バーチャルエージェントの視点取得による向社会的行動の促進

Perspective taking of virtual agents for promoting pro-social behaviors

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Abstract: Perspective taking, which allows people to imagine another's thinking and goals, is known to be an effective method for promoting pro-social behaviors in human-computer interactions. However, most of the previous studies have focused on simulating human-human interactions in the real world by offering participants experiences related to various moral tasks through the use of human-like virtual agents. In this study we investigated whether taking the perspective of a different robot in a robot-altruistic task would influence the social behaviors of participants in a dictator game. Our findings showed that participants who watched the help-receiver view exhibited more altruistic behaviors toward a certain robot than those who watched the help-provider view. We also found that, after watching two different views of robots in the robot-altruistic task, participants did not change their behavior with regard to the other participant or to a specific robot.

1. Introduction

Technological artefacts such as autonomous cars, vacuum cleaners, smartphones, virtual agents, and robots that act autonomously in social environments are fast becoming a reality and are expected to increasingly interact with humans in a social way [1]. Many researchers have been fascinated with how these artefacts can persuade people to engage in pro-social behavior [2-7]. Empathy, which plays a central role in human social relationships and is considered a major element in human social interaction, has been shown to increase understanding and motivate pro-social behaviors [8-11]. Paiva et al. mentioned two possible systems for empathy: (1) a basic emotional and unconscious one and (2) a more advanced cognitive perspective-taking system [12]. As the basic system includes unconscious elements, which may lead to ethical problems, we focus on the perspective-taking system in this work. Extensive research has shown that taking the perspective of others (i.e., imagining what it would feel like to be the other person) can be a valid way of promoting pro-social behaviors [11]. Imagine-self perspective-taking tasks have typically resulted in better performances than the imagine-other approach for maximizing the motivation to help someone [13]. The image-self task, in which participants are instructed to imagine how they would feel if they were in someone else’s situation, is somewhat different from the image-other task, in which participants imagine how someone else feels about a specific situation. With the development of technology, mediated perspective -taking tasks (e.g., online role-playing games, videos, immersive virtual realities) that provide additional information to participants or users instead of relying only on the user's imagination have also shown good potential for promoting pro-social behaviors [14-17].

In the context of mediated perspective-taking tasks for promoting pro-social behaviors, most researchers have focused on simulating a specific situation based on a human-human interaction, and the virtual agents they use are almost always human-like appearances [16-19]. Considering the harmonious relation between humans and robots, we need to examine whether taking the perspective of robots in a robot task can influence people's pro-social behaviors to a human or a robot. Among the variety of elements that make up the pro-social task, in this work we focus on altruism, which forms a major part of pro-social behavior and plays a central role in our evolutionary origins, social relations, and societal organization [20]. Based on the definition of altruism, i.e., the behavior of a person who helps others at his or her own expense [21], the altruistic task should contain at least two objects (the help provider and the help receiver). Therefore, we conducted an experiment to determine whether participants who took the perspective of different robots in a robot-altruistic task would be influenced in their social behaviors.

The between-participants experiment was conducted by showing different perspective views of robots engaged in a robot-altruistic task. One of the groups watched the help-provider-view video and the other group watched help-receiver-view video. The task settings are based on the work by Hang et al. [22], who applied nudge mechanisms in video stimulus utilizing robot-like virtual agents for promoting human altruistic behaviors. They conducted a task in which two robots each had to arrange a meeting room, where one robot was lower-charged (treated as the receiver in our study) and the other was fully charged (treated as the provider in our study). The idea was that the provider would share its battery with the receiver when the receiver ran out of power. We measured the behavior changes through a dictator game, which is a simple economic game typically used to measure altruistic attitudes. Our motivation was to determine not only the behavior changes to human but also to a certain robot and the specific robot that appeared in the video stimulus. The results showed that there was no difference in the behavior changes of participants to human and a certain robot. However, participants had significant differences in behavior change after watching the different robot's perspective to a certain robot.

