Check Your Stereotypes at the Door: an Analysis of Gender Typecasts in Social Human-Robot Interaction

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Abstract. In this paper, we provide evidence that suggests prominent gender stereotypes might not be as pronounced in human-robot interaction as may be expected based on previous research. We investigate stereotypes about people interacting with robots, such as men being more engaged, and stereotypes which may be applied to robots that have a perceived gender, such as female robots being perceived as more suitable for household duties. Through a user study, we not only fail to find support for many existing stereotypes, but our analysis suggests that if such effects exist, they may be small. This implies that interface and robot designers need to be wary of which stereotypes they bring to the table, and should understand that even stereotypes with prior experimental evidence may not manifest strongly in social human-robot interaction.

Keywords. Human-Robot Interaction; Gender Studies

1 Introduction

Social Human Robot Interaction (sHRI) investigates how robots and people interact socially. For instance, robots are already emerging into the real world as personal care, tutoring, or even professional team robots (e.g., search and rescue), and need to interact using speech, gaze, and gestures, and need to be aware of and work within social structures and norms – e.g., a robot should be good at conversational turn taking. Thus, sHRI research goes beyond the technical robotics challenges, and involves social elements rooted in psychology and sociology.

One such area of importance to sHRI is gender studies. While there is a body of research on how women and men may have different needs and may interact differently with their worlds (such as new technologies) and other people [1, 2], the intersection of Human-Computer Interaction (HCI) and gender studies is only in its infancy. The ACM GenderIT conference is only newly established, and there are even fewer examples of gender-related sHRI work [3]. Despite this, understanding how gender relates to interaction with robots is very important for sHRI, as robots need to understand the specific differences and needs of women and men, the same as people do, if they are to interact with people and integrate naturally. Further, in order to design effectively, sHRI designers need to know what gender stereotypes may be applied to their robots.

There is a large amount of work in sociology and psychology that investigates gender stereotypes, for example, that women may be more nervous with new technology [4] or men may be more rude to others [5]. However, such generalizations are dangerous as they may be used (e.g., by designers) to oversimplify the complexities of gender, resulting in designs that may re-enforce potentially-harmful stereotypes (e.g., if little boys do not like kitchen toys a toy company may market theirs to girls only). Instead, particularly given that social robots will be in shared public and private spaces, we argue we should to try to understand the needs of both women and men: such *inclusionary* designs should be sensitive to specific needs of *both* genders simultaneously, instead of *exclusionary* ones that target only one gender and can potentially re-enforce stereotypes [3]. Our work takes this approach: while we investigate stereotypes, it is part of a bigger goal of simply understanding all users and how broad stereotypes may be manifested in actual interaction.

We cannot directly apply existing gender work on technology to robots, as people tend to interact with robots more socially than with traditional technologies such as laptops or smart phones, and are more likely to attribute names, emotions, etc. [6]; this is especially true when robots are designed specifically for social interaction. Conversely, people will not interact with robots the same as with other people (e.g. [7]), and so interpersonal gender work likewise cannot be directly applied, and it is important to reconsider gender studies results specifically for sHRI.

In this paper we use the term "gender" synonymously with biological sex, which we recognize is overly simplistic. We used "gender" for the practical purpose of simplifying our investigation; this approach is used heavily not only in sHRI and HCI [1], [8] but in feminism work in Science and Technology Studies in Sociology (e.g. [2]).

We present an investigation into how gender stereotypes may be manifested in sHRI, with our results indicating the possibility that some prominent stereotypes may not manifest in sHRI, and if they do, they may be too subtle to warrant much consideration. This has direct implications for sHRI design – designers should be careful of leveraging gender stereotypes – and provides a starting point for continued gender work in sHRI.

2 Related Work

Gender studies, feminism, or men's studies, is a mature research area that uses gender, gender identity, and sex as central themes of investigation [1]. Some of this work has been heavily applied to science and technology studies, for example, through investigations of how gender has impacted technology developments and trajectories [2].

More recently, HCI has started drawing from gender studies [9]: researchers are mapping out gender-specific interaction needs and strategies, for example, in software exploration [10], interface problem-solving strategies [11], navigating virtual environments [12], and even in experiment design [13]. There has been an *inclusive* theme throughout this work, of trying to understand the needs of both women and men and to develop strategies and flexible solutions that work for both, rather than *exclusionary* designs that benefit one group more than the other.

There has been much less gender work specifically in sHRI; most gender results are afterthoughts or small components of work targeted at non-gender questions [3]. Such results include evidence that men and women may have different criteria for evaluating robots [14], may have different ideas about what sorts of tasks robots will do [15], or that women and men may have different preferences regarding how a robot should approach them [16]. We continue investigation in this direction with a study that directly and primarily investigates how gender may be a component of sHRI.

