ABSTRACT

Previous research found that robots should best be designed to fit their given task, whilst others identified gender effects in people’s evaluations of robots. This study combines this knowledge to investigate stereotyping effects of robot genderedness and assigned tasks in an online experiment (n = 89) manipulating robot gender (male vs. female) and task type (analytical vs. social) in a between subject’s design in terms of trust, social perception, and humanness. People deem robots more competent and have higher trust in their capacity when they perform analytical tasks compared to social tasks, independent of the robot’s gender. Furthermore, we observed a trend in the data indicating that people seem to dehumanize female robots (regardless of task performed) to animals lacking higher-level mental processes, and additionally that people seem to dehumanize robots to emotionless objects only when gendered robots perform tasks contradicting the stereotypes of their gender.

KEYWORDS

Robots; Gender Stereotypes; Social Perception; Dehumanization; Trust

1 INTRODUCTION

Robots will soon be embracing a myriad of tasks in our everyday lives, in hospitals, schools, the office, and our homes. Previous research in human-robot interaction (HRI) have considered different angles investigating people’s evaluations of robots’ suitability to perform a given task. Some studies analyzed people’s general social acceptance of robots in several potential future jobs [9, 12]. These studies conclude that people are willing to accept robots as entertainment or personal service and in applications for hazardous environments but are likely to reject robot applications that require intellectual directed their research at a fit between task and appearance [21] which trigger gender stereotypical beliefs about such gendered robots [13, 38]. The current study expands current knowledge on appearance-task fit and gender inferences by investigating stereotyping effects of robot genderedness and assigned tasks in an online experiment.

1.1 Social Categorization and Stereotypes

Social categorization is a cognitive process to make sense of the social world by simplifying and systematizing perceptive information [1]. Such categorization serves as a beneficial heuristic when meeting strangers as we infer interpersonal characteristics based on the social group that stranger belongs to [28]. However, categorizing others to social groups rather than treating them as unique individuals has various negative consequences. Social categorization prompts our tendency to hold distort perceptions and exaggerate the differences between people from distinct social groups while perceiving intensified similarities of members within those groups [37]. Consequently, it becomes easy to apply our distort perceptions to individual members of social groups without having to consider whether the characteristics pertain to that individual. This process is called stereotyping, which are over-generalized assessments of an individual based on the group to which that individual belongs [20]. Gender stereotypes are automatically activated immediately following categorization of a target as a member of that group [11].

A long history of research on gender stereotyping shows that people tend to associate different traits to men and women. Stereotypical male traits focus on competence and agency [35] and denote concern for others (e.g., kind, caring), affiliative tendencies (e.g., friendly, collaborative), deference (e.g., obedient, respectful) and emotional sensitivity (e.g., intuitive, understanding) [20]. Bem [3] mapped this distinction between stereotypical male and female traits; a division which shows a strong overlap with the Stereotype Content Model [7] dimensions of warmth and competence. Subsequent research shows that people generally deem competence more desirable for males, and warmth for females [4]. Following the Computers Are Social Actors paradigm [29], gender stereotypes have also been reported in HRI research.

1.2 Gender Stereotypes in HRI Research

People project social categories and social behaviors onto robots based on their traits and characteristics, including gender cues from physical appearance [13] as well as face and voice [32]. Robots were originally meant solely to perform instrumental tasks [41]. While their purpose regarding their task type is changing, this classical image of robots in dirty, dangerous and dull tasks is persisting in people’s minds [27]. Nonetheless, human-robot collaborations increasingly become everyday practice [22]. Research on human-robot collaborations stress the importance of trust for a successful introduction of robots to the workforce [16] as trust determines
2 METHOD
To investigate stereotyping effects of robot genderedness and assigned tasks on social perception, trust, and humanness, we conducted an online experiment (n = 89) manipulating robot gender (male vs. female) and task type (analytical vs. social) in a between subject’s design.

