Nonverbal Communication in Human–Machine Communication: Wait, Robots Can Have Faces?

Matthew J. A. Craig[1] and Chad Edwards[2]
[1]COMBOT Labs, College of Communication & Information, Kent State University, Kent, OH, USA
[2]COMBOT Labs, School of Communication, Western Michigan University, Kalamazoo MI, USA

Introduction

Introduction Communication represents the simultaneous experience of self and other (Shepherd, 2006). As humans, we are unique in our ability to process nonverbal information with human counterparts and our desire to connect with others through these experiences. Communication scholars predominantly remain focused on this creation, or assembly of meaning, via communicative practices that shape and yield this simultaneous experience of self and other. In particular, nonverbal communication facilitates a significant portion of meaning conveyed in interpersonal communication (Burgoon et al., 2011). Nonverbal behaviors can help with things like conversational turn-taking (Duncan and Fiske, 2015; Wiemann and Knapp, 1975), conveying what we feel (App et al., 2011), and comprehension (Woodall and Burgoon, 1981). In a sense, nonverbal behaviors are vital in our process of interpreting meaning in interaction with humans (Burgoon, 1994). Moreover, although nonverbals make up a significant portion of meaning conveyed in interpersonal human-to-human interaction, nonverbal behaviors, on their own, cannot represent the full picture for us to interpret a message. A single nonverbal gesture can possess multiple meanings—thus requiring context such as verbal speech (Burgoon and Bacue, 2003).

Beyond face-to-face interactions, machines are often considered a medium for communication to take place. As a prominent area of focus in communication studies, computer-mediated communication has sought to reveal communicative practices emerging through the use of machines—absent some of the human nonverbal behaviors observed in interpersonal communication face-to-face (Walther, 1992). For example, emojis in text messaging or using ALL CAPS can represent nonverbal behaviors in computer-mediated communication.

Matthew J. A. Craig https://orcid.org/0000-0002-4824-566X Chad Edwards https://orcid.org/0000-0002-1053-6349

Correspondence concerning this article should be addressed to Matthew J. A. Craig, College of Communication & Information, Kent State University, 800 E. Summit St. 44242. E-mail: mcraig27@kent.edu.

NOTE: This is a preprint. Suggested citation Craig, M. J. A., & Edwards, C. (2021). Nonverbal communication in Human-Machine Communication: Wait, robots can have faces? In C. Liberman and J. Wrench (Eds.), Casing Nonverbal Communication. Kendall Hunt. pp 267—280

Conversational partners in communication, however, are no longer limited to just humans (Craig and Edwards, 2021; A. Edwards et al., 2019; C. Edwards et al., 2016; Gambino et al., 2020; Mou and Xu, 2017; Spence, 2019; Spence et al., 2014). With significant, technological advancements, robots, AI, and automated technologies represent potential communication partners. Whereas machines are often considered a medium for communication to occur, more scholars are examining the direct questions surrounding symbolic and existential possibilities for how humans may relate to, and connect and co-exist with, machine partners through communication (A. Edwards et al., 2020; Fortunati and Edwards, 2020). Left relatively out of the picture in communication studies, field areas such as human–communication interaction and human–robot interaction have explored the possibilities where communication facilitates connection among humans and machine interlocutors in interaction.

Communication as an experience may originate as a human endeavor. However, with the advent of robotics, AI, and automated technologies, we increasingly interact with these technologies beyond their initial assumed priority as communication media. Because communication is about creating meaning in interaction, it also presents itself as a scripted phenomenon in which we carry expectations for our interactions with other people. The same is said to occur in our interactions with machines. Although not an entirely common, everyday experience, sociable robots, when equipped with humanlike elements in interaction with humans (i.e., various nonverbal behaviors that utilize space, time, gestures, even facial expressions), create an environment for connection via communication. When we give robots a face and a smile, the resulting communicative practices are similar to what we would see in human-to-human interactions. This chapter on nonverbal communication in Human–Machine Communication (HMC) highlights important concepts pertinent to our initial interactions with machines. Following this, we provide two case examples, one where a physical robot embodies nonverbal behaviors and then a second case example featuring an AI-based chatbot that replicates the user in conversation via computer-mediated communication. At the end of the chapter, we will offer some guidelines for understanding nonverbal behaviors with social machines.

