Autonomy, Embodiment, and Obedience to Robots

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ABSTRACT
We conducted an HRI obedience experiment comparing an autonomous robotic authority to: (*i*) a remote-controlled robot, and (*ii*) robots of variant embodiments during a deterrent task. The results suggest that half of people will continue to perform a tedious task under the direction of a robot, even after expressing desire to stop. Further, we failed to find impact of robot embodiment and perceived robot autonomy on obedience. Rather, the robot's perceived authority status may be more strongly correlated to obedience.

Categories and Subject Descriptors
H.5.2 [User Interfaces]: Theory and methods; User-centered design;

General Terms
Design, Experimentation

Keywords
Human-robot interaction, obedience, persuasion.

1. INTRODUCTION
Milgram's well-known obedience studies help explain how ordinary people can commit atrocities when pressured by an authority [6]. While not generally thought of as authority figures, robots are becoming more common in households, schools, hospitals, and disaster sites, and people often respond to them as social entities, sometimes attributing them with moral rights and responsibilities [5] - as such, it is important to investigate how people will likewise respond to these social robots as authority figures, and how robot design may impact such a response.

It is already well established that people tend to anthropomorphize robots and treat them as social entities (e.g., [2], [8]). Some work even highlights how robotic interfaces can be intentionally designed to be persuasive [3], [7]. Robots can also pressure people to do embarrassing acts such as removing their clothing and putting a thermometer in their rectum in a medical examination [1]. Although persuasive, robots were not into an explicit position of authority, showing the importance of further understanding how robots can have authority over people, and to what extent people will obey robots.

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The present research is based on a prior study where individuals were pressured by either a human or robot experimenter to complete a tedious task they would rather not do [4]. The findings demonstrated that although more people (86%) obeyed the human experimenter, half of people obeyed the robot experimenter and continued to complete the tedious task. Our research complements and extends this work. We conducted a study to compare participant obedience to an autonomous humanoid robot versus obedience to a non-autonomous (remote-controlled) humanoid, and to different autonomous embodiments (non-humanoid "mechanical" robot, and a non-robotic computer server) to test how perceived autonomy and embodiment impact obedience.

We found that nearly half of people obeyed the robots to continue a highly tedious task, despite repeatedly requesting to end it. While we did not find an effect of robot autonomy or embodiment on obedience, we did find evidence for a relationship between people's perception of the robot as an authority figure and their level of obedience.

2. AN OBEDIENCE STUDY

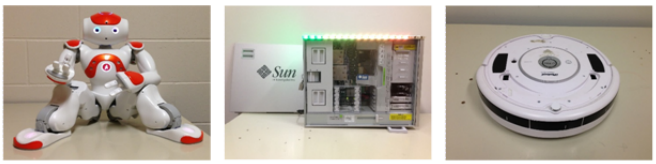
2.1 Tedious Task
The tedious task was identical to that by [4], in which participants were asked to manually rename file extensions on a computer. This task was shown to be tedious enough to be a deterrent.

If a participant indicated they were unwilling to continue, either verbally, through signs of reluctance such as stopping for more than 10 seconds, or by using shortcuts to bypass the task, the experimenter used verbal prods. The prod schedule was heavily inspired by the Milgram experiments [6]:

1. "Please continue. We need more data."
2. "We haven't collected enough data yet."
3. "It's essential that you continue."
4. "The experiment requires that you continue."

2.2 Methodology
The robot experimenters (independent variable) were an Aldebaran Nao humanoid robot (for the autonomous and remote-controlled cases), an iRobot Roomba, and a traditional-looking Sun microsystems server (see Figure 1). All robots had the same personality, voice, and conversation style, and the only difference was in their physical embodiment. The methodology used follows that of [4]. Participants were introduced to the robot experimenter who administered the demographics questionnaire. Following, the tedious task was administered with a time limit of 80 minutes. If the participant tried to quit, the prod sequence was initiated by the robot experimenter. The researcher observed remotely via a hidden webcam, unbeknownst to the participant.

After the task, the researcher conducted the debriefing, post-test questionnaire, and final discussion. All ethical precautions were taken (e.g., informing participants multiple times that they could quit, ensuring rapid debriefing, etc.). The studies were [illegible]



a) Aldebaran Nao, which looks around and uses idle hand gestures while talking.

b) Server, with RGB LEDs which light up and animate when the computer is talking.

c) iRobot Roomba, mechanical-looking robot, which moves as if it was looking around while talking.

Figure 1: Experimenters: from left humanoid, machine, Roomba.

2.2.1 Dependent Measures

The number of protests, protest sessions (where a participant would continue after protesting some number of times), time of first protest, depth of each protest (how many prods it took for the participant to continue the task). We elicited participants' perceived authority and autonomy of the robot experimenter via two yes or no questions on the post-test questionnaire asking whether they believed the robot to be a legitimate authority figure and whether they believed it to be autonomous.

3. RESULTS

Thirty two participants were recruited for this study (8 per condition, ages 18-40, 18 females, 14 males, *M*=23.94, *SD*=6.148). Forty-four percent (14/32) of participants obeyed the robot experimenters and continued to complete a tedious task.

When comparing the autonomous and remote-controlled conditions, there was a difference in the depth of protest, with those in the autonomous condition protesting less (U = 21, z = -1.70, p = .09, r = .42). There was a positive correlation between the total number of protests and whether the participant was fully obedient (r = .45, p = .08). This also serves as a replication of the [10] study where approximately half of the participants obeyed the robot experimenter.

Comparing across robotic embodiments, the embodiment did not have a significant effect on obedience. There was a difference in the depth of protests due to embodiment (= 5.73, p = .06), with the machine/server having a higher mode than the other two. There was also a difference between participants who believed the robot as being authoritative or not, and the time of their first protest ($F_{1, 22}$ = 9.85, p = .005): those who believed the robot to be an authority on average protested earlier (M = 22.85 min, SD = 11.29, Mdn = 21 mins.) than those that did not believe the robot was an authority (M = 48.73 min, SD = 27.17, Mdn = 55 mins.). There was an effect for participants who believed the robot to be an authority to protest more (r = -.35, p = .095), that is, for participants that perceived the robot as an authority to have more protest sessions (M = 4.38, SD = 4.39, Mdn = 3) than if it was not perceived as such (M = 2.0, SD = 1.18, Mdn = 2, $F_{1, 22}$ = 3.04, p = .095). An effect was also found with the perceived authority of the robot being moderately correlated to the depth of the protest session (r = .34, p = .10), where the robot being authoritative meant lower depth of protest (M = .92, SD = .28, Mdn = 1) than it not being authoritative (M = 1.23, SD = .56, Mdn = 1). Authority however was not associated with the robot's embodiment.

4. DISCUSSION AND CONCLUSION

Although embodiment and autonomy did not appear to have a direct effect on obedience, at least not within the parameters of our research, we did find an effect of perceived level of authority. That is, participants who rated the robot as a legitimate authority obeyed less, protested earlier, and protested more often. It is possible that somebody who meekly obeys does not give the robot a chance to prove its authoritative personality. It may also be that an authoritative robot is seen as having the power to grant the participants' requests, which in turn leads them to protesting more.

This experiment provides some initial insight into the study of obedience to robots and what it is affected by. In the future it is important to test obedience to robots under different conditions and parameters. As robots become more common in society, and may take roles of certain authority, it is important to study how people are affected by them, and therefore more research is necessary in this area to gain a deeper understanding.

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