The Influence of Robot Autonomy on Perception Distance, Acceptance and Subjective Norm

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Abstract. The emergence of automatic machines is a topic of social concern. In this study, we examine the effects of robot autonomy on perceived distance, acceptance, and subjective norm. Participants watched a video of a robot performing a variety of tasks - the robot was either autonomous and able to ignore human commands, or non-autonomous and could only obey human commands. The results showed that participants who watched videos of autonomous robots generally perceived that the robot was more distant than the non-autonomous robot. On the other hand, people who watched videos of autonomous robots were less acceptable and had lower subjective norms than watched videos of non-autonomous robots. These findings can help us better study artificial intelligence and raise new questions about what giving robots autonomy would do to human perception.

Keywords: Autonomy, Perceived Distance, Acceptance, Subjective Norm

1. Introduction
Artificial intelligence is gradually deepening into our life, it brings us convenience, but also a lot of challenges. The type of robot that we are most exposed to is non-autonomous, that is, it absolutely obeys human commands. Will there be autonomous robots in the future? Autonomous robots have the ability to think, and they can decide for themselves whether to obey or reject human orders. In other words, when we're with an autonomous robot, it's more like we're interacting with an independent-minded person. A person's attitude toward ideas, people, situations, or objects determines whether he or she will react positively or negatively [1,2]. Therefore, people's attitude and acceptance of autonomous robots are critical to whether autonomous robots can enter the human environment in the future.

Organizations invest in a technology because it allows them to remain competitive, but technology investment alone is not enough to ensure that people will use the new technology [3,4]. Since autonomous robots are a new field, there is a lack of research on the acceptance difference between autonomous and non-autonomous robots. However, robot types that are closer to the traditional machines that have been used in industrial automation for decades may be more acceptable [5]. For example, previous studies have shown that people think humanoid robots more unsettling than mechanical robots [6,7,8]. In addition, robots are not well accepted in work areas that rely on human interaction, such as nursing work [9]. Autonomous robots often interact with human beings at work,
and may refuse human instructions, which may cause obstacles to people's acceptance of autonomous robots.

Specifically, compared with the non-autonomous master robot, the autonomous robot has a stronger ability to work independently, which breaks the cognition of human to the traditional robot working mode, and may lead to a lower acceptance of it by human. In addition, we also measured people's perceived distance to autonomous robots and their perceived impact on employment.

2. Theory and Hypothesis
One possible reason for the focus on robots may be that people don't have a realistic idea of the features and capabilities of the currently available social robots [10]. Our image of autonomous robots is often stuck in science fiction movies and literature. We don't know if people will accept autonomous robots in the real world. Such literary depiction may prejudice people against robots, leading to an overestimation of the potential of robots and affecting the willingness of humans to interact with autonomous robots.

The previous research examined public attitudes towards robots by measuring the perception and acceptance of robots in different application areas [11]. Overall, the results show that EU citizens have a positive attitude towards robots. However, people think of robots should be as instrument-like machines rather than social partners. This concept is also reflected in the way people think about the fields where robots are used.

2.1 Autonomy and Perceived Distance
Tarde first used the term “social distance” in sociology [12]. He considered the concept of social distance to be the distance that exists between social classes, and pointed out that we can measure it by the degree to which they imitate each other. Hassenzahl believes that when we see a product for the first time, we will form a unique view of the characteristics of the product, such as the function, presentation and specific content of the product, which is an instinctive perception of human beings [13]. On the other hand, the perceived distance to the autonomous robot may be affected by the perceived characteristics of the robot. Autonomous robots have different behavior patterns from traditional robots. When people have adapted to traditional cognition, autonomous robots may be difficult to narrow the distance of human perception to them.

H1: Compared with the non-autonomous robot, the perceived distance score of the autonomous robot was higher.