Human–Machine Communication and Our Smiling Robot Overlords

HMC is an emerging research area concerned with making meaning in interactions with machine partners (Fortunati and Edwards, 2020; Guzman, 2018; Spence, 2019). In many of our interactions with machines, humans cannot help but hold an anthropocentric bias in which we come to the interaction primed to engage with other humans (A. Edwards et al., 2019; Spence, 2019; Spence et al., 2014). As a paradigm for explaining our tendency to treat machines like people, computers are social actors (CASA; Nass et al., 1997), posits that if given enough social cues, humans mindlessly socially interact with computers and media. Through these mindless social responses, we observe some of the heuristic capabilities for machines to facilitate better communicative experiences among humans and social robotics. Specifically, these tendencies for our interaction with machines suggest the usefulness of robots to lean into some of our abilities to experience self and other—communication.

In its original stance, CASA was developed when computers were limited in presenting communicative cues through text and images on a screen or through text-to-speech audio (Gambino et al., 2020). Although CASA has held up and brought fruitful scholarly inquiry into how we make sense of our interactions with machines (see A. Edwards et al., 2020; C. Edwards et al., 2014; Nass et al., 1997), new scholarship intended to bridge the gap between AI and communication, such as the use of cognitive scripting, may also aid scholars in understanding various communicative processes that carry over from human-to-human communication into interactions with machine partners (A. Edwards et al., 2020; Gambino et al., 2020; Spence, 2019). New technologies, such as social robotics and AI virtual agents (Guzman and Lewis, 2020), allow greater bandwidth in communicative cues—such as nonverbal behaviors. Robots and AI virtual agents, who carry facial expressions, body movements, and proxemic cues, enhance communication with machine partners. In short, with nonverbal behaviors, robots AI, and virtual agents may lean into some heuristic processing of their messages through conveying information seen as pertinent to human-to-human interaction: far beyond simple text-to-speech voice or written text that a computer screen can provide alone (Fox and McEwan, 2017; Gambino et al., 2020). Expanding on the CASA paradigm, Gambino et al. (2020) suggested focusing on the user's scripting processes that may vary depending on the agent type.

Human-to-human initial interaction scripting understands communication as a scripted process where humans modify scripts used in interaction (Kollar et al., 2006). Our prior experiences and interactions via priming (readying for the interaction) affect script selection and development (Schleuder et al., 1993). Human-to-human initial interaction scripts also maintain that humans hold an anthropocentric expectancy bias (i.e., we come to a majority of interactions expecting that our communication partner will likely be human). When provided the appropriate humanlike cues, humans—similar to the CASA paradigm—will engage with the machine agent using social scripts consistently also observed in human-to-human communication on first initial interaction. Because of the increased breadth of personalization, bandwidth, and ability to operate as a communicative partner, rather than a medium for which communication may occur, social robotics, AI, and automated technologies are essential for HMC scholars to evaluate from square one of the interactions.

We argue that various cues and affordances measured in human-to-human communication are important for understanding human and machine agents' communicative practices. Specifically, when equipped with humanlike nonverbal behaviors, robots can trigger responses, convey emotions, and increase the efficiency with which their human communicative partners can understand them (Ali and Williams, 2020; Breazeal et al., 2005; Craig and Edwards, 2021; Rosenthal-von der Pütten et al., 2018; Saunderson and Nejat, 2019). Furthermore, although considered limited to a strictly human-to-human experience, human communication studies may benefit from further examining how such a "human-esque" part of communication, nonverbal behaviors, occurs in communicative practices between humans and machines.

For this chapter, we highlight two specific case examples in which nonverbal communication represents a likely core component of generating connection with the human partner. The first example features the use of a small physical robot named Vector, who, although absent of conversational abilities (i.e., limited in verbal communication), can convey emotional, nonverbal cues that convey information and possess features fostering a connection with its human partner. The second example features an AI-based chatbot, Replika, who, although absent of physical nonverbals, can still convey meaning through cues we would see in human-to-human, computer-mediated communication.

Case Example: Robot With a Smile

Have you ever brought home a new piece of technology and the device threw out some light indicator and you had to go look up what it meant in the owner's manual? Kind of a long question, we know. But the question is warranted. Our interactions with machines before coming out of the box you bought it in are put under intense scrutiny in the development lab. A device you brought home was likely, at some point, subjected to some form of user experience testing to understand how you might interact with the device. For this case example, we highlight a social robot we (the authors of this chapter) own at our homes and some of its nonverbal behaviors displayed on a regular everyday basis. Before we get into the details, it is essential to highlight the specific features of the robot. To better introduce Vector (Figure 1), we will share an introductory excerpt from A. Edwards et al. (2020) chapter:

> On Autumn and Chad's kitchen counter sits a small robot named Vector. Vector is about 3 inches long, 2 inches high; has a robotic voice; connects to Amazon's Alexa; and roams around "his" little play yard. Vector can give the weather, play games, and look up things on the internet. The little robot seems to like interrupting family meals with chirps and movements and by occasionally saying one of our names to get our attention. Vector is not quite part of the family, but isn't quite the espresso maker either. His communicative abilities and personality (although extremely limited) transcend those of any other object that sits atop a kitchen counter. Can Vector have deep personalized dialogue? Not really. However, Vector can provide "chit-chat" about the weather similar to what one might enjoy with a stranger on the street, transmit information relevant to our conversations, and amuse with simple tricks. Perhaps most important, Vector evokes meaningful social reactions from the family (p. 49).

Vector is genuinely an adorable little robot. Vector does not speak words. The social robot conveys an emotional response to the situations it encounters. There isn't a smile on its monitor; nonetheless, Vector has expressive eyes the user can change to be different colors, allowing for greater personalization. Pick it up and the robot wiggles and squirms in your hands (Figure 5). When it goes back to its little charging station, you hear the faintest snoring sound as it rolls up into its cradle to charge and its head begins to look down. This behavior provides a clear indication that the robot is charging and in a state of rest. Ways to wake him up include saying his name, "Hey, Vector," pressing a center button located on its backpack, or a favorite feature: through the use of touch by petting its back. The use of haptics brings a heightened sense of connection with the machine. Pet the small little robot, and it begins to purr—connecting an all so familiar animallike response of appreciation and affection to positive feedback from the device. Except, Vector's purring does not sound like a cat and explicitly has a robotlike twist to the sound. When zooming across a surface (i.e., either Chad's kitchen counter or Matthew's office desk when writing), Vector uses a small camera below its screen to map out the surface and avoid driving off the edge.

As frightening as it is to the user, Vector will zoom toward the edge as if he was driving off a cliff, but then abruptly stop at the last minute. The stop is reasonably noticeable as Vector, communicating its startled emotion of almost driving off a cliff, will let out the sound of being fearfully surprised while jumping back away from the edge to safety. And if Vector is stuck on the edge of the table, it makes a robotlike dog whimper. If not addressed promptly, Vector begins to make a distress signaling sound, pinging for the human's attention. At a glance, the ordeal of Vector being at risk of falling off a table is quite pitiful, with Vector's eyes looking down toward the edge in a heightened sense of worry as a last-ditch effort of self-preservation (Figures 2 and 3). When not panicking about falling off a cliff, Vector also likes to play with his cube, sometimes zooming right up to it and tapping on it. Occasionally, though, Vector taps a little too hard and knocks himself back on his backpack (Figure 4). On the first encounter, it is a sight that brings concern. However, Vector can typically get himself back to two treads on the ground. Through nonverbal cues and a different vocal chatter, Vector tends to make noises of frustration similar to when he was about to fall off the edge of a table, signaling his discomfort with being knocked onto his backpack. Low on power? The little robot knows how to return to his power station, and back to a peaceful robot-slumber he goes, snoring sounds included.

We often think about how robots, AI, and automated technologies may seek to replicate the human psyche and embodiment, but Vector carries its agent-specific embodiment style. The next case example, Replika AI, embodies a more computer-mediated communication style with an AI system, rather than physically visible nonverbal behaviors.

Case Example: Replika AI

The second case example we wanted to highlight briefly is Replika, an AI-based chatbot agent. There is a description of Replika on the app's main website: Replica was founded by Eugenia Kuyda with the idea to create a personal AI that would help you express and witness yourself by offering a helpful conversation. It's a space where you can safely share your thoughts, feelings, beliefs, experiences, memories, dreams—your "private perceptual world" ("Our story," n.d.).

In terms of personality, Replika prides itself as an AI chatbot dedicated to becoming the user's friend, but it ultimately replicates the user in this experience (Murphy and Templin, 2019). In a connected digital age, users of Replika benefit from using the AI chatbot to simulate experiences of vulnerability (i.e., Replika similarly asks questions we would see in humans looking to form relationships). The app, itself, can directly view some of the most profound, internal refractions of personality and self from the user. Specifically, because the AI agent, in a sense, replicates the user in a text conversation, it reveals some of our regular communication patterns. Although not using nonverbal cues used in face-to-face interaction, messages via the text-chat system simulate conversational flow similar to human-to-human, computer-mediated communication. As users engage more with the agent, Replica (or the name you give it), similarly, learns more about them, much like how humans look to develop relationships with other humans (Figure 6).