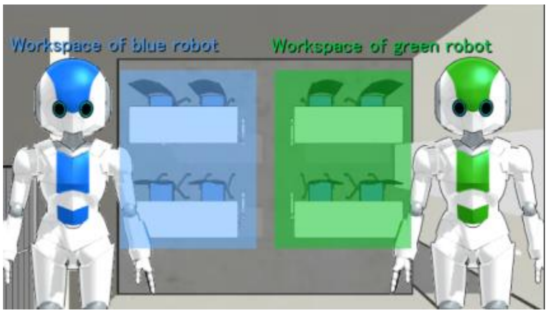
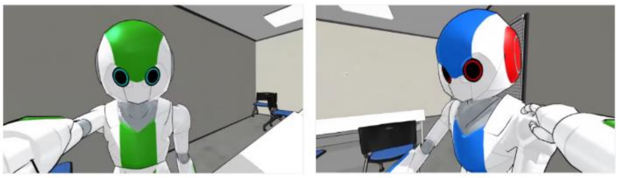


Figure.1 Workspace of each robot



(a) Blue robot's view (b) Green robot's view

Figure.2 The view of different robot in the same frame

2. Experiment

2.1. Video stimulus

To imitate a real-life situation, Hang et al. [22] used virtual agents with a robot-like appearance in the video stimulus. Based on the definition of altruism (i.e., the behavior of a person who helps others at their own expense [21]), with the expense of the robots symbolized by their batteries, they investigated a scenario involving two robots doing the same task (organizing tables and chairs in a meeting room) (see Figure.1), where one of the robots suddenly stops working because its battery runs out. The battery of one robot was near 3% while the other was fully charged, so the intent was to have the lower-charged robot stop working soon and this would lead to altruistic behavior from the other robot. A beep sounded when the lower-charged robot's battery died, and its eyes and ears flashed a red light. After hearing the alarm and seeing the flashing lights, the fully charged robot moved towards the lower-charged robot and shared its battery power by placing a hand on its shoulder.

In our study, we set the view of the lower-charged robot as the help-receiver's view and that of the fully charged robot as the provider's view. We used MikuMikuDance, a content edits tooling for 3DCG videos. To imitate the first-person perspective, we set the view of the video at the position of each robot's head. As there are two robots in the setting, we take one video for each robot. Figure.2 shows the view of the two robots at the same frame, with that of the blue robot (lower-charged) on the left and that of the green robot (fully charged) on the right.

2.2. Participants

Before collecting data for the experiment, we conducted a power analysis to determine the best sample size. A *G* Power* 3.1.9.7 analysis [23] (effect size $f = 0.25$, $\alpha = 0.05$, and $1 - \beta = 0.80$) suggested an initial target sample size of $N = 128$. A total of 176 participants (116 male, 60 female) ranging in age from 16 to 87 years ($M = 45.06$, $SD = 12.91$) took part in the experiment online. The participants were recruited through a crowd sourcing service provided by Yahoo! Japan. Regarding online experiments in general, Crump et al. [24] have suggested that data collected online using a web browser seem mostly in line with laboratory results, so long as the experiment methods are solid.

Thirty-three participants were excluded due to a failure to answer comprehension questions on the video stimulus. Then, using the calculation of *G*Power* 3.1.9.7 analysis [23] as a basis, 64 participants were analyzed under each of the two conditions in our experiment in chronological order. The final sample of participants was composed of 128 (male = 84, female = 44, $M = 45.70$, $SD = 12.59$).

2.3. Procedure

We first asked the participants to read an introduction of the experiment and then watch the video stimulus. Next, to ensure they had watched the video completely, two comprehension questions were asked. They were then asked to play the dictator game with three other players (another participant, a certain robot, and the lower-charged robot in the video stimulus (see Figure. 3)) and state how much money they would give their fellow players if they had 1,000 yen. These three situations of dictator game were shown in a random order to avoid the effect of order bias (i.e., practice effect [25]). Finally, a free description question was asked to obtain comments from the participants at the end of the experiments.

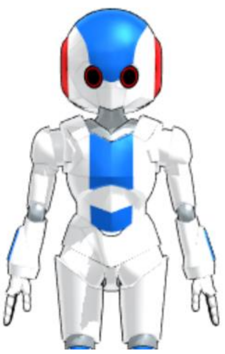


Figure.3 Virtual agent in Dictator game

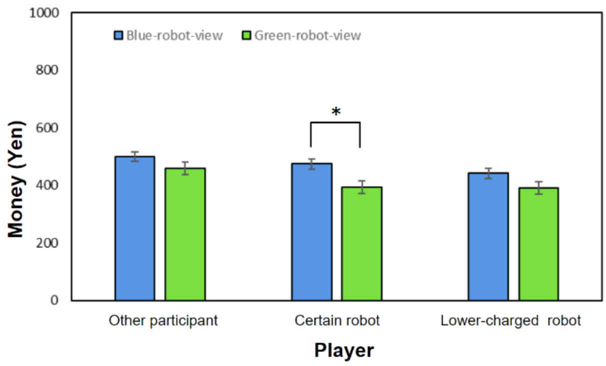


Figure.4 The table of results

2.4. Measurement

We used the dictator game to measure the altruistic attitudes of participants as the dependent variable. In the basic structure of this game, A (the dictator) freely decides how much x of an endowment to give to B (the recipient). B has no veto power; that is, she cannot react to A's decision. Based on this structure, we set three different recipients (the other participant, a certain robot, and the lower-charged robot in the video stimulus). The reason we only chose the lower-charged robot was to forbid reciprocal thinking on the part of the green robot.

