Be Nice to Garbage Bot

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***Abstract*— In this paper, we explore how the addition of eyes to a non-humanoid robot affects human responses to requests for assistance from the robot. The experiment was executed in a public setting, with the robot asking passers-by for help picking up an item of garbage. Participants interacted with a robot with and without eyes by assisting it to pick up a piece of trash that it audibly requested help with. Most people from whom the robot requested help paused to assess the situation, but we found far more participants in the eye condition actually intervening. The no eyes condition had similar rates of participants pausing to view the robot, but these participants more often described confusion about the source of the voice or the intentions of the robot. We also recorded whether the people that approached the robots were individuals or small groups. We found that all the small groups that we recorded chose to intervene, we believe, because members of small groups were more likely to stop and discuss the robot, as well as to reassure each other about how to assist it.**

I. Introduction

With more service assistive robots being put into use in real-world public settings such as hospitals, restaurants, and hotels, robots prove to people that they are capable of a wide range of service tasks and sometimes much more efficient than human laborers. However, there are also times when robots run into challenges that they could not solve, not without some assistance from humans. Such problems occur commonly for autonomous robots in a public setting due to the amount of uncertainties and thus the high level of flexibility required. For example, the Nuro R2 delivery robot has no idea how to help itself if no one comes out of the house for the delivery. Neither does the robot have any idea how to enter an elevator in an apartment since it does not have the function of climbing stairs. Instead of actually designing an additional stair-climbing function for the delivery robot, we could solve the problem with a simpler and easier way: asking humans for assistance.

Previous works have demonstrated that some design strategies could increase the likeliness of the humans assisting the robot. This paper transfers ideas from psychology and specifically focuses on two new factors that have potential impact in shaping assistive interaction in a public setting. We explore firstly whether adding a pair of googly eyes to a public trash-picking robot would increase its probability of getting assistance from people walking by. We also look into the question of whether the robot should approach an individual or a group of people to ask for assistance.

II. Background

A. Robots Requesting Assistance

Prior works in the HRI field have suggested several design strategies to increase the persuasiveness of mobile service robots when asking for human assistance. Srinivasan et al. [1] developed the politeness strategy for verbal communication and suggested a polite verbal request from the robot leads to more helpfulness and a higher perceived appropriateness of the request. Backhaus et al. further stated that the politeness effect might be stronger in persons that are less familiar with the technological system [2]. It is thus important when the robot requests assistance from uninvolved or unexperienced humans in public settings. People also tend to help faster if they're convinced that a robot is working autonomously rather than being remotely controlled[1].

Liebner et al. [3] suggested the long-term benefit of making an Assistance Requiring Robot to actively search for people instead of staying at a single place. Fallatah et al.[4] also investigated how microculture affected people's likelihood to help and express care to the robot. (for example, they suggested that the robot should be assertive about asking for help in order to motivate bystanders, and seek help where people are taking a break or have casual attitudes, rather than people rushing to work or meetings) Experiments have also shown that some visual cues like lights could help robots that are non-anthropomorphic acquire assistance[5].

Though many prior works built on the topic of robots requesting assistance, most took place in a lab setting rather than a public one (probably due to the difficulty of full automation of the robot as well as the lack of flexibility when facing challenges that exceed the robots' capabilities). We believe that it is thus necessary to apply the design strategies to a specific public scenario in order to investigate whether each strategy is equally applicable to public settings.

B. Eyes and Aesthetics

Psychological research into the human responses to eyes has yielded many interesting results, but for our purposes, it's particularly interesting to understand how eyes may impact collaborative or assistive behavior. In a 2010 study, Max Ernest Jones, et. al. conducted a study to understand how images of eyes might affect littering behavior.[6] They ran a 2x2 study with posters having images of eyes or flowers, and posters expressing an anti-littering message or an alternative unrelated message. They found that the rate of littering decreased by 50% in cases where the posters had eyes, whether or not they displayed anti-littering messaging. This very strong result indicates that there may be an increase in cooperative behavior or a decrease in "bad" behavior from people who feel watched.