2.1 Stimuli
For this experiment, we manipulated the robot gender as well as the task type to create four different vignettes. Robot gender was manipulated by modifying a picture of the Pepper robot by either giving it a blue tie for the male or a pink scarf for the female robot (see Figure 1), which are subtle but powerful gender cues [21]. Additionally, we referred to the robot as either Alexander in the male or Alexandra in the female task description respectively. Task type was manipulated by altering some words in a text description to indicate either an analytical or social task which were kept at similar length (i.e., 69 and 67 words respectively). The analytical task described the robot studying large datasets with medical data to provide an overview of treatment plans for hospital patients to support healthcare professionals in making solid decisions of patient treatment. The social task described the robot utilizing large datasets with verbal and non-verbal behaviors to provide emotional support to hospital patients facilitating healthcare professionals in monitoring patient well-being. The mixture of stimuli (robot gender X task type) resulted in four different vignettes.

We pretested these stimuli (n = 12). The female robot (M = 7.67) was perceived as more female than the male robot (M = 5.56) measured on a 9-point Likert scale from mostly male to mostly female (p = .012). The analytical task (M = 8.22) was perceived as more analytical (p = .032) than the social task (M = 6.78), and the social task (M = 6.67) was perceived as more social (p < .001) than the analytical task (M = 2.22) measured on two separate 9-point Likert scales from not at all [analytical / social] to very [analytical / social].

2.2 Procedure
After giving consent, participants were introduced to the survey topic by addressing the ageing society and that robots could aid the growing demand for optimization in healthcare. They were then assigned to one of the four vignettes that presented a picture of the robot (male or female) together with the task description (analytical or social), after which they responded to several statements regarding their trust, dehumanization, and social perception of the robot. The questionnaire ended with some demographic items and thanking the participant for their contribution.
We observed a significant main effect for task type ($F(3,1) = 4.79, p = .031, d = .47$) on capacity trust, but not for robot gender ($F(3,1) = 1.27, p = .264, d = .25$) nor for their interaction effect ($F(3,1) = 0.02, p = .885, d = .05$). However, we observed no significant main effect for robot gender ($F(3,1) = 2.05, p = .156, d = .31$) or task type ($F(3,1) = 1.26, p = .264, d = .25$) on moral trust nor for their interaction effect ($F(3,1) = 0.10, p = .748, d = .06$). These results suggest that only people’s capacity trust in a robot is affected and exclusively by the type of task it performed. Specifically, participants have higher trust in a robot’s capacity when it performed an analytical task compared to when it performed a social task (see Figure 2).

### 3.2 Social Perception

We observed no significant main effect for robot gender ($F(3,1) = 1.26, p = .265, d = .25$) or for task type ($F(3,1) = 0.19, p = .666, d = .09$) on warmth nor for their interaction effect ($F(3,1) < 0.01, p = .990, d = .05$). However, we observed a significant main effect for task type ($F(3,1) = 7.11, p = .009, d = .58$) on competence, but not for robot gender ($F(3,1) = 0.62, p = .434, d = .17$) nor for their interaction effect ($F(3,1) = 1.94, p = .311, d = .22$). These results suggest that people’s social perception of a robot is particularly affected by the task it performs. Specifically, people perceive a robot as more competent when it performs an analytical task compared to a social task independent of the robot’s gender (see Figure 3).

### 3.3 Humanness

We observed a marginally significant main effect for robot gender ($F(3,1) = 2.77, p = .100, d = .35$) on human uniqueness, but not for task type ($F(3,1) = 0.17, p = .683, d = .09$) nor for their interaction effect ($F(3,1) = 0.06, p = .812, d = .06$). Moreover, we observed no significant main effect for robot gender ($F(3,1) = 0.18, p = .671, d = .09$) nor for task type ($F(3,1) = 1.51, p = .223, d = .28$) on human nature while their interaction effect approached significance ($F(3,1) = 3.80, p = .055, d = .44$). These results suggest that people’s humanness perception of a robot is independent of the robot’s gender and the type of task it performed, while the data indicated a trend where: (1) participants perceptions of a robot’s human uniqueness might be affected by robot gender; and (2) participants perceptions of a robot’s human nature might be an effect of the combination of robot gender and task type. Specifically, participants seem more inclined to dehumanize female robots to animals lacking higher-level mental processes (i.e., lacking human uniqueness) compared to male robots.
independent of the task they performed (see Figure 4). Moreover, participants seem to dehumanize robots to emotionless objects (i.e., lacking human nature) exclusively when a female robot performs analytical tasks or when a male robot performs social tasks (see Figure 5).

