Human–machine communication

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12. Human–Machine Communication

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Abstract

Humans increasingly communicate with machines, such as chatbots and social robots. This has given rise to the field of human–machine communication. Since the second half of the 2010s, ASCoR researchers have embraced research on human–machine communication and studied communicating machines both from a theoretical and an empirical perspective. This chapter first highlights selected theoretical contributions of ASCoR researchers to human–machine communication and then outlines insights gained by empirical studies on conversational agents, social robots, as well as artificial intelligence more generally. The chapter subsequently identifies key empirical and theoretical challenges encountered by ASCoR researchers and concludes with a brief outline of two important issues for future research.

Keywords: technology, artificial intelligence, chatbots, human–robot interaction, automation

Introduction

Communication research has traditionally focused on interpersonal, computer-mediated, and mass communication. All these types of communication deal with communication between at least two humans (Guzman, 2018). In recent years, however, machines have become sophisticated enough to engage in meaningful communication with humans (Hepp, 2020), not least because of groundbreaking developments in machine learning and artificial intelligence. Responding to a broader "non-human turn" in intellectual endeavours in the

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social sciences and humanities (Grusin, 2015), which gravitate away from a primary focus on exclusively human phenomena as research subjects, communication scholars have, therefore, started to embrace human–machine communication (HMC) as an additional field of research (Guzman & Lewis, 2020). In this context, researchers have not only started to study the processes and effects of HMC but have also developed theoretical frameworks to do so.

Roughly since the second half of the 2010s, researchers in the Amsterdam School of Communication Research (ASCoR) have also turned toward studying HMC, dealing with various types of communicating machines, such as conversational agents, social robots, as well as artificial intelligence more broadly. This chapter highlights and summarises selected theoretical underpinnings of this research; describes its empirical contributions to our understanding of HMC; and identifies important empirical and theoretical challenges encountered by ASCoR researchers and HMC scholars more broadly. The chapter concludes with a brief outline of two important issues for future research. In its focus on ASCoR research, the chapter mainly features studies by ASCoR researchers and thus represents the HMC literature selectively.

Theoretical and conceptual underpinning

As a nascent field of research, HMC research needs to demarcate itself from other fields and, at the same time, develop theoretical frameworks that guide its research. Based on earlier work (Gunkel, 2012; Guzman, 2018) and focusing on social robots, Peter and Kühne (2018), for example, have argued that the study of communicating machines, such as social robots, distinguishes human communication research from other fields in communication research in at least three ways: First, studying communicating machines questions traditional notions of the communication partner. Whereas communication research typically assumes that communication partners are human, HMC research explicitly posits that machines can be our communication partners and, by extension, that humans and machines can engage in interactions that are meaningful to the humans involved. Second, when we study how humans communicate with machines, we question long-standing notions of the medium. The medium is no longer the object that transmits a human-made message (as it is typical of mass communication), but becomes itself a subject with which humans communicate (see also Zhao, 2006). Third, according to Peter and Kühne (2018), the study of communicating machines forces us to reconsider the limits

of communication because the boundaries of HMC may no longer equal those of human–human communication. Machines may be, for example, superior to humans in how they process and retrieve information. This may inevitably change how we communicate—and what we define as the boundaries of communication. HMC may thus both challenge and extend how we think and conceptualise communication.