2.2 Autonomy and Acceptance
In general, young people are more receptive to new technology than old people, men are more receptive than women, and those with higher education levels are more receptive than those with lower education levels [14]. However, previous technology experience can mitigate the impact of socio-demographic factors (such as age and gender) on acceptance: the impact of sociodemographic factors may decrease as users become more familiar with the technology [14]. In addition to user and technical reviews, the core of understanding the acceptance of new technologies may be professional background [15,16]. For example, many majors in our life have access to artificial intelligence, and their attitude and acceptance of autonomous robots may be different from that of other majors who have not had access to artificial intelligence, because they are familiar with the design procedures of autonomous robots. Will it be socially acceptable to allow robots to be autonomous? Are humans willing to allow this technology to exist in society?

Autonomous robots are equipped to finish all the tasks themselves without human presence, and could pose a serious threat to humans if they flood the workplace. When the uniqueness of human groups is threatened, it can lead to prejudice, discrimination and inter-group conflict against autonomous robots. In addition, autonomous robots are likely to reject human commands, which may affect human dominance in human-robot interactions and create a sense of loss of control for us. So, we think autonomous robots are less acceptable than non-autonomous robots.
H2: Compared with the non-autonomous robot, the acceptance score of the autonomous robot was lower.

2.3 Autonomy and Subjective Norm
Planned Behavior Theory (TPB) is one of the most famous models which can effectively describe behavioral intentions. And it has been successfully applied to the acceptance of technical products and information systems. We also incorporate this model into the human-robot interaction environment to help explain the user's acceptance of autonomous robots. TPB postulates that our behavior is influenced by intention, which can be further explained as: perceived behavioral control, subjective norms and attitudes toward behavior. We focus on the impact of subjective norms. Since autonomous robots will lead to the loss of human subjectivity and the sense of control, we believe that the subjective norm score of autonomous robots will be lower.

H3: Compared with the non-autonomous robot, the subjective norm score of the autonomous robot was lower.

3. Method

3.1 Participants
This study recruited 240 students from a university to conduct this experiment. In order to ensure the accuracy of the experimental results, students majoring in automation and artificial intelligence were excluded. The experiment video lasted more than 4 minutes, and participants also had to complete a questionnaire, so participants who completed all tasks within 6 minutes were excluded. In this experiment, a total of 48 people did not meet the experimental requirements, and the remaining samples included 192 people, including 82 males and 110 females.

3.2 Manipulation
A total of two types of robots are demonstrated in the video used in the experiment. The first category is autonomous robots, which can judge whether to obey human orders based on the situation on the spot. If the human order is contrary to their own judgment, it is possible to reject the human order. The second type of robots are non-autonomous robots. They have no independent judgment ability and act completely in accordance with human instructions. The content of these two videos is completely same. We can see that there are industrial robots, medical robots, rescue robots, etc. in the video. They demonstrate their abilities in the video and complete various tasks, including fire-fighting and rescue, medical operations, and assembly line production. In order to ensure the accuracy of the experimental results, the two videos differ only in narrative, and are completely consistent in other aspects.

3.3 Measures

3.3.1 Perceived Distance. Participants were asked to complete four items to rate how well they perceived the robot's distance. Sample items included: “I feel a distance between the robot and me”, “I feel resistance to talk to the robot”. We use a 7-point Likert scale to measure these items, from strongly disagree (1) to strongly agree (7).

3.3.2 Acceptance. Participants were asked to complete three items to assess how much they would accept autonomous robots. Sample items include: “If given a chance, I think I’ll use this robot in the near future”, “If given a chance, I’m certain to use this robot in the near future”. We use a 7-point Likert scale to measure these items, from strongly disagree (1) to strongly agree (7).

3.3.3 Subjective Norm. Participants were asked to complete two projects to assess their subjective norms of autonomous robots. Items include: “I think those who are important to me would like me
using this robot”, “I think it would give a good impression if I use this robot”. We use a 7-point Likert scale to measure these items, from strongly disagree (1) to strongly agree (7).