In past studies, experimenters have conducted design workshops to understand what traits make for an ideal public service robot, and found that often, a less-anthropomorphic robot may be preferable to a more human-looking one. [7] However, this result was given, in addition to the conclusion that eyes and a mouth may be required for people to understand how to interact with a robot.

The Stretch robot could be considered an appearance-constrained robot, because of its utilitarian aesthetic that does not at all aim to replicate human features. We used studies involving appearance-constrained robots or robots very similar in level of anthropomorphism to the stretch to set expectations for participant response to our addition of eyes to the robot.

Authors of previous work on similar robots, which have investigated how sounds, lights, vibrations, and screens might be used by these kinds of robots to convey emotions or other kinds of messages. Interestingly, different emotions may be best represented by different communication modalities, like emotions associated with a color may be easily expressed by color changing lights, while others may be better expressed by a sound. [8] Specifically, these studies concluded that sound was especially effective and maybe even necessary to communicate emotions like sadness or distress.

C. Group Dynamics and Bystanders

Past psychological researches looked into how the presence of bystanders in a critical situation would reduce the likelihood of an individual offering help (known as the bystander effect) [9]. However, Bommel et al.[10] tested the bystander effect on an online forum and found that the bystander effect could be reversed (the individual is more likely to help others when more bystanders are present) when an individual builds an enhanced self-awareness on the presence of other bystanders. Yet the definition of bystander is vague and depends on experimental contexts. In our experiment, we define bystanders to be specifically a potential helper (who does not know in advance about the public experiment) that perceives the robots' request (ie. via sound) but does not offer assistance.

There is thus a difference between the robot approaching a group of people for help and the robot approaching an individual, due to the fact that there could be potential bystanders in the group. Fallatah et al.[4] compared the two mentioned conditions in the paper and concluded that a higher number of people showed caring behaviors toward the robot when they were by themselves compared to when in a group of two or more people. However, this result was not statistically significant in the paper. In our paper, we would like to further test the behaviors and psychological processes occurring within groups compared to those of an individual.

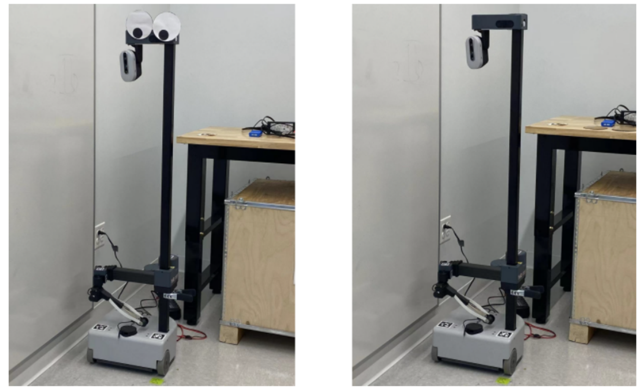

Fig. 1: a photograph of the Stretch robot with paper eyes (left) and without the eyes(right).

III. Methodology

A. Experimental Design

We constructed an in-the-wild user study with 2x2 conditions. The first factor is the physical appearance of the robot (with and without a pair of googly eyes on its upper body) and the second factor is the robot approaching a group of people for help and the robot approaching an individual (Fig. 1). Our hypotheses are that:

H1: The addition of googly eyes to the hello robot Stretch (which is not anthropomorphic) increases people's willingness to help the robot in a public context.

H2: The robot is more likely to get assistance when it approaches groups of people than approaching individuals.

The experiment took place on the first floor of John Crerar Library, University of Chicago's computer science building. The stretch was controlled by members of our team using a Wizard-of-Oz approach with one person using an XBox controller to steer the robot and manipulate its gripper, while another teammate used a digital soundboard connected to a Bluetooth speaker aboard the robot to trigger the robot's script lines. The Stretch was placed next to a public trash can next to two empty bottles on the ground in order to recreate a realistic scenario for a garbage collecting robot. In between approaching subjects, the Stretch would attempt to pick up the bottles, showing signs of success but then ultimately dropping the bottle to realistically represent a situation in which a robot might struggle. When a new potential participant entered the lobby, we turned the robot toward them by rotating it to face them, and played the script item requesting help from the participant. See figure 2 for the physical layout of the experiment.