Several scholars have also called for the development of theoretical frameworks that focus on the specificities of human communication research (e.g., Fox & Gambino, 2021; Peter et al., 2019). An important step into this direction is the work on the "computers are social actors" (CASA) framework (Nass & Moon, 2000). This framework posits that if a "computer's cues are sufficient for humans to attribute humanness to it, we then mindlessly apply scripts from human–human interaction to the human–computer interaction" (Westerman et al., 2020, p. 396). Scholars, however, have criticised CASA for its anthropocentric bias (Gambino et al., 2020), and have extended its scope, for example, by specifying its propositions and generalising it to "media as social actors" (Lombard & Xu, 2021). In this context, van der Goot and Etzrodt (in press) have recently attempted to contextualise CASA theoretically. The authors contrast the original media equation paradigm, from which CASA developed (Reeves & Nass, 1996), with what they call, based on Turkle's (2007) work, the "media evocation paradigm." The media equation paradigm assumes that people equate media and machines with people if these media and machines provide social cues. As a result, people treat them mindlessly as if they were social actors (van der Goot & Etzrodt, in press). The media evocation paradigm, in contrast, proposes that media, and communicating machines, in particular, have an ambiguous ontological status somewhere between the animate and the inanimate and between thing and person. As a result, media and machines evoke mindful responses in which we rethink what a social actor is. In this view, machines are social actors to which/whom people respond socially (van der Goot & Etzrodt, in press). According to van der Goot and Etzrodt (in press), explicating the two paradigms more systematically may not only improve the rigor of theorising in HMC research, but also our understanding of social responses to machines.

Scholars have emphasised that research on HMC is often impaired by conceptual inconsistencies (e.g., Peter et al., 2019; van der Goot, 2022; van Straten, Peter, & Kühne, 2020). While some variation in the use of (the same) concepts may be understandable given the interdisciplinary roots of HMC research, it does reduce the comparability of studies and hampers cumulative research insights. Against this background, various researchers have started to clarify crucial concepts in HMC. Focusing on

anthropomorphism, Kühne and Peter (2023), for example, have argued that previous conceptualisations of the construct tended to conflate antecedents and consequences with defining dimensions of anthropomorphism, which renders the concept's scope and content fuzzy. As an alternative and based on a theory of mind framework, they suggest that anthropomorphism can be seen as "attributing thinking, feeling, perceiving, desiring, and choosing" to communicating machines, such as social robots (Kühne & Peter, 2023, p. 42). Next to clarifying widely used concepts, ASCoR scholars have also turned their attention to somewhat neglected concepts. Van der Goot (2022), for instance, has emphasised that a broader understanding of how people respond to communicating machines requires a stronger focus on source orientation, that is, whether people orient themselves toward the manifest machine as the source of communication or toward latent sources, such as algorithms or the producers of the machines.

Researchers have observed that conceptualisation problems not only affect the constructs with which they try to understand HMC but also the very objects they aim to study. Addressing unclarities in the definition of a rapidly spreading category of communicating machines—intelligent assistants like Amazon's Alexa of Microsoft's Cortana—Shaikh (2023) has reviewed their evolution and existing definitions and concluded that such assistants can only be labelled intelligent when they are powered by artificial intelligence, interact with users, and assist them in various tasks. Similarly, Peter et al. (2019) distinguished social robots from advanced toys according to whether (1) they feature sensors, software control, interactivity, movement, embodiment, and energy; (2) the extent to which each of these features is present; and (3) their need for connectivity to function.

Overall, HMC scholars have proactively dealt with the theoretical and conceptual problems that the study of communicating machines entails. Although the field has progressed, researchers are confronted with at least two challenges. First, the technologies that drive communicating machines, notably machine learning and artificial intelligence, develop rapidly and often unpredictably, as do the ways in which people use and understand these technologies. What scholars study—the technology, the user, and the interplay between both—is thus subject to permanent change. Second, communicating machines themselves present us with hitherto unasked questions, for example, about their ontological and moral status. Accordingly, people may lack adequate ways of verbalising what they encounter in HMC and scholars may lack theories and concepts of how to investigate it best (van der Goot & Etzrodt, in press). How scholars study HMC thus requires

theoretical and conceptual discussions that go beyond the field itself and require input from other disciplines, such as engineering and philosophy.

Empirical findings

As the number of communicating machines and their functionalities is increasing quickly, it remains difficult to single out the key lines of research in HMC. Two currently thriving research areas, however, centre on conversational agents and social robots. A third area deals with artificial intelligence more generally.