A real-life example of the dictator game would be one where players decide about making donations to a public charity but considering that robots do not have any public charity, we set the questions based on the original structure. The questions were asked as follows. "Now you are given 1,000 yen (about US$8.70). The money needs to be shared with the other participant/ a certain robot/ the lower-charged robot in the video stimulus. How much money you would give to the other participant/ a certain robot/ the lower-charged robot in the video stimulus?" The answer was provided using free input ranging from 0 to 1,000 yen.

2.5. Result

We analyzed the results of the dictator game for each player (the other participant, a certain robot, and the lower-charged robot in the video stimulus) separately with independent sample t-test (see Figure.4).

The results of the other participant showed that there was no significant difference ($t(126) = 1.83$, $p = 0.07$) between the group that watched the green robot's view and the group that watched the blue robot's view. In contrast, the results of a certain robot showed that there was significant difference ($t(126) = 2.20$, $p = 0.029$) between the two groups. Moreover, participants who watched the blue robot's view tended to give more money to a certain robot. As for the lower-charged robot in the video stimulus, the results showed that there was no significant difference ($t(126) = 1.45$, $p = 0.14$) between the two groups.

3. Discussion

We conducted this experiment to investigate whether experiencing two different views of virtual robots in the same altruistic task could promote human altruistic behavior. Our analysis of the data obtained from the experiment showed that, for the other participant and the lower-charged robot in the video stimulus, participants did not exhibit much difference in their altruistic behavior after watching the videos of the blue robot's view and the green robot's view. However, for a certain robot, participants showed more altruistic behavior after watching the blue robot's view than the green robot's one.

As for the results of the other participants, although there was no significant difference in altruistic behavior after watching the blue or green robots' videos, the comments of the participants revealed that many of them felt a human-like quality in the robots when they performed altruistic behaviors (sharing battery power with the lower-charged robot), and this prompted them to recall their own coworkers or even to reflect on their daily behavior. Many previous works have shown that interacting with human-like agents actually enhances the pro-social behavior of participants [16-19]. The significant difference between our work and previous research is not only the appearance of the virtual agent but also the task that is shown in the video stimulus. Therefore, it would be interesting to investigate the relation between the task and appearances that can not only promote human pro-social behavior but also push the relation between human-robot and human-agent interactions. In addition, we plan to conduct additional experiments to determine whether there would be more of an influence when we use various equipment that enables participants to receive physical feedback. For example, by extending our video-based experiment to the immersive virtual reality, participants will be able to really feel what it is like when the battery runs out, such as by making their body stuck.

The results for the lower-charged robot also showed that there was no significant difference in altruistic behavior after watching the videos of either robot. This suggests that the exposure of the lower-charged robot is not sufficient. Specifically, in the blue-robot-view video, the participants could not see what happened to the appearance of the blue robot when it ran out of battery. Similarly, in the green-robot-view video, the participants could only see the lower-charged robot from the time the green robot walked toward to it to the time it finished sharing the battery, which was only the final 20 seconds of a video that was two-and-a-half minutes long.

The results for a certain robot showed that participants who watched the blue-robot-view video gave more money to a specific robot than those who watched the green-robot-view video. This demonstrates that taking the perspective of the help-receive robot will cause people to give more money to a certain robot, which is similar to the experiment done by Baston et al. [9] in which participants who took the perspective of a member of a stigmatized group reported more positive attitudes even toward the stigmatized group as a whole.

Finally, the biggest difference between these two video stimuli was the period where the blue robot ran out of battery: the view of it was static until the green robot shared its battery with it. We conjecture that the static period of the blue robot might have influenced the participants a lot.

The results of our study demonstrate the positive effect of perspective taking on altruistic behavior in a cooperation task. However, Pierce et al. have shown that taking the perspective of a competitor might led to more unethical behaviors [26]. The influence of watching the different robot's view in a more competitive robot task would be an interesting avenue for future work.

4. Conclusion

In this paper, we investigated how taking the perspective of different robots in a robot-altruistic task affected the social behavior of participants. Our findings showed that participants watching the help-receiver view exhibited more altruistic behaviors than those who watched the help-provider view to a certain robot. We also found that watching two different views of robots in the robot-altruistic task did not result in any behavior changes with regard to the other participant or a specific robot. In future work, we will apply our study to immersive virtual reality and clarify the effects of different tasks and relationships.

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