If the participant threw the bottles into the trash can, then the robot would send another verbal message that says "thank you." If the participant does not offer assistance and walk away, the robot would remain in its fixed position. If the participant picks up the bottle and puts it into the gripper, the robot would try to grip the bottle and throw it into the trash can. Following the human-robot interaction, we conducted a brief survey with the participant. Participants were mainly

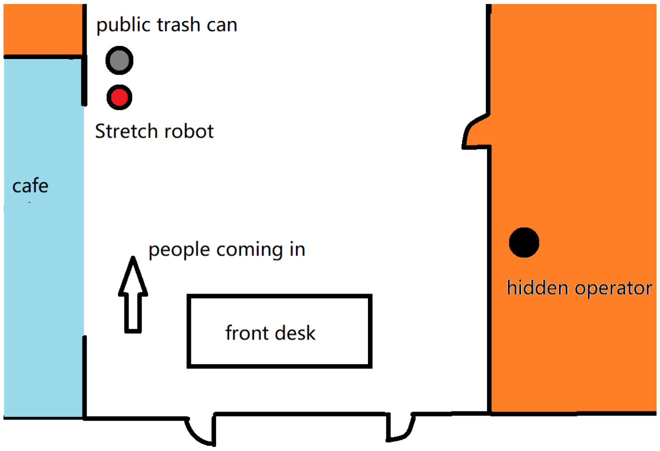

Fig. 2: An approximate-scale diagram of the 1st floor of John Crerar Library (white area is the hallway in the building, the blue area is the cafe and the orange areas are closed rooms and spaces).

'recruited' by coming into the building and walking past the trash can. We also ensured that the participants were not aware of the experiment during the survey and we did not recruit anyone sitting in the cafe since they might have seen the researchers setting up the robot.

B. Hello Robot Stretch

For the experiment, we used the Hello Robot Stretch from the Hello Robot company founded by former Google robotics director Aaron Edsinger and Georgia Tech professor Charlie Kemp. Stretch was launched in June, 2020 and was designed to Interact with people using a low mass, contact-sensitive body. It has a roomba-like mobile base that moves at a maximum speed of 0.6 m/s, a telescoping arm and lift, and a custom gripper that offers a 3.3lb payload. The gripper could be extended to an approximate length of 1 meter. The robot weighs 50lbs and has a height of 4 foot 6 inches. The googly eyes are attached to the upper body of the robot as shown in Figure 2 below. The robot is equipped with a bluetooth speaker that is placed on its lower base.

C. Interaction Script

The robot's speech interactions were operated by one of our experimenters using a free, open-source, soundboard application on a laptop nearby the robot, playing to a bluetooth speaker onboard the robot. In all interaction scenarios, we initiated the interaction by engaging a participant with the line "Could you please assist me in picking up this piece of garbage?" If the participant intervened and helped the robot, we responded with "Thank you". The only time we used the other available lines was when a participant stopped to listen to the robot for a while but took no action. We followed up with, "Hello, I am an experimental garbage-collecting robot," followed by, "I am having difficulty picking up an item and require assistance." Then, we played the initial line requesting assistance again. This approach was only required in two interactions.

