Cooperation with a Robotic Assistant

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ABSTRACT
Robotic assistants soon will serve many assistive roles in our everyday lives. It is important to understand how these robots can interact with users, not just as tools, but also as social agents. In a controlled laboratory experiment, we examined cooperation in an effortful task with a robot that displayed one of two personalities. We found that a serious, caring robot induced more compliance than a playful, enjoyable robot on this task. We propose possible explanations and further research.

Keywords
Experiment, social interfaces, human-robot interaction, cooperation, compliance, robotic assistants

INTRODUCTION
Autonomous mobile robots work today as assistants in hospitals, factories, and museums. Speech interaction technology and robot mobility support a uniquely modifiable interface. Autonomous robots have the unique ability to initiate interaction instead of waiting to be used. As development of robots focuses more on assisting humans with everyday tasks, interaction styles will be crucial to gaining people's acceptance, trust, and cooperation. Our research examines how a robot makes an impression on people and has social influence on their behavior.

Reeves & Nass [4] suggest that people attribute human characteristics to objects. Artificial intelligence researchers have used this idea in creating emotionally expressive believable agents that are likeable [1] and to interactions that are more similar to that of a friend than an appliance [2]. Controlled experiments with interactive robots have not yet shown how these attributes affect users' emotions and behavior.

Medical compliance research suggests that patients who perceive a positive relationship with their physician are more likely to comply with medical directives. The literature is inconsistent, however; some studies have found that communication of some negative affect (i.e. anger or concern) may increase compliance [5].

EXPERIMENT
We tested the influence of a robot displaying two different personalities on user compliance with an exercise routine. In one condition, the robot was extraverted and playful; in the second condition the robot was serious and concerned. Because people tend to like extraverted others, we predicted that participants would enjoy interacting with the playful robot and would cooperate best with its requests.

Figure 1. Participant with robotic assistant.

Method
Design. Forty participants (average age = 22) interacted with the robot, shown in Figure 1. Half of the participants interacted with the robot displaying the playful personality; half of the participants interacted with the robot displaying the serious personality. The playful robot joked and treated the tasks as fun. The serious robot mentioned health concerns and treated the tasks as healthy. Over a period of about 20 minutes, the robot led the participants in a series of breathing and stretching routines. The routines got progressively more difficult. After the last routine, the robot asked participants to make up their own routine and do it as long as they could. (This study also included a manipulation of participants' mood. Space precludes a complete description here, but the effects we report did not change.)

Measures. Participants rated their impressions of the robot's personality twice using an adaptation of the Big Five Inventory [3], a measure of personality. Our measures included scales for robot agreeableness, conscientiousness,

extraversion, neuroticism, and openness to new experiences. Users also rated the robot's intellect. We measured social influence with a self-report of mood and by coding a videotape of the interaction. We coded compliance—how long users performed their routine, as well as how much participants laughed and smiled, and how close they stood to the robot. Results are from mixed models ANOVAs (between groups; repeated measures).

RESULTS

Impressions. The robot in both conditions on both trials was rated as more extraverted, agreeable, and conscientious than neurotic or open to new experiences. The playful robot was rated more positively (for example, more extraverted) than the serious robot on all scales ($p<.05$).

Impressions of the robots' intellect decreased over trials ($p<.05$). Users indicated on the scales that the robot knew facts, but that it was not intelligent. There was no effect of personality of the robot on intellect scores.

Social Influence. Participants' mood improved after interacting with either robot ($p<.05$) but those who interacted with the playful robot were significantly happier ($p<.05$). A significant interaction ($p<.0001$) emerged between the mood scales and trials. Post hoc analyses showed that participants felt less engaged by the end of the experiment despite their increase in happiness.

Consistent with the mood findings, participants who interacted with the playful robot laughed more ($p<.001$) and smiled more ($p<.01$) than those who interacted with the serious robot.

Our prediction that the playful robot would elicit the most compliance was not confirmed. One participant who interacted with the serious robot did not comply at all, but the other 19 participants who interacted with the serious robot exercised longer than the 20 who interacted with the playful robot. ($p<.01$). Including everyone, average routine time was 85 seconds with the serious robot as compared with only 24.7 seconds with the playful robot.

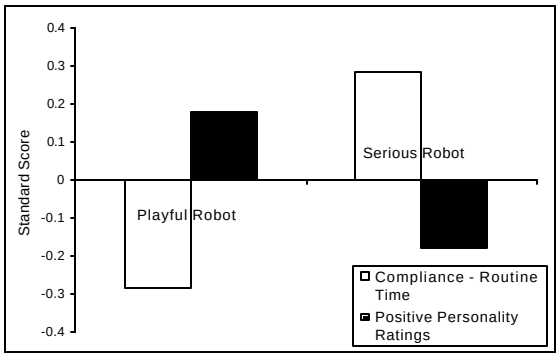

Figure 2. Personality ratings and cooperation. (Scores are standardized to permit comparison of the trends.)

Our results are summed up in Figure 2. Standardizing the scores to compare ratings of personality with compliance show that although participants rated the playful robot more positively, but they cooperated more with the serious robot.

DISCUSSION

Our results present an interesting paradox. Participants enjoyed participating more with the playful robot and rated its personality more positively, but they actually cooperated with the playful robot's requests much less than they cooperated with the serious, concerned robot's requests.

We are investigating possible explanations for our results. First, our original assumptions may be incorrect; a likeable robot may not be useful in gaining cooperation. In effortful tasks such as exercising, people may be more convinced by concern and caring. In this experiment, the serious robot encouraged users by saying, "This is so good for you" and "You're going to be so healthy." Consistent with this interpretation, participants' mood ratings over trials were suggest the task was not fun. It is possible a playful robot would have more influence if the task were fun. We plan experiments using tasks that are inherently more fun.

Another possible explanation of our results is that participants in the playful condition were laughing *at* the robot, not with it. Perhaps a playful robot personality is incongruent with participants' expectations and with their robot stereotypes. We are also doing research on people's stereotypes and expectations of interactive robots.

CONCLUSION

Robotic assistants that initiate contact and need people's cooperation must be designed in such a way to as to create good impressions and appropriate compliance. Our results suggest that these goals will require a better understanding of people's mental models of interactive robots, of the attributes they expect robots to have, and of how their responses differ over contexts and tasks.

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