4 GENERAL DISCUSSION

Our study expands current knowledge on appearance-task fit and gender inferences by investigating the effects of robot genderedness (male vs. female) and assigned task (analytical vs. social) on social perception, trust, and humanness.

Our data shows that people’s evaluation of their trust in a robot only focuses on its capacity, but not on its morality, independent of its gender. These results show that trust evaluations of a robot cannot be linked to a robot’s gender as we hypothesized (H2). Instead, our results indicate that trust in robots is more strongly associated with the performed task. Additionally, people perceive a robot to be more competent when it performs an analytical task compared to a robot performing a social task, independent of its gender. These results also contradict our hypothesis expecting an effect for robot gender on people’s social perception of a robot (H1). It seems that, when associating gendered robots with specific tasks, the observed effects of gender stereotyping in both the psychology [3] and HRI [13] research seem to steer away from the genderedness of the embodiment towards the (perhaps also perceived gender-stereotypical) performed tasks – at least in terms of our social perception of and trust in such robots. An earlier study examining the relationship among occupational gender-roles, user trust and gendered robots also found no significant difference in the perception of trust in the robot’s competency when considering the gender of the robot [5]. Similar findings have been reported in our HRI studies on gender-task fit [25], reporting that people are less willing to accept help from a robot with a typically female task (i.e., a social task).

These combined results on the dominant effects for task type, rather than for robot gender, are not completely surprising though. Prior research indeed shows that people in general hold more utilitarian perceptions on robots [9, 12, 15]. However, we also need to point to a potential limitation of our stimuli. Although the male robot was significantly perceived as more male than the female robot, its rating was leaning towards the female end of the gender scale. A similar observation was made for the social task, which was significantly perceived as less analytical than the analytical task yet its rating was leaning towards the analytical end of the scale. Future research should therefore not only explore different task descriptions but should also further investigate gendered appearances of robots or include of a gender-neutral robot as well as
study subsequent (interaction) effects on people’s social perception of and trust in such robots. Moreover, previous research in psychology [6] as well as HRI [34] shows interaction effects between the gender of the participant and that of the social other in terms of trust. Additional interaction effects between participant and robot gender have been found by [30] who reported a higher chance of an uncanny reaction to other-gender robots when a robot meets the gender expectations of warm females and competence males. Therefore, exploring interaction effects between the gender of the participant and the gender of robot in the context of gender-task fit might be promising as well.

Moreover, based on the literature in psychology, we expected that people’s perceptions of a robot’s humanness is a function of both robot gender and performed task (H3). This hypothesis was not supported with our data. However, we would like to discuss the observed trend in our data indicating a potential interaction effect between robot gender and performed task on a robot’s perceived humanness. Following this trend, it seems that people dehumanize female robots (regardless of task performed) to animals lacking higher-level mental processes. Sexist responses to female robots have been reported in HRI research more generally [36, 40]. Additionally, people seem to dehumanize robots to emotionless objects only when gendered robots perform tasks contradicting the stereotypes of their gender. Research in social psychology has shown that women are dehumanized to both animals and objects [33], which is a precursor to aggression against them [17]. Inserting the concept of gender into current debates regarding robot abuse (e.g., that mindless robots get bullied [23]) might offer alternative perspectives on these issues.

The field of social robotics aims to build robots that can engage in social interaction scenarios with humans in a natural, familiar, efficient, and above all intuitive manner [10]. The easiest way to deal with expectations of gendered robots and subsequent stereotypical impressions is to enhance people’s social acceptance of gendered robots by tailoring their gender appearance to their intended task or application domain. Alternatively, robots might offer a unique potential to illuminate implicit bias in social cognition and challenging persisting gender-task stereotypes in society.

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