Other work has more directly investigated the impact of the perceived gender of the robot itself (e.g., as being more masculine or feminine), and how people interact with it (e.g., men may be more positive toward female robots [17]). Some work has further suggested that human gender stereotypes may also be applied to robots, for example, people may have predispositions toward a robot's knowledge base [18] or usefulness [8] based on its perceived gender. These initial works investigate highly-targeted questions [17, 18] or rely on picture or text descriptions of robots and do not yet involve interaction with an actual robot [3], [8]. We continue this line of work with a broader look at how stereotypes may be manifested in actual interaction with a robot.

3 Stereotypes and Hypotheses

We look at two perspectives of gender stereotypes in sHRI: what existing stereotypes suggest about how women and men will interact with robots, and which stereotypes may be applied to robots that are perceived as being masculine or feminine. Our selection of stereotypes in this section are by no means complete, as the number and range of such stereotypes is large. However, we selected stereotypes with prior empirical evidence in human-robot interaction as a starting point.

3.1 Selected Stereotypes about Male and Female Users

Politeness – Politeness toward others is a cornerstone of interpersonal interaction. There is evidence that women, in general, may be more polite than men [5], [19] – we test if this manifests when women and men interact with a robot.

Engagement – Research shows men are typically more engaged with new technologies than women [20, 21] and so men may be more engaged with a robot.

Relaxation – Women have reported lower self-efficacy toward new technologies and in some cases have higher anxiety surrounding using them [4]. This has also been found regarding perceptions of interaction with robots [3].

3.2 Selected Stereotypes Applied to Male or Female Robots

People may apply gender stereotypes to a robot that has a perceived gender. A recent work found people apply stereotypes to a hypothetical robot (shown as an image) depending on the robot's haircut [8]. Participants attributed the female-haircut robot with traditional female traits (communal, e.g., compassionate, empathic), and rated it as more suited to traditional female tasks (e.g., patient or child care). Conversely, the male-haircut robot was attributed with more male traits (i.e., agentic, e.g., assertive, competitive) and was rated as being more suited to typical male tasks (e.g., repairing equipment, transporting goods).

We investigate if similar stereotypes would emerge when interacting with a real robot instead of only viewing images.

4 Study Design

Our study uses a Wizard-of-Oz scenario where participants were told to interact with an autonomous, intelligent robot that moves and speaks, while the robot was secretly controlled by a researcher in another room. Our study involved thirty-nine participants from the local university population that were paid $10 for 30 minutes of participation. Gender was balanced (19 male) and split between the *he* and *she* robot cases, for a 2x2 study design. Our demographics questionnaire also included *inter-sex* in addition to male and female, although no participants selected this option.

4.1 Instruments and Analysis Method

For investigating how participants interact with a robot, we recorded video and coded for *politeness*, *engagement*, and *relaxation*, counting the instances per session. We coded for positive and negative, e.g., a rude action would be *negative politeness,* using participant speech style and body language; we provide our coding guideline for *relaxation* in Appendix A, but the full coding guideline is omitted for brevity. Videos were coded by two researchers (30% overlap), with good inter-coder reliability (Krippendorph's $\alpha = .79$).

To investigate people's stereotypes toward male or female robots, we employed the exact questionnaires from the previous robot haircut work to measure perceived male (agentic) or female (communion) traits of the robot, and appropriateness for typically male and female tasks such as housework or physical labor [8]. Each of these scales sum to a single number that can be tested.

Our robot was an Aldebaran NAO (Fig. 1), a small humanoid robot that is capable of complex gestures and speech. It was remotely controlled (unbeknownst to the participant) via a Wizard-of-Oz setup, with in-house controller software that enabled a high level of interaction flexibility and pre-coded actions and speech. The voice was chosen to be NAO's default English voice.

4.2 Manipulations

To create a robot that is perceived as being feminine or masculine we manipulated the pronoun used to refer to the robot, using either 'he' or 'she'; the robot had the unisex name 'Taylor' in all cases to isolate the effect of pronoun use. Non-gender-specific word choice has recently been shown to potentially influence the gender people imagine something to be [13], so we hypothesize that our specifically gendered pronouns will affect the robot's perceived gender. Our manipulation was between participants, and we asked participants to rate the robot as masculine or feminine during the post-test to validate this. To ensure our manipulation was consistent, the researcher controlling the robot maintained a rehearsal regime throughout the duration our studies, and held a cue-card (unseen by participants) during each experiment to help focus and use the correct pronoun consistently.

