'If You Sound Like Me, You Must Be More Human': On the Interplay of Robot and User Features on Human-Robot Acceptance and Anthropomorphism

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ABSTRACT
In an experiment we manipulated a robot's voice in two ways: First, we varied robot gender; second, we equipped the robot with a human-like or a robot-like synthesized voice. Moreover, we took into account user gender and tested effects of these factors on human–robot acceptance, psychological closeness and psychological anthropomorphism. When participants formed an impression of a same-gender robot, the robot was perceived more positively. Participants also felt more psychological closeness to the same-gender robot. Similarly, the same-gender robot was anthropomorphized more strongly, but only when it utilized a human-like voice. Results indicate that a projection mechanism could underlie these effects.

Categories and Subject Descriptors
J.4 [**Social and Behavioral Sciences**]: *psychology*.

General Terms
Theory, Experimentation, Measurement.

Keywords
Human-Robot Interaction; Anthropomorphism; Gender Stereotypes; Social Robotics.

1. INTRODUCTION
Previous research has shown that people interact with computers in ways that are comparable to human–human interactions [1]. For example, Nass and colleagues have demonstrated repeatedly that people instinctively treat nonliving entities just like humans [2]. Similarly, in the field of human–robot interaction (HRI), we have shown that people use visual gender cues as a basis for their judgments about social robots. That is, they used visual gender cues, such as a robot's hair length in order to make gender-stereotypical inferences about the robot [3]. However, such effects of social category information are not restricted to features of a robot itself. [4], for instance, have shown that additional to the robot gender also the user gender affects people's reactions toward robots. Moreover, in recent research, we have demonstrated that the users' own group membership affects subsequent evaluations of a robot [5, 6]. Taken together, features of the robot interaction partner as well as characteristics of the user determine how people react toward robots. To date, however, no study has yet investigated the interplay of robot features and characteristics of the user on HRI acceptance and psychological anthropomorphism of the robot. To address this research gap, we conducted an experiment in which we tested the simultaneous effects of a robot's vocal features (i.e., human-like vs. robot-like voice; gender of robot voice) and user gender on HRI acceptance, perceived psychological closeness and anthropomorphism.

2. METHOD
58 students (31 women, 27 men; mean age $M = 22.98$, $SD = 2.81$) were randomly assigned to one of four experimental conditions that resulted from the 2 (*gender of robot voice*: male vs. female) x 2 (*voice type*: human-like vs. robot-like) between-subjects design. In addition, we analyzed the factor *participant gender*.

After arriving in the laboratory, participants were presented with a short video of the robot Flobi [7] and were asked to form an impression of it. Importantly, the robot appeared gender-neutral as its modular industrial design allowed us to omit the robot's hair mask. Thus, participants only relied on the robot's vocal cues as a basis for their judgments. In the video, Flobi uttered the neutral sentence 'It is quarter past three', either with a *male human* voice, a *female human* voice, a *male robotic* voice, or a *female robotic* voice. All voice samples were selected based on pretests regarding human-likeness vs. robot-likeness and vocal femininity vs. masculinity.

After watching the video clip, participants completed a set of computerized questionnaires. To collect participants' responses to the dependent measures, 7-point Likert scales were used. For subsequent data analyses, average scores were computed to form indices of the respective dimensions. To measure *HRI acceptance*, we used four items (e.g., 'How much would you like to get acquainted with the robot?') [see 8] that formed a reliable index (α = .83). To assess the degree of *psychological closeness*, participants responded to five items (e.g., 'To what extent do you feel similar to the robot', [see 8], (α = .85)). In order to assess participants' *anthropomorphic inferences* about the robot, we measured the extent to which participants attributed *mind* to the robot. Participants rated the robot with regard to 24 mental capacities (e. g., the capacity to feel pain, hunger, or to make plans, [see 8, 9], (α = .91)).

3. RESULTS

To investigate the effects of the factors *gender of robot voice*, *voice type* and *participant gender* on our dependent measures, we conducted 2 (*gender of robot voice*: male vs. female) x 2 (*voice type*: human-like vs. robot-like) x 2 (*participant gender*: male vs. female) multivariate analyses of variance (MANOVA).