D. Participants

Our study faced unique challenges when deciding who should be counted as a participant, given that it took place in a public space and there were always more people around the space than just the people that our robot interacted with. We've decided to consider people who we approached and spoke to with the robot, as well as bystanders that overheard and intervened in those scenarios as participants. Ideally, we would be able to measure the number of bystanders that did not intervene, but this is an especially hard number to track in a public space. Not only is it a large and constantly changing number, but many of these potential bystanders could be disqualified based on their knowledge of the study, like reception and janitorial staff who were notified of the experiment and cafe patrons who have been sitting nearby for long enough to have seen us coordinate setting up the robot and move to our hiding places. We only counted people who were walking by and actually perceived the verbal message from the robot as the participant of our experiment. (ie. people with earphones who did not hear the robot were not counted as participants) In total, we surveyed 22 participants, 11 in each condition (eyes / no eyes). Ultimately, because of the high number of people who pass through, we were able to recruit a set of participants who were more diverse in age and robotics background than we anticipated in the computer science building.

Gender	9 (Female), 13 (Male)
Age	5 (18 - 20), 11 (21 - 30), 3 (31 - 40), 1 (51 - 60)
Group Status	15 (individual), 7 (members of groups)

E. Data Collection and Measures

We evaluate the two hypothesis using the following measures:

- Decision outcome: did participants assist the robot or not?
- Self-reported reason behind decision: we asked the participants in the survey to write down why they assisted or did not assist the robot.
- Individual or group: we journaled whether the participants were walking alone or in a group (and marked participants who were in the same group)

We choose to conduct fly-on-the-wall observations in order to minimize our intervention to the situation of human-robot interaction. While one team member played the role of the wizard and remotely controlled the robot from a distant position, two other members conducted fly-on-the-wall observations on a sofa near the reception across the cafe. They journaled in a notebook for most trials and also collected data via secret video cameras for three trials. We use logistic regression—a generalized linear model with binomial distribution—to analyze the binary outcomes of whether participants actively assisted the robot or not. (as shown in Figure 4 and 5) While the statistical significance is analyzed later in section 4.1, the logistical regression does not fit the data well since both p-values for the two conditions are > 0.05. (p in both conditions are 0.6472)

IV. Results

A. Main Results

We analyze the aforementioned hypothesis by looking at the assistance rate (the ratio of number of assists to the number of trials) for each condition. Table 2 below shows the numerical data while Figure 3 shows the calculated rate for each condition.

Study variant	Population	Number of Trials	Number of Assists
With Eyes	Individual	6	5
	Group	5	2
Without Eyes	Individual	9	3
	Group	2	1

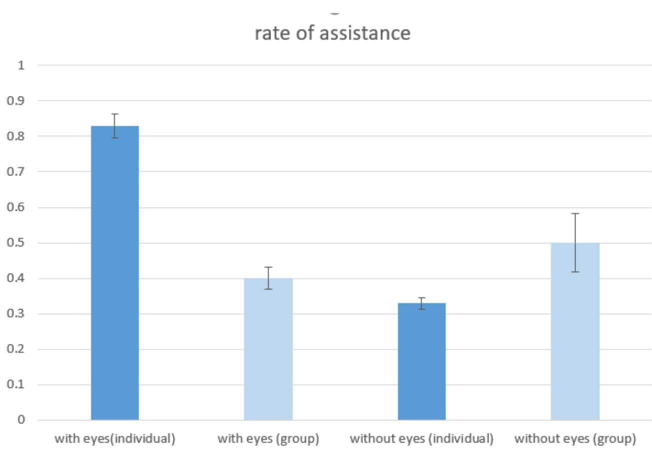

Fig. 3: The rate of assistance from each condition, with each error bar representing one standard error from the mean.

1) Testing H1: For the individual condition, the addition of googly eyes substantially increased the likeliness of human assisting. While 3 out of 9 individuals (33%) offered assistance when the robot did not have googly eyes, 5 out of 6 individuals (83%) offered assistance when the robot wore googly eyes. Yet though there is a huge difference between the two assistance rates, it was not statistically significant (chi-square $X^2_{df=1,N=15} = 3.616$ and $p = 0.057$) For the group condition, the result was also not statistically significant (chi-square $X^2_{df=1,N=7} = 0.05845$ and $p = 0.809$) Such results might result from a limited sample size (15 trials for individual condition and 7 trials for group condition).