Conversational agents

A conversational agent can be defined as "any dialogue system that conducts natural language processing (NLP) and responds automatically using human language" (Griffing, 2022). When a conversational agent is disembodied, it can be text-based (i.e., chatbot) or voice-based (e.g., Siri). When a conversational agent is embodied, it can be graphically (i.e., on screens) or physically embodied (Griffing, 2022; see also Araujo, 2018). Researchers have predominantly dealt with disembodied conversational agents, typically in the form of chatbots (Følstad et al., 2021), focusing, for instance, on younger and older users (van der Goot & Pilgrim, 2020; Wald et al., 2023) as well as on political and commercial use contexts (Ischen et al., 2022; van der Goot et al., 2021; Zarouali et al., 2021).

While current research is diverse, three main lines permeate studies on conversational agents. A first line of research centres on the antecedents of the use of conversational agents. People's acceptance and use of a technology along with the question of what predicts it have been long-standing foci in technology research (Davis, 1989) and have also generated attention among researchers of conversational agents. In their survey-based research among families with small children, Wald et al. (2023), for example, found that the use of voice-based assistants is primarily hedonically motivated: Parents want to have fun when they use devices like Google Assistant with their children. In a teamwork setting, however, the use of voice-based assistants seems more functionally motivated. When under time pressure, teams use voice-based intelligent assistants more often than when they are not under time pressure, as Shaikh and Cruz (2022) showed in an experimental lab study.

The use of customer service chatbots is also mainly functional. Qualitative interview studies indicated that both older and younger people use such chatbots to receive answers to their queries in an easy and efficient manner (van der Goot & Pilgrim, 2020) and expect the interaction to be informative, fast, and friendly (van der Goot et al., 2021). The intended use of chatbots for sensitive purposes, such as mental health, finally, seems to be more complex. Based on an online survey among LGBTQIA+ individuals, Henkel et al. (2023) found that chatbot use is more likely when the chatbot is expected to perform well. In contrast, when people expect the chatbot to be difficult to use, they are less likely to use it. Characteristics such as an individual's willingness to self-disclose to a chatbot and the influence of significant others also increases the intention to use a chatbot (Henkel et al., 2023).

A second line of research on conversational agents investigates how they are experienced and perceived. Researchers often focus on concepts such as anthropomorphism, social presence, or interactivity, that are also theoretically important to other research on HMC. For instance, an online experiment comparing a chatbot and website unexpectedly found that the two did not differ in their perceived anthropomorphism and interactivity. The chatbot, however, was experienced as more enjoyable than the website (Ischen, Araujo, van Noort, et al., 2020). In another online experiment, a text-based chatbot was surprisingly seen as more human-like than a voice-based agent (Ischen et al., 2022). Not all text-based chatbots, however, perform equally: Araujo (2018) found in an experiment that a more human-like chatbot yielded higher levels of anthropomorphism than a machine-like chatbot. Interestingly, the effect on (mindless) anthropomorphism declined when the human-like chatbot was described as AI-powered. Social presence remained unaffected by the chatbot's human-like or machine-like character (Araujo, 2018). One explanation of the somewhat unexpected findings may be that users, at least of customer service chatbots, still seem to be frustrated by the limited functionality of chatbots (van der Goot et al., 2021; van der Goot & Pilgrim, 2020), which may affect the extent to which people experience them as human-like and socially present.

A third line of research on conversational agents deals with their effects. In a commercial context, a text-based chatbot was found to positively influence people's attitude toward a brand and their purchase intention because it was seen as more human-like than a voice-based agent (Ischen et al., 2022). Similarly, when people encountered a human-like chatbot rather than a machine-like chatbot, they disclosed more personal information and

adhered more to its recommendations because they perceived it as more human-like and had fewer privacy concerns with it. The results, however, were the same when compared to a website as another experiment showed (Ischen, Araujo, Voorveld, et al., 2020). In a news context, by contrast, a news chatbot was more persuasive than a website article. In an experimental study, people accepted a counter-attitudinal article more easily when the chatbot provided the information. They also considered the information more credible because they (mindlessly) anthropomorphised the chatbot more than the website (Zarouali et al., 2021).