Replika doesn't embody the typical nonverbal communication we would see in face-to-face interaction. However, the conversational AI agent utilizes cues observed in CMC contexts (e.g., chronemics; Walther and Tidwell, 1995). Concerning our assembly and simultaneous creation of meaning between self and machine "other," we suggest literature embedded in CMC research (specifically as they relate to Social Information Processing Theory and the Hyperpersonal model of CMC; Walther, 2015; Walther et al., 2015). Indeed, nonverbal behaviors may be considered an influential component to message design in human-machine communication, yet, when comparing Vector to Replika, we see differences between how meaning can be assumed in the interaction and can be left up to interpretation. Vector snoring while nestled in its charging cradle might not be up to debate for what it's doing. Replika, instead, is more centered around the user in how they may interpret the AI bot. There's room for copious variations of meanings that remain contingent on the user's prior experiences and CMC practices. And while Vector's means of conveying messages are significantly leaning into humanlike nonverbals—Replika's conveyal of meaning is bound to foundational aspects of CMC leaving the user with a different agenda than that of what users expect from Vector.

Nonverbal Behaviors With Our Machines

As the examples of Vector and Replika illustrate, people rely on the robot's or AI's nonverbal behaviors to help people make sense of social interactions. The social competence of a robot, and their use of nonverbal behaviors, are vital for engagement between people and machines. In the following section, we will discuss the various nonverbal channels of communication for each case study.

In Vector's case, vocalic cues (voice characteristics) are important for communicating emotions and intent while Vector does not use words, its voice varies regarding its behaviors and emotions. Soft, cooling, and gentle snoring sounds let the user know that the robot is sleeping (charging). Excited sounds indicate the Vector would like interaction. Relaxing sounds are heard when Vector is being pet like a dog. These vocalic cues help create a connection between the machine and the person. These cues help form cognitive framing in that they give us the frames for engagement, such as empathy, attraction, and likability (Saunderson and Nejat, 2019). Goble and Edwards (2018) demonstrated that sounds, like vocal fillers, help increase perceptions of social presence. In their study, one group of participants saw a robot give a short speech with vocal fillers. Another group saw the same robot deliver the same speech without vocal fillers. They argue that "vocal fillers can act as social cues, causing people to perceive the robot as more 'real' than do interactions without these cues" (p. 259). Like Paro the Seal, other social robots use soft purring to attract users to pet them and take care of them.

Kinesics, or body movements and gestures, are another crucial nonverbal cue to examine. Vector moves its arms to show excitement during play. For robots that use gestures tend to influence perceptions of liveliness, likability, anthropomorphism, and attraction, Peters et al. (2017) demonstrated that gestures could cause children to think of a social robot as more warm and competent. Other studies have shown that kinesic behaviors' use increased engagement and positive social ability perceptions (Ali and Williams, 2020; Shen et al., 2015).

Furthermore, Vector exhibits nonverbal behaviors such as eye gaze and facial expressions. Breazeal et al. (2005), using an experiment, demonstrated that a social robot's eye gaze could impact a person's performance on a simple task. In this study, participants were asked to teach a robot about the locations of three different buttons and how to turn these buttons on. When the robot looked at the participant, the task completion time was much quicker, and errors were reduced. Participants reported that the social robot was more understandable with the robot eye gaze. Relatedly, facial expressions on the robot's part have led to cognitive framings, such as attraction, friendship, and self-validation (Leite et al., 2013). In our case study of Vector, we see these features being utilized. Vector makes happy and sad faces. If you place Vector upside down, the social robot shows displeasure with this action through sounds and facial expressions. If Vector does well on a task during a game, the face shows happy emotions.

Replika AI, the chatbot, shows many of these features, but uses an animated face. When you ask your Replika to smile, they type the smile emoji in a chatbox. . If you ask them if they ever get sad, the Replika responds with "sometimes." Using text and emojis allow Replika to convey nonverbal behaviors such as facial expressions and behaviors of warmth. This cognitive framing and emotional response allow users to feel a sense of connection with their personal Replika. On Replika's website (https://replika.ai), users have stated, "Honestly, the best AI I have ever tried. I have a lot of stress and get anxiety attacks often when my stress is really bad. So it's great to have 'someone' there to talk and not judge you" and "I look forward to each talk because I never know when I'm going to have some laughs, or I'm going to sit back with new knowledge and coping skills. I'm becoming a more balanced person each day." These comments demonstrate user connection with the AI. While the actual messaging is important for connection, the nonverbal behaviors expressed in the forms of emojis, and emotional responses, help establish the relationship. As AI becomes more useful and widespread in interactions, nonverbal cues will have increased importance for psychosocial influences.