2) Testing H2: The result shows that there is no significant difference between the robot approaching individuals versus the robot approaching groups. The rate of assistance seems to vary randomly regardless of the individual or group factor. The result was also not statistically significant (chi-square $X^2_{df=1,N=22} = 0.2095$ and $p = 0.6472$)

B. Participant Responses

1) Common Responses: Almost all survey respondents reported little to no prior experience with robots, and not a single survey respondent noted that they had been previously informed about this study in some way. This assures us that our results are sound and not influenced by participants knowing the purpose of the study.

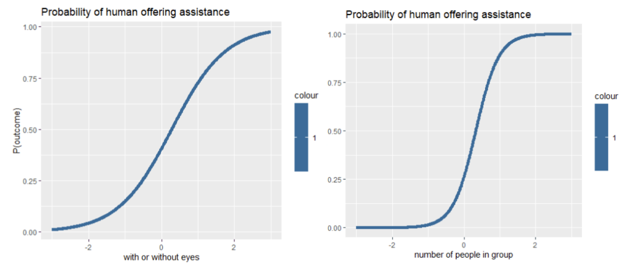

Fig. 4: Logistic regression of the outcome with two independent variables

Most participants did not have any verbal interaction with the robot. Instead, they decided either quietly, if they were alone, or amongst themselves whether or not they should assist the robot. If they chose to do so, they would pick up the bottles and throw them into the trash can or attempt to place them into the grip of the robot. Often participants were unsure of which action to take, whether on their own or in a group, and many participants who did and didn't help described being confused about how to help the robot in their survey responses.

In groups, we saw more lingering around the robot while the group deliberated about whether to help or not, usually resulting in a single group member intervening to pick up the bottles. This deliberation usually involved some quiet conversation about whether they were the right people to help, as well as laughing and discussion of the purpose of the robot.

We also identified a trend in the data of respondents falling into one of two categories of how the robot made them feel. Many participants said it made them feel happy, intrigued, or excited to see a robot navigating the public space, while another large portion said that it made them feel sad, useless, or nervous for the future. All of these responses feel like some version of the novelty effect, expressed through a positive or negative association that the person has with robots.

2) Noteworthy Anecdotes: A collection of interesting tales from our trials.

What Robot?

In the non-googly eyes condition, one participant rushed through the lobby, glanced when the robot spoke to her, and exited the building. When asked why she didn't stop for the robot, she responded that she was rushing to class and knew she was addressed but wasn't sure where the sound was coming from. She mentioned that she thought it may have come from the garbage can. Similarly, in another no-eyes trial, another respondent who did not assist the robot mentioned thinking that the robot was some kind of fancy hand-sanitizer dispenser.

The Robot Should Try Harder

One of the participants stopped at the robot without the googly eyes when walking past the cafe. The participant watched the robot extend its grasp and fail to grab the bottle, shook his head and walked away. The participant wrote in the survey about his reason for not helping the robot that "Just thought it didn't try."

The Hater

In the robot with googly eyes condition, three participants were passing through the lobby together until they heard the robot. One of the participants stood at a distance and watched a member of her group pick up the bottles for the robot. The participant seemed to have some facial expressions of unwillingness and later expressed his hostility towards the robot in her survey: "I hate robots. I did not like the robot. It made me mad." When asked why she did not help the robot, she responded, "Because I don't like robots and would rather they don't improve their functioning. I don't want to help improve AI or robots."

Personal Business

One participant was walking at a fast pace in the hallway while the robot with the googly eyes sent the verbal request: "Could you please assist me in picking up this piece of garbage?" The participant looked surprised and stopped near the robot. He then looked around while the robot sent the second verbal message: "Hello, I am an experimental garbage-collecting robot." The participant did not wait for the robot to finish the message. He shook his head and walked away at a faster pace to the restroom on the same floor.