For *HRI acceptance* we found a *gender of robot voice* x *participant gender* interaction, $F(1, 50) = 6.61$, $p = .02$. Subsequent t-tests revealed: In tendency, female participants accepted the female robot more ($M = 3.30$ $SD = 1.67$) than the male one ($M = 2.72$, $SD = 0.71$), $t(29) = 1.31$, $p = .20$. Similarly, male participants showed marginally greater acceptance of the male robot ($M = 3.41$, $SD = 1.44$) relative to the robot with a female voice ($M = 2.52$, $SD = 0.80$), $t(25) = -1.96$, $p = .06$. With regard to *psychological closeness* to the robot, the *gender of robot voice* x *participant gender* interaction was significant, $F(1, 50) = 5.56$, $p = .02$. Subsequent t-tests revealed that in tendency, female participants felt psychologically closer to the female robot ($M = 2.11$, $SD = 1.04$) than to the male robot ($M = 1.71$, $SD = 0.58$), $t(29) = 1.36$, $p = .19$. Likewise, male participants felt significantly more psychological closeness to the male ($M = 2.26$ $SD = 1.04$) than to the female robot ($M = 1.57$, $SD = 0.51$), $t(25) = -2.14$, $p = .04$. Regarding *anthropomorphism*, analyses revealed a significant three-way interaction, $F(1, 50) = 4.89$, $p = .03$. We thus conducted separate ANOVAs for *voice type*. For the human voice condition, we obtained a significant interaction of *gender of robot voice* and *participant gender*, $F(1, 29) = 9.00$, $p = .005$. That is, male and female participants both anthropomorphized the robot with the same-gender human voice more strongly compared to the robot with the opposite-gender human voice. However, for the robot with the robotic voice, no such effect was found.

4. DISCUSSION

The present research is the first that simultaneously tested effects of robot features (human-likeness and gender) and user characteristics on HRI acceptance and psychological anthropomorphism. This research goes beyond previous work on effects of vocal cues in robot systems, because we manipulated not only robot gender, but also its human-likeness by means of vocal cues. Furthermore, we took into account user gender and examined the interplay of these factors on novel dependent measures: As predicted, participants showed greater HRI acceptance and felt psychologically closer to the robot when robot and participants shared the same gender. Moreover, participants even anthropomorphized a system more strongly when it used a same-gender, but human-like voice. From our findings we conclude that projection of one's own attributes to the robot could be one important mechanism that underlies anthropomorphic and evaluative judgments about robots. Moreover, similarity between the robot and the user could be a key aspect that moderates these processes. However, in future work we need to test these assumptions more directly. In sum, our findings clearly point out that future research in social robotics shall take into account idiosyncratic features of both user and robot system in order to build and advance user-friendly, acceptable technological systems.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Reeves, B. and Nass, C. 1996. *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge University Press, New York, NY.

[2] Nass, C., Moon, Y. and Green, N. 1997. Are machines gender neutral? Gender-stereotypic responses to computers with voices. *Journal of Applied Social Psychology*, 27, 864-876.

[3] Eyssel, F. and Hegel, F. (in press). (S)he's got the look: Gender stereotyping of social robots. *Journal of Applied Social Psychology*.

[4] Crowell, C. R., Scheutz, M., Schermerhorn, P. and Villano, M. 2009. Gendered voice and robot entities: Perceptions and reactions of male and female subjects. In *Proceedings of the 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2009),* 3735-3741.

[5] Eyssel, F. and Kuchenbrandt, D. (in press). Social categorization of social robots: Anthropomorphism as a function of robot group membership. *British Journal of Social Psychology.*

[6] Kuchenbrandt, D., Eyssel, F., Bobinger, S. and Neufeld. M. 2011. Minimal group - maximal effect? Evaluation and anthropomorphization of the humanoid robot NAO. *Proceedings of the 3rd International Conference on Social Robotics,* 104-113.

[7] Hegel, F., Eyssel, F. and Wrede, B. 2010. The social robot Flobi: Key concepts of industrial design. In *Proceedings of the 19th IEEE International Symposium in Robot and Human Interactive Communication (RO-MAN 2010)*, 120-125.

[8] Eyssel, F., Kuchenbrandt, D. and Bobinger, S. 2011. Effects of anticipated human-robot interaction and predictability of robot behavior on perceptions of anthropomorphism. *Proceedings of the 6th ACM/IEEE Conference on Human-Robot Interaction*, 61-67.

[9] Gray, H. M., Gray, K. and Wegner, D. M. 2007. Dimensions of mind perception. *Science, 315*, 619.