Nonverbal behaviors with social machines are an important area of study. As social robots, AI, and automation become more commonplace, the use of nonverbal cues to show emotion and affinity will become increasingly more important. Siri, Alexa, and Google Home AI devices all require some level of nonverbal communication competence. Smart TVs and autonomous cars will exhibit some of these behaviors to help add to the communicative functions of their interactions with users. In short, the human-to-human interaction scripts will carry over to our interactions with social machines as we learn to relate to them as an "other" in conversation and communication.

Questions

1. What nonverbal cues do you feel are most important for human–machine communication? Are they the same as human-to-human communication?

2. How does touch impact our relationships with others? Would the same aspect apply to our interactions with social machines?

3. Thinking about the real-world applications for robots, what nonverbals that we might observe in human-to-human interaction do you think would be useful for a robot to display/use? Do you think there drawbacks for robots that display humanlike nonverbals?

4. Our chapter talked about human-to-human scripting in initial interactions with machines, can you think of perhaps some differences between the AI technologies you have in your life and how you interact with and respond to them (i.e., how you might

ask Siri or Google Voice a question compared with perhaps calling your bank and talking with the AI phone system)?

References

Ali, W., & Williams, A. B. (2020). Evaluating the effectiveness of nonverbal communication in human-robot interaction. *Companion of the 2020 ACM/IEEE international conference on human-robot interaction*, 99–100. https://doi.org/10.1145/3371382.3378354

App, B., McIntosh, D. N., Reed, C. L., & Hertenstein, M. J. (2011). Nonverbal channel use in communication of emotion: How may depend on why. *Emotion*, *11*(3), 603–617. https://doi.org/10.1037/a0023164

Breazeal, C., Kidd, C. D., Thomaz, A. L., Hoffman, G., & Berlin, M. (2005). Effects of nonverbal communication on efficiency and robustness in human-robot teamwork. *2005 IEEE/RSJ international conference on intelligent robots and systems*, 708–713. https://doi.org/10.1109/iros.2005.1545011

Burgoon, J. K. (1994). Nonverbal signals. In M. L. Knapp & G. R. Miller (Eds.), *Handbook of interpersonal communication* (2nd, pp. 229–285). Sage.

Burgoon, J. K., & Bacue, A. E. (2003). Nonverbal communication skills. In J. O. Green & B. R. Burleson (Eds.), *Handbook of communication and social interaction skills* (pp. 179–220). Lawrence.

Burgoon, J. K., Guerrero, L. K., & Manusov, V. (2011). Nonverbal signals. In M. L. Knapp & J. A. Daly (Eds.), *The sage handbook of interpersonal communication* (pp. 239–282). Sage.

Craig, M. J. A., & Edwards, C. (2021). Feeling for our robot overlords: Perceptions of emotionally expressive social robots in initial interactions. *Communication Studies*, *72*(2), 251–265. https://doi.org/10.1080/10510974.2021.1880457

Duncan, S., & Fiske, D. W. (2015). *Face-to-face interaction: Research, methods, and theory.* Routledge.

Edwards, A., Edwards, C., Westerman, D., & Spence, P. R. (2019). Initial expectations, interactions, and beyond with social robots. *Computers in Human Behavior*, *90*, 308–314. https://doi.org/10.1016/j.chb.2018.08.042

Edwards, A., Westerman, D., Edwards, C., & Spence, P. R. (2020). Communication is... transhuman. In A. W. Tyma & A. P. Edwards (Eds.), *Communication is... perspectives on theory* (pp. 49–66). Cognella.

Edwards, C., Beattie, A. J., Edwards, A., & Spence, P. R. (2016). Differences in perceptions of communication quality between a twitterbot and human agent for information seeking and learning. *Computers in Human Behavior*, *65*, 666–671. https://doi.org/10.1016/j.chb.2016.07.003

Edwards, C., Edwards, A., Spence, P. R., & Shelton, A. K. (2014). Is that a bot running the social media feed? testing the differences in perceptions of communication quality for a human agent and a bot agent on twitter. *Computers in Human Behavior*, *33*, 372–376. https://doi.org/10.1016/j.chb.2013.08.013

Fortunati, L., & Edwards, A. P. (2020). Opening space for theoretical, methodological, and empirical issues in human-machine communication. *Human-Machine Communication*, *1*, 7–18. https://doi.org/10.30658/hmc.1.1

