective-taking and awareness of vulnerability may have made the robot feel creepy or uncanny to participants, counteracting any positive shift in impressions. Previous research [26] has shown that explicit instruction to suppress prejudice toward robots can reduce robot anxiety, but perspective-taking does not have the same effect. This suggests that direct and explicit procedures may be more effective in improving impressions of robots compared to indirect procedures like perspective-taking and awareness of vulnerability. Negative impressions of robots may be naturally held in everyday life situations [2; 18], and communicating with robots may evoke mixed responses, ranging from feeling anthropomorphic to feeling distant from humans [21; 22].

Perspective taking and vulnerability awareness, which were manipulated in the study, did not significantly affect impressions of the robot. Based on the results of this study, research should be planned to discover ways to mitigate negative impressions of robots. To promote coexistence with robots in the future, it may be necessary to consider a variety of measures, including explicit procedures to suppress prejudice, in addition to indirect approaches like perspective-taking and awareness of vulnerability. Understanding the complex and multifaceted nature of human-robot interactions and impressions of robots is important for developing effective strategies for human-robot coexistence. Further research in this area can contribute to our understanding of how to improve impressions of robots and foster positive interactions between humans and robots.

Conclusion

The strategic application of perspective-taking, renowned for its efficacy in ameliorating adverse perceptions of humans, may demonstrate diminished effectiveness when applied to mitigate negative impressions associated with robots. This discrepancy might be attributed to the inherent challenge of engaging in perspective-taking for robots compared to humans. In anticipation of an era characterized by the harmonious coexistence of humans and robots, the imperative arises to seek social-psychological solutions facilitating a more congruent and harmonized societal life, including the explicit attenuation of prejudice directed towards robots.

Declarations

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The data that support the findings of this study and materials are openly available in Open Science Framework at https://osf.io/49uns/?view_only=9cc7353e43b545d3973a6af933176ca4

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Information about the authors
Shinnosuke Ikeda, PhD in Education, Associate Professor, Human and Social Administration Department, Kanazawa University Kakuma-machi, Kanazawa, Ishikawa, Japan, ORCID: https://orcid.org/0000-0001-9128-5627, e-mail: odenshin@gmail.com

Информация об авторах
Икеда Шинноске, кандидат педагогических наук, доцент, факультет управления людьми и социальной сферы, Университет Канадзавы Какума-мачи, Канадзава, Исикава, Япония, ORCID: https://orcid.org/0000-0001-9128-5627, e-mail: odenshin@gmail.com

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