How User Presence impacts Perceptions and Operation Routines of Robotic Vacuum Cleaners – A 'Stay at Home' Experiment

Shanee Honig and **Tal Oron-Gilad,** Dept. of Industrial Engineering and Management, Ben-Gurion University of the Negev, Israel

Human Factors Engineering
Industrial Engineering & Management
Ben-Gurion University of the Negev

Objective

Many people will continue to work from home long after COVID-19 is behind us [1,2]. The design of Domestic Service Robots (DSRs) must accommodate user needs and preferences when working from home. Yet, little is known about how being at home impacts the way people use or perceive their DSRs.

This study explores the following Research Questions:

1) **How do usage patterns of DSRs change when people spend more time at home?**
2) **Whether active observation of robotic behaviors impact the perception of robotic characteristics?**

Related Work

The influence of user presence on robot perceptions was investigated by comparing conditions where participants actively observed and/or collaborated with the robot [3,4]. But, in domestic settings, users decide when, how, and if to use their robots. This may lead to differences in how people perceive robots in naturalistic settings vs. controlled experiments.

Ethnographic studies that deployed iRobot Roombas for six months to households [5,6] found that some usage habits changed based on user presence; however, definitive conclusions were not drawn since user presence was not manipulated within the study.

The BYOB (Bring Your Own Bot) Methodology

Thirty-one owners of robotic vacuum cleaners (15M, 16F) volunteered to participate in an interactive online questionnaire of 6 parts:

1. **Study Description and Consent Form.**
2. **Demographic Information.** Age, gender, profession, household members, time under stay-at-home orders, robot's brand & model, robot ownership time.
3. **Questions re: Presence at Home and Robot Operational Routines.** Before and after COVID-19 restrictions took place
4. **Pre-Observation Questions.** Assessing perceptions of their robot, satisfaction with robot, and predicted robot behavior in four situations: general cleaning, cleaning under a chair, cleaning around an obstacle (shoe), and carpet vacuuming.
5. **Active Observation of the Robot.** Participants were asked to actively observe their robot while it handled the four aforementioned situations and to record their experiences out loud on video (click on images below).
6. **Post-Observation Questions. T**he same questions as in the pre-observation section. Participants were also asked about unexpected and unclear robot behaviors, things that impressed them about the robot, and what they would have liked the robot to do differently. At the end, they were asked to upload their videorecording directly into the survey or by email.




Results

Impact of Active Observation on Robot Perception [1-5, 1-highest]

The robots' perceived safety was significantly lower (p=0.02) after active observation ($\bar{x}$=3.62, σ=0.91) than before ($\bar{x}$=3.42, σ=0.91) (Figure 1). No significant change was found in the robot's competence, discomfort, and satisfaction.

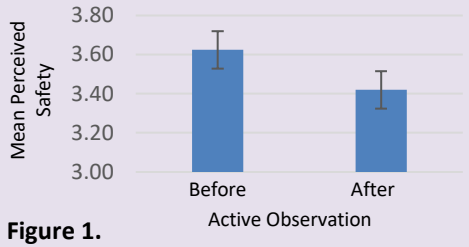

Figure 1.

26 participants (84%) had at least one inaccurate perception regarding their robot's behavior (Figure 2). Only 4 (13%) participants had no surprises during the activity.

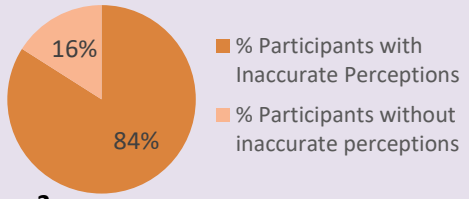

Figure 2.

Impact of Increased Time at Home on Robot Usage Habits

25 (81%) participants increased their presence at home due to the Covid lockdown. No significant differences were found in usage habits or robot importance before and after this change.

Discussion

- User presence had limited impact on operation routines or robot importance. This may reflect our sample group or recollection biases.
- Misconceptions of robot behaviors did not impact perceptions of robot competence, discomfort and satisfaction. Perhaps the end-result (floor cleanliness) is more impactful than how the robot cleaned.
- Many were disappointed by their robots' response to obstacles & how it moved, and uncomfortable with robot noises. These may have reduced the robot's perceived safety. Designers should isolate which behaviors are perceived as unsafe and change them or encourage remote operation.
- In naturalistic settings, people often multitask and operate their robots remotely or with partial attention, likely impacting how they perceive their robot and its abilities. Researchers and designers should consider this in the design of future studies.

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Acknowledgements

Shanee Honig is supported by a scholarship from The Helmsley Charitable Trust through the Agricultural, Biological, Cognitive Robotics Center, and by Ben-Gurion University of the Negev through the High-tech, Bio-tech and Chemo-tech Scholarship.