Social robots

Research on social robots has only advanced in the past 20 years or so. As a young and interdisciplinary field, dominant lines of research have yet to emerge, but some topics have attracted considerable research attention. Largely based on Peter (2022), we sketch research on the acceptance of, and relationship formation with, social robots. In our focus on ASCoR research, we limit ourselves to research done among children.

Similar to research on conversational agents, the question of when users accept social robots has become more central in research as social robots have become more widely accessible. Research that studied children's acceptance of social robots by surveying them before or after interactions with social robots has shown that children look primarily for hedonic gratifications in social robots. For children, social robots seem to be an object of play while social and informational gratifications are less important (de Jong et al., 2019; de Jong et al., 2021). However, prior to interacting with them, children hardly know what to expect from social robots (de Jong et al., 2019). Instead, children's intention to accept a robot is largely associated with more stable predictors, notably their general attitude toward robots, hedonic attitudes, as well as injunctive and descriptive norms about robot use (de Jong et al., 2022). Although children's acceptance of social robots is initially very high, it decays quickly, with a sharp drop after two weeks of acquiring a robot. Many children alternate between using and not using a robot, largely because robots face the competition of other toys and devices in children's (digital) environment (de Jong, 2022, ch. 5).

Social robots can affect various learning outcomes in children (e.g., prosocial behaviour) (Peter et al., 2021). The emergence of child–robot relationships is seen as crucial in this context and has been studied in a series of experiments. For example, similar to interpersonal relationships,

child–robot relationships can be intensified when a robot asks a child questions. At the same time, a robot's self-disclosure reduced children's perceptions of the robot as being able to understand their feelings (van Straten et al., 2022). Likewise, when a robot specifically described itself, children perceived it as less similar to themselves (van Straten et al., 2021). Whereas self-disclosure and self-description are crucial to interpersonal relationships, neither affected the process of child–robot relationship formation itself. However, when children were informed about a robot's lack of human psychological abilities, either by a researcher or by a robot itself, child–robot relationship formation decreased (van Straten et al., 2023; van Straten, Peter, Kühne, et al., 2020), which supports calls for responsible robotics and ethics by design (see, e.g., de Pagter, 2023).

Artificial intelligence

Artificial intelligence (AI) largely drives the development of communicating machines and can be defined as "the study, understanding, and building of intelligent agents which can receive percepts from their environment(s), adapt, and act rationally, and make changes to their environments" (Shaikh, 2023, p. 784; see also de Vreese, 2024, this book). Given the far-reaching societal consequences of AI, ASCoR researchers have started to deal with people's attitudes toward AI. Based on a scenario-based survey experiment, Araujo et al. (2020), for instance, showed that people see risks in the use of AI in automated decision-making and doubt its fairness and usefulness. At the same time, people seem to evaluate automated decisions as equal to, or even better than, decisions by human experts. Using the same data, Helberger et al. (2020) found that automated decision-making is also considered as fairer than decisions taken by experts. To substantiate this judgement, people particularly rely on their assessment of the negative role of emotions in human decision-making and of the perceived objective (i.e., data-driven) character of automated decision-making, notably when it is correctly programmed (Helberger et al., 2020). Based on a content analysis of English-language media on the use of AI in the newsroom, Moran and Shaikh (2022) found opposing views among members of news organisations and journalists: News organisations see AI mostly as a cost-saving way of dealing with enormous amounts of information, which may enable journalist to do more substantive work. Journalists, in contrast, consider the products that AI generates to be of low quality and are worried about badly informed news consumers, while, simultaneously, they fear for their jobs.