V. Discussion

A. Impact of Eyes

The strongest result of our work, although not statistically significant but anecdotally supported, is that the presence of eyes played a large role in reducing participant confusion about where the sound was coming from or how to help the robot. As mentioned in the anecdotes above, multiple participants in the no-eyes condition reported walking straight past the robot who requested help because when they heard the sound, they thought it may have come from a garbage can, or that the robot itself was some sort of fancy hand sanitizer dispenser. These participants were the most extreme confusion cases, but were not at all alone among no-eye condition participants who were just not quite sure if they were being addressed or how they should help. We believe this to be the leading cause of the difference in robot assist rates in our eyes groups vs the no eyes groups.

As far as the mechanism of this confusion - it seems that particularly in situations where participants are walking quickly through the lobby, when they hear a voice off to their side, having eyes on the robot helps the participants quickly and subconsciously lock on to the entity that's speaking to them. This is particularly compelling because the speaker from which the robot's request originated was sitting at the base of the robot, while the eyes were placed at the robot's "head". In the eyes condition, no one mentioned being confused about the origin of the sound, behaving as though the sound originated from this head, whereas in the no eyes condition, the speaker's position near the ground led to more confusion and ultimately a lower response rate.

B. Politeness

A large percentage of survey respondents who did choose to help the robot mentioned explicitly that they assisted because the robot was nice or polite. This finding is strongly supported by other HRI studies, but the magnitude of this was still interesting, as we did not ask any questions about politeness explicitly, just "If you chose to assist the robot, why?"

C. Bystanders

Our study did not initially concern the effect of the presence of bystanders and, as previously mentioned, we were unable to record a practical measure for the number of bystanders in a space because of difficulty tracking large numbers of people and the need for criteria to disqualify bystanders who were informed about or had previously participated in the experiment. Given all of this, in many of our trials, people who were not the primary target of the robot's request for help came to the robot's aid. The robot's audio was quite loud, so it could be heard and understood by people in other parts of the room, The bystander effect is also hard to measure or test due to the subjective nature of the psychological theory (how many people were actually at the scene compared to how many bystanders were watching the participant according to his/her own eyes and perceptions)

D. Challenges

A public study if this nature comes with many challenges. Public spaces are constantly changing and unexpected things occur frequently. Our earliest trials had a much higher error rate, causing us to scrap most of the data from those trials, including situations where we were caught controlling the robot remotely or staff who had been warned about the robot but not the nature of the experiment came to notify us, exposing our disguise, when the robot began ask for help.

If an individual or group who was aware of the experiment previously (friends, coworkers, etc.) entered the lobby, we would not approach them with the robot or include them in the study. These people often came over to talk to us about the experiment, again exposing our cover and increasing the importance of including only people passing through the lobby in our study.

When speaking to participants, we ran into issues where a participant fully did not hear the first request for help and paused to check out the situation. Our script beyond the first interaction was loosely defined, meaning that we didn't have a real contingency plan for whether or not we should be using follow up clarification voice lines to explain to ensure participants how they can help. Additionally, we had some participants try and hand the garbage items to the robot directly, but we had not planned any voice lines to communicate to participants whether we would prefer the garbage handed directly to the robot or just to the garbage can itself.

VI. Conclusion

This study re-affirmed a result that has been achieved in many different ways - the addition of eyes, even very basic paper eyes, to a robot operating in public spaces is hugely effective for communicating to people how they should interact with the robot or how the robot may interact with them. Our results are especially strong, considering how non-anthropomorphic our robot's appearance is, and how simple our paper eyes were. These results likely mean that any robot which requests assistance from people would likely benefit from the addition of eyes.