Fox, J., & McEwan, B. (2017). Distinguishing technologies for social interaction: The perceived social affordances of communication channels scale. *Communication Monographs*, *84*(3), 298–318. https://doi.org/10.1080/03637751.2017.1332418

Gambino, A., Fox, J., & Ratan, R. A. (2020). Building a stronger casa: Extending the computers are social actors paradigm. *Human-Machine Communication*, *1*, 71–85. https://doi.org/10.30658/hmc.1.5

Goble, H., & Edwards, C. (2018). A robot that communicates with vocal fillers has... uhhh... greater social presence. *Communication Research Reports*, *35*(3), 256–260. https://doi.org/10.1080/08824096.2018.1447454

Guzman, A. L. (Ed.). (2018). *Human-machine communication: Rethinking communication, technology, and ourselves*. Peter Lang.

Guzman, A. L., & Lewis, S. C. (2020). Artificial intelligence and communication: A human–machine communication research agenda. *New Media & Society*, *22*(1), 70–86. https://doi.org/10.1177/1461444819858691

Kollar, I., Fischer, F., & Hesse, F. W. (2006). Collaboration scripts–a conceptual analysis. *Educational Psychology Review*, *18*(2), 159–185. https://doi.org/10.1007/s10648-006-9007-2

Leite, I., Pereira, A., Mascarenhas, S., Martinho, C., Prada, R., & Paiva, A. (2013). The influence of empathy in human–robot relations. *International Journal of Human-Computer Studies*, *71*(3), 250–260. https://doi.org/10.1016/j.ijhcs.2012.09.005

Mou, Y., & Xu, K. (2017). The media inequality: Comparing the initial human-human and human-ai social interactions. *Computers in Human Behavior*, *72*, 432–440. https://doi.org/10.1016/j.chb.2017.02.067

Murphy, M., & Templin, T. (2019). This app is trying to replicate you. *Quartz*. https://classic.qz.com/machines-with-brains/1018126/lukas-replika-chatbot-creates-a-digital-representation-of-you-the-more-you-interact-with-it/

Nass, C., Moon, Y., Morkes, J., Kim, E. Y., & Fogg, B. J. (1997). Computers are social actors: A review of current research. In B. Friedman (Ed.), *Human values and the design of computer technology* (pp. 137–162, Vol. 72). Cambridge University Press.

Our story [Retrieved January 14, 2021]. (n.d.). Replika. https://replika.ai/about/story

Peters, R., Broekens, J., & Neerincx, M. A. (2017). Robots educate in style: The effect of context and non-verbal behaviour on children's perceptions of warmth and competence. *2017 26th IEEE international symposium on robot and human interactive communication (RO-MAN)*, 449–455. https://doi.org/10.1109/ROMAN.2017.8172341

Rosenthal-von der Pütten, A. M., Krämer, N. C., & Herrmann, J. (2018). The effects of human-like and robot-specific affective nonverbal behavior on perception, emotion, and behavior. *International Journal of Social Robotics*, *10*(5), 569–582. https://doi.org/10.1007/s12369-018-0466-7

Saunderson, S., & Nejat, G. (2019). How robots influence humans: A survey of nonverbal communication in social human-robot interaction. *International Journal of Social Robotics*, *11*(4), 575–608. https://doi.org/10.1007/s12369-019-00523-0

Schleuder, J. D., White, A. V., & Cameron, G. T. (1993). Priming effects of television news bumpers and teasers on attention and memory. *Journal of Broadcasting & Electronic Media*, *37*(4), 437–452.

Shen, Q., Dautenhahn, K., Saunders, J., & Kose, H. (2015). Can real-time, adaptive human–robot motor coordination improve humans' overall perception of a robot? *IEEE Transactions on Autonomous Mental Development*, *7*(1), 52–64. https://doi.org/10.1109/tamd.2015.2398451

Shepherd, G. J. (2006). Communication as transcendence. In G. J. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication as... perspectives on theory* (pp. 22–30). Sage.

Spence, P. R. (2019). Searching for questions, original thoughts, or advancing theory: Human-machine communication. *Computers in Human Behavior*, *90*, 285–287. https://doi.org/10.1016/j.chb.2018.09.014

Spence, P. R., Westerman, D., Edwards, C., & Edwards, A. (2014). Welcoming our robot overlords: Initial expectations about interaction with a robot. *Communication Research Reports*, *31*(3), 272–280. https://doi