Conclusion

All the research described in the previous sub-sections deals with advanced communicating machines or sophisticated technologies that rapidly change. ASCoR researchers have taken up this challenge and enriched our knowledge about antecedents of chatbot and robot acceptance and use; about people's perceptions of chatbots and social robots; and about the effects that chatbots and social robots have on issues as diverse as consumer behaviour, news reception, and relationship formation. We also start to recognise that people may have diverse, and even contradictory, attitudes toward technologies powered by AI.

At the same time, studying quickly changing communicating machines necessarily leads to "snapshot findings"—insights that are inevitably affected by the features and functionalities of a machine at a given point of time and, as a result, are often inconsistent and difficult to compare. While we understand, for example, that the acceptance and use of communicating machines depend, in their hedonic or functional orientation, on the context, we are still left with rather broad attitudes and norms as predictors of such acceptance and use. Similarly, although the importance of concepts such as social presence and notably anthropomorphism has been demonstrated repeatedly, it is still hard to pinpoint the exact features in communicating machines that increase or decrease them. Finally, compared to only a few years ago, we know now much more about the effects of conversational agents and social robots. However, many of these effects are based on the limited social abilities of these machines and we consequently lack insights into what communicating machines do with human sociality and human relationships more broadly. Overall, then, there is an urgent need for ongoing empirical research on HMC along with a keen eye on important technological developments.

Next steps: Development of a research infrastructure and an ethical framework

As research on HMC is still an emerging field, scholars have noted several problems in the field, ranging from methodological issues to theoretical challenges to cultural bias (e.g., Følstad et al., 2021; Peter et al., 2019). Partly in response to such current obstacles in the field, researchers have proposed avenues, or complete agendas, for future research on chatbots (Følstad et al., 2021), social robots (Peter & van Straten, in press), and AI and communication

(Guzman & Lewis, 2020; van der Goot & Etzrodt, in press). We agree with the suggestions that these researchers have made and support the turn toward more programmatic research on HMC. In this context, we believe that two basic aspects of HMC research deserve particular attention.

First, whenever communicating machines need to really act in studies (like in the studies on chatbots and social robots presented above), research is technologically demanding and resource intensive. We, therefore, need to establish research infrastructures that are easy to use and at the same time affordable. An example is the development of the Conversational Agent Research Toolkit (CART) (Araujo, 2020), with which researchers can rather easily create text-based chatbots for research. Research on social robots would also benefit from similar developments. Currently, researchers of social robots either rely on robots created in robotics institutes (e.g., Kaspar, University of Hertfordshire) or on commercially available, but often expensive robots (e.g., Nao, SoftBank). Findings, however, may depend heavily on the different types of robots used. A more homogenous infrastructure both in chatbot and social robot research may greatly advance the comparability of studies and the cumulative insights they generate.

Second, in the context of questions about the ontological status of communicating machines (van der Goot & Etzrodt, in press), researchers also face questions about the ethics of these machines and doing research with them. We, therefore, need an ethical framework that guides researchers, notably when we study machines or technologies that feature novel functionalities that may conflict with traditional ethical boundaries (e.g., advanced data collection or cognitive possibilities). Specifically, we need to focus on ethics by design and the challenge of how communicating machines can be designed such that they meet ethical principles (Følstad et al., 2021). Moreover, we need to consider more strongly potential privacy and security problems when using communicating machines in research, as well as when it is justified to deceive people about the features of communicating machines (Følstad et al., 2021; Peter & van Straten, in press; van der Goot, 2022).

As communicating machines become rapidly more advanced, communication researchers have started to chart this new field of research. ASCoR researchers have dealt with many of the technologies and developments and contributed to a better understanding of fundamental issues and pressing problems, both theoretically and empirically. With the progress in AI, the key driver of communicating machines, accelerating rather than slowing down, research on how humans and machines communicate with each other will become even more important in the future, not only within ASCoR, but also in communication research more broadly.

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