VII. Contributions

Lane

1) Project Proposal
   a) Assembled Group
   b) Assisted with drafting project proposal
   c) Group brainstorming an innovation
2) Experiment Prep
   a) Participated in rounds of IRB Prep
   b) Multiple group sessions to pilot and prep stretch
   c) Created Stretch Eyes
3) Project Execution
   a) Debriefed Subjects and Conducted Surveys
4) Presentation
   a) Created Slides: The Team, Motivation Timeline, Stretch Details, Learning Outcomes, Quotes
5) Report
   a) Abstract (1st Draft), Introduction (1st Draft), Experimental Design (1st Draft)

Sam

1) Project Proposal
   a) Assisted with drafting project proposal, group brainstorming
2) Experiment Prep
   a) Participated in many rounds of IRB prep, updated and submitted IRB
   b) Multiple group sessions to pilot and prep stretch robot
   c) Prepare sounds and soundboard for trials
3) Project Execution
   a) Operated soundboard and camera during trials
   b) Worked with Lane to debrief subjects and conduct surveys
4) Presentation
   a) Put together experiment video
   b) Background - appearance, Results, Discussion slides
5) Report
   a) Abstract, Background - appearance, Methods, Discussion, Conclusion, Formatting

Yutao

1) Project Proposal
   a) Assisted with drafting project proposal, group brainstorming
2) Experiment Prep
   a) Participated in many rounds of IRB prep, updated IRB
   b) Multiple group sessions to pilot and prep stretch robot
   c) Trained to remotely control the robot trials
3) Project Execution
   a) Remotely operated the robot during trials
4) Presentation
   a) Background - asking for assistance, methods, results slides
5) Report
   a) Introduction, Background - requesting assistance and group dynamics, methods, Results and analysis (chi-square tests and logistic regression), Results - participant responses

References

[1] V. Srinivasan and L. Takayama, "Help me please: Robot politeness strategies for soliciting help from humans," in *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pp. 4945–4955, Jose California USA, 2016.

[2] N. Backhaus, P. H. Rosen, A. Scheidig, H. Gross, and S. Wischniewski, "Somebody help me, please?!," *Interaction Design Framework for Needy Mobile Service Robots*,", pp. 54–61, 2018.

[3] J. Liebner, A. Scheidig, and G. HM., "Now i need help! passing doors and using elevators as an assistance requiring robot," in *Social Robotics* (M. Salichs and others Salichs M. al, eds.), vol 11876. Springer, Cham: ICSR 2019. Lecture Notes in Computer Science, 2019.

[4] A. Fallatah, B. Chun, S. Balali, and H. Knight, "Would you please buy me a coffee?: How microculturesimpact people's helpful actions toward robots," pp. 939–950, 2020.

[5] M. Kopka and K. Krause, "Can you help me? testing hmi designs and psychological influences on intended helping behavior towards autonomous cargo bikes," pp. 64–68, Mensch und Computer 2021 (MuC21)., 2021.

[6] M. Ernest-Jones, D. Nettle, and M. Bateson, "Effects of eye images on everyday cooperative behavior: a field experiment, evolution and human behavior, volume 32," *Issue*, vol. 3, pp. Pages 172–178, 2011.

[7] F. F"orster, A. Weiss, and M. Tscheligi, "Anthropomorphic design for an interactive urban robot - the right design approach?," in *6th ACM/IEEE International Conference on Human-Robot Interaction (HRI 2011)*, pp. 137–138, 2011.

[8] S. Song and S. Yamada, "Expressing emotions through color, sound, and vibration with an appearance-constrained social robot," in *12th ACM/IEEE International Conference on Human-Robot Interaction (HRI 2017)*, pp. 2–11, 2017.

[9] P. Fischer, J. I. Krueger, T. Greitemeyer, C. Vogrincic, A. Kastenm"uller, D. Frey, M. Heene, M. Wicher, and M. Kainbacher, "The bystander-effect: a meta-analytic review on bystander intervention in dangerous and non-dangerous emergencies," *Psychological Bulletin*, vol. 137, no. 4, pp. 517–537, 2011.

[10] M. van Bommel, J.-W. van Prooijen, H. Elffers, and P. A. M. V. Lange, "Be aware to care: Public self-awareness leads to a reversal of the bystander effect," *Journal of Experimental Social Psychology*, vol. 48, no. 4, pp. Pages 926–930, 2012.