Friend or Tool? Designing Robots

A study in the field of engineering psychology shows that human-like characteristics in robots do not always have a positive effect in human-robot interaction.

Why does a robot have two eyes, a mouth and a nose? Does it help if it speaks and moves like a human? This can have positive effects in social sectors, such as care. But a human-like robot can be ineffective or even have a negative impact in the industrial sector. Scientists from Technische Universität Berlin and Humboldt-Universität zu Berlin investigated the extent the use of human-like features encourages effective human-robot interaction. The results of this meta-analysis were published in the September issue of the journal “Science Robotics.” They paint a nuanced picture of the circumstances under which the anthropomorphic design of robots is beneficial.

“There is a widespread belief that a certain degree of anthropomorphism has a positive effect on how robots are perceived and how humans interact with them. But there are findings that suggest that these effects are not ubiquitous,” says Eileen Roesler, who holds an M.Sc. in psychology with a focus in human performance in socio-technical systems and is a teaching and research assistant at the TU Berlin Chair of Work, Engineering & Organizational Psychology. She is the lead author of the article “A meta-analysis on the effectiveness of anthropomorphism in human-robot interaction,” which she wrote with Professor Dr. Dietrich Manzey, head of the academic chair, and Professor Dr. Linda Onnasch from the Department of Psychology at Humboldt-Universität zu Berlin.

Effects of anthropomorphic design cannot be generalized – differences between social work, the service sector, and industry

These anthropomorphic design features can be implemented as part of the robot’s appearance, communication, movement and description. Previous findings suggesting that this anthropomorphization yields positive effects come mainly from the field of social robotics, i.e., a sector in which robots are used as social, interactive partners for people, for example in care or education.

However, the researchers’ own studies suggested that these effects cannot necessarily be generalized and that they do not affect all areas of human–robot interaction equally. Particularly with regard to the appearance and description of robots, the authors’ studies have shown, for example, that equipping robots with human-like characteristics in task-related and industrial fields can also have negative consequences. “In these scenarios, anthropomorphism can, for example, disguise the utilitarian character of robots and thus reduce the level of trust,” says Roesler. “Based on these independent experiments, some of which are in stark contrast to the current state of research in social robotics, we developed the idea and the specific questions behind the meta-analysis that has now been published.”

Studies with around 6000 test subjects evaluated – when does anthropomorphic design make sense?
The researchers evaluated over 4800 scientific articles for their investigation and were able to use 78 studies with a total of around 6000 test subjects to research under which circumstances anthropomorphic design can be effective, ineffective or even counterproductive.

“The results of the meta-analysis show that, across all individual studies, anthropomorphism has a positive effect on the perception, attitudes, and affective and behavioral reactions of people interacting with robots,” explains Professor Dietrich Manzey, who co-authored the study. “More specific sub-analyses of the data set, however, also show that anthropomorphic design in robots is by no means a universal means of promoting human-robot interaction.” For example, no evidence could be found of anthropomorphism having a positive effect on the perceived safety of robots and the performance of joint tasks that are particularly important in areas where robots are used as tools, for example in service or industry.

Aside from the consistently positive findings from the field of social robotics, the scientists were able to show that the overall picture is more nuanced, especially in areas where robots are used to complete collective tasks. According to their research, an improved perception of anthropomorphic robots – for example, as “intelligent” or “likable” – does not necessarily have to go hand in hand with an actual improvement in performance when collaborating with robots.

Approaches to human-centered robot design for further research and practitioners

The study shows that the way in which anthropomorphic elements are implemented also plays a key role. These features show positive effects most notably when they are designed in a way that makes the most possible sense in relation to the task – for example, an eye movement that signals what the robot is currently processing. “This is particularly interesting when it comes to designing robots for industrial applications and the service sector,” explains Roesler. “The importance of superficial anthropomorphization is seemingly still overestimated in these areas.”

According to the authors of the study, there are still significant gaps in the research here. Anthropomorphic design in robots is often seen as essential to increasing people’s trust in and acceptance of technical systems. However, the analysis shows a lack of empirical evidence supporting this assumption. “Our results show many starting points for scientists to further investigate human-robot interaction, especially from a psychological perspective,” says Roesler. “For practitioners and developers of robotic systems, however, findings can already be derived for the most human-centered design of robots, which also make it possible to implement anthropomorphic robotic system designs more strategically and effectively than before.”

The Chair of Work, Engineering & Organizational Psychology at TU Berlin

The Chair of Work, Engineering & Organizational Psychology deals with issues relating to how people can work more efficiently, safely and humanely in complex technical systems. This includes the areas of multitasking, aviation and space psychology, automation psychology, and human-robot interaction.

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The Science article on the study

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