4. Results

4.1 Perceived Distance
After ensuring strong internal consistency (\(\alpha = 0.81\)), a comprehensive measure of perceived distance was created by averaging all four items. Using this method, one-way ANOVA showed that participants were asked to think that these robots were autonomous (M = 3.73; SD = 1.09) there was a higher score on perceived distance than who thought these robots were non-autonomous (M = 3.36; SD = 0.97), F (1,190) = 5.89, p =0.016. (See Table 1).

4.2 Acceptance
After ensuring strong internal consistency (\(\alpha = 0.81\)), a comprehensive measure of acceptance was created by averaging all three items. Using this method, one-way ANOVA showed that participants were asked to think that these robots were autonomous (M = 4.43; SD = 1.05) there was a lower score on acceptance than who thought these robots were non-autonomous (M = 4.87; SD = 1.01), F (1,190) = 8.73, P =0.004.

4.3 Subjective Norm
After ensuring that there was strong internal consistency (\(\alpha = 0.93\)), a comprehensive measure of subjective norm was created by averaging all two items. Using this method, one-way ANOVA showed that participants were asked to think that these robots were autonomous (M = 3.61; SD = 0.65) there was a lower score on subjective norm than who thought these robots were non-autonomous (M = 4.11; SD = 0.95), F (1,190) = 6.66, P =0.011.

Table 1. Descriptive statistics and significance testing for each dependent variable

| Measure          | Autonomous Robot | Non-Autonomous Robot | F-value | p-value |
|------------------|------------------|----------------------|---------|---------|
| Perceived Distance | 3.73 (1.09)      | 3.36 (0.97)          | 5.89    | 0.016*  |
| Acceptance       | 4.43 (1.05)      | 4.87 (1.01)          | 8.73    | 0.004*  |
| Subjective norm  | 3.61 (0.65)      | 4.11 (0.95)          | 6.66    | 0.011*  |

5. Discussion
We investigated the effects of robot autonomy on acceptance, perceived distance and subjective norm in this study.

Our H1 – Compared with the non-autonomous robot, the perceived distance score of the autonomous robot was higher – was supported by the results. Autonomous robots can complete tasks by themselves and have strong independent thinking ability. In contrast, robots in the traditional sense obey human commands completely like non-autonomous robots. This gap may cause humans to perceive themselves as far away from autonomous robots, as opposed to traditional human-robot interactions.

Our H2 – Compared with the non-autonomous robot, the acceptance score of the autonomous robot was lower – was supported by the results. Because autonomous robots are so capable of working independently, they may replace some more difficult tasks in the future, so people will inevitably be suspicious of them. If a technology threatens the security and interests of mankind in the future, people
may oppose it. Therefore, due to the advanced nature of autonomous robots, they will be less accepted by human beings.

Our H3 – Compared with the non-autonomous robot, the subjective norm score of the autonomous robot was lower – was also supported by the results. It is possible for autonomous robots to reject human commands, which is psychologically uncomfortable to a large extent. In the eyes of many people, a robot may be nothing more than a tool, as long as it obeys human commands. However, non-autonomous robots completely break this traditional concept, which may lead to the reduction of human subjective norms and the weak intention to use them.

6. Conclusion
Research into artificial intelligence and autonomous robots will continue in the future, but how far it goes will depend in part on what happens next. Therefore, we need to carry out comprehensive research on autonomous robots. Only by fully understanding the pros and cons of autonomous robots can we make better use of this technology.

In this research, we explore the influence of robot autonomy on acceptance, subjective norm and perceived distance. We found that the perceived distance of autonomous robots was larger than that of non-autonomous robots. On the other hand, non-autonomous robots are considered to be more acceptable and have stronger subjective norms than autonomous robots.

This research is a preliminary exploration of the relationship between robot autonomy and social acceptance, and we have found many interesting things in it. The research on autonomous robots will not stop here, there are more things waiting for us in the future. Artificial intelligence will enter people’s life and work in large numbers in the future, if we can’t escape, it is only a comprehensive understanding, good use, through artificial intelligence to benefit mankind.

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