4.3 Method

Fig. 1. The NAO robot used in our experiment

After a briefing, participants signed an informed consent form and completed a demographic questionnaire. The researcher introduced the robot, which stood up, waved, and introduced itself to demonstrate its abilities. At this point, the researcher left, claiming they forgot additional forms, and said they will return shortly, informing the participant they could chat with the robot during this time. While the researcher was away (~4 min.), the robot engaged the participant in casual conversation on daily topics (e.g., hobbies, work, or school) with casual gestures for realism. The robot aimed for consistent conversation across participants by sticking to and coming back to pre-defined topics, although we needed to be flexible enough to respond individually to each participant to maintain an illusion of intelligence. After returning, the researcher administered the questionnaire on robot perceptions (from [8]) and the post-test questionnaire, and debriefed participants.

5 Results

We conducted 2-way ANOVAs (participant gender by robot gender) on our dependent measures (perceived robot gender, stereotypes about male and female users, and gender stereotypes applied to robots), to investigate the impacts of participant gender or perceived robot gender, as well as potential interactions.

To investigate if our *she* versus *he* manipulation was successful, we conducted a 2-way ANOVA on participant rating of the robot as more masculine or feminine (7-pt Likert-like scale). There was a main effect of robot gender; the *he* robot was rated as more masculine (M=4.8, se=.28) and *she* as more feminine (M=2.9, se=.29, $F_{1,35}$=20.83, p<.001, ω^2=.87), and no main effect of participant gender or interaction p>.05). This means that our *she* versus *he* manipulation was successful in gendering the robot.

For stereotypes about male or female users, there was a main effect of participant gender on politeness, where our female participants were less rude (M=.15, se=.32) than the male participants (M=1.05, se=.31, $F_{1,35}$=4.14, p<.05, ω^2=.63). No other effects of participant gender or robot gender were found, and there were no interactions (p>.05).

Relating to gender stereotypes being applied to robots, we found no main effects of robot gender on participant rating of the robot's suitability for either female tasks ($F_{1,35}$=.52, p=.48, ω^2=.09) or male tasks ($F_{1,35}$=.04, p=.84, ω^2=.04), or on female traits ($F_{1,35}$=1.12, p=.30, ω^2=.50) or male traits ($F_{1,35}$=.70, p=.41 ω^2=.13). There were also no main effects of participant gender on these measures and no interaction effects (p>.05).

5.1 Post-Hoc Analysis

Across most of our tests we found a lack of support for the gender stereotypes we were looking for, even though we can confidently assume that our *he* versus *she* gender manipulation of the robot was successful (based on our statistical results). A lack of support does not imply no effect; we performed a post-hoc analysis to investigate further. Across the negative tests we have very low observed power (most <.2, Table 1), suggesting that we may have simply failed to detect effects that may exist. Apart from a few exceptions, the standard deviations of our measures were reasonably low (Table 1), particularly for the robot stereotype measures, improving our confidence that we did not miss a large uncontrolled confound such as interpersonal variability being more influential than our controls.

Table 1. An overview of our results: grand means, standard deviations, effect sizes, and observed power (1-β). *p<.05

stereotypes toward robots, average score on 1-7 scale (by robot gender)	grand mean	*std. dev.*	*effect size (ω²)*	*obs. pwr.*
female tasks	4.75	1.19	.09	.11
male tasks	4.94	.85	.04	.06
agentic (male) traits	4.01	.89	.13	.13
communal (female) traits	4.55	.90	.55	.18
stereotypes toward users, average count (by participant gender)				
positive engagement	7.74	3.06	.20	.09
negative engagement	1.18	1.17	.11	.09
positive relaxation	7.87	3.83	.01	.05
negative relaxation	2.46	2.82	.11	.07
positive politeness	4.59	1.53	.33	.11
negative politeness	.62	1.43	.63*	.51*

We further note that we have very small effect sizes across tests (Table 1). This suggests that even if a difference were to approach significance (e.g., with a larger sample size), we could expect the actual difference to be small or subtle; thus our data provides evidence that a strong effect may not emerge, even with more participants, discouraging us from conducting follow-up tests on this approach.

5.2 Discussion

We conducted an experiment where female and male participants interacted with either a masculine or feminine robot, and analyzed how these variables impact common stereotypes regarding both. As supported by previous work, we found our male participants to be ruder to our robot during interaction than our female participants. While this has clear implications for developing sHRI interfaces, we believe that the other, lack of findings, are more interesting.

Our lack of results regarding applying stereotypes to robots seemingly contradicts the recent results showing how robot hair style can invoke gender stereotypes [8] (supporting results from prior work [22]), though we would like to stress that we did not perform equivalence testing (which requires *a priori* planning), and as such we do not claim that no effect exists. One possibility is that the visual stimulus of a hairstyle may elicit stronger responses than our real robot with a verbal stimulus, despite having statistical support that the robot's perceived gender was successfully manipulated by our pronoun choice ('he' versus 'she'). It will be important follow-up work to consider visually gendering robots; verbal stimuli may not be enough to cross the "lower bound" necessary to invoke gender stereotypes. We highlight that our real robot and interaction greatly improves ecological validity compared to the picture stimulus in prior work. In addition, the prior work used a comparative, within-subjects design [8] (in contrast to our between-subjects) which may have encouraged participants to dichotomize the two robots to a male-female binary.

Although the previous work does not report standardized effect sizes [8], the actual differences observed in their studies were quite small and within the range of our observed differences (<.5 on the same scales); their finding significance may be due to the added statistical power of the within-participants method and 50% more participants than our study. Thus, our results and statistical analysis fall in line with the prior results given our sample size. While we did not find a statistical difference, given our tight standard deviations and small effect sizes, if a difference does exist, in future work, our understanding of the effect size would additionally benefit from understanding what gender participants perceive our robot as regardless of our pronoun treatment—a gender-neutral case of addressing the robot as "it."

It is important to consider this disparity between our lack of results and prior related, more general gender work as outlined earlier in the paper. One reason may be the fact that people interact with social robots in a fundamentally different way than with traditional technologies. This would explain the lack of stereotypical differences in *engagement* or *relaxation* around social robots, as participants interact with them more as a social other than a typical new technology. This further explains why our only positive result was *politeness*, as this stereotype stems from how people interact with *each other*, not from how people interact with *technologies*; social robots possibly fit the former model better than the latter. Perhaps inter-personal stereotypes surrounding gender may be more applicable to sHRI than stereotypes of how people interact with technology.

Finally, it is important to acknowledge the limitation surrounding our mixed use of "gender" and "sex," which are fundamentally different concepts [1]. Our use of "sex" to roughly represent gender (similar to other works, e.g. [2], [8], [18]) over-simplifies the interpretation of gender effects and limits our analysis. Moving forward, sHRI needs to address this issue more thoroughly as a field.

6 Summary

In this paper, we investigated how prominent gender stereotypes regarding how women and men may interact with robots, and how people may perceive gendered robots, might be realized in social human-robot interaction scenarios. We presented results from a study that involved interaction with a real robot and an analysis that highlights how these stereotypes may not manifest strongly in real human-robot interactions. In particular, although we found male participants to be less polite to robots, we found no support for expecting women to be less engaged or relaxed around robots, and found no support for the idea that people may apply gender stereotypes to robots themselves. While we stress this is not statistical proof that there are no gender differences (we did not perform equivalence testing), our analysis suggests that if such differences do exist, then they may be small and possibly insignificant for practical sHRI research. For researchers in sHRI, this means that we must be very careful and wary of using stereotypes in our interaction and robotic designs as, even with prior research evidence, established stereotypes may not always manifest strongly in social interaction with robots.

We believe that the pursuit of gender studies in sHRI will be an ongoing crucial element of developing robots that interact naturally with people in social situations, and envision that our work helps to grow this direction of work.

A Appendix

Below is a sample of our coding guideline for the dependent variable *relaxation*.

Table 2. The coding guideline used by both of our coders.
This sample is for the variable *relaxation*.

<table>
<tr><td colspan="2">Relaxation: as the previous study shows, women tend to be more fearful of new technology. I would like to explore if there are some differences between men and women in terms of relaxation/nervousness during the conversation.</td></tr>
<tr><td colspan="2">Hypothesis: women are more nervous than men when they interact with a robot</td></tr>
<tr><td colspan="2">Baseline for judging nervousness: by observing participants’ facial expression or body language, we may tell that the participants are nervous about something, or they are quite calm and less tense or worried.</td></tr>
<tr><td>Positive (relaxed):
standard:
observing participants’ facial expression and body language to see if they are calm and less tense or worried</td><td>Negative (nervous):
standard:
observing participants’ facial expression and body language to see if they are nervous or worried about something.</td></tr>
<tr><td>examples for short instances:
Code PR#</td><td>examples for short instances:
Code NR#</td></tr>
<tr><td>PR1: relaxation showed by body language:
(1) sit comfortably, like put one leg on the other/put their feet on the chair/use their hand to support their chin (maximum 3 per video) (2)approach the robot, observe the robot from different angles;
PR2: relaxation showed by facial expression: smiling naturally or laugh out loud
PR3: relaxation conveyed by verbal expression:
talk with or ask robot questions actively to continue the conversation, but do not show the desire/need to know more about the robot
PR*: instances clearly show participants are relaxed.</td><td>NR1: nervousness showed by body language:
(1) fidget with their hands or clinched hands; (2) sitting rigid/straight;(3) moving while biting lips or having some hand movements
NR2: nervousness showed by facial expression:
(1) avert eyes from the robot (avoid eye contact); (2) smile or laughing nervously; embarrassed laugh
NR3: nervousness conveyed by verbal expression:
take a long time to answer a question as if they are thinking or unsure (not bored or distracted)
NR*: instances clearly show participants are nervous. Eg., move away or keep distance from the robot</td></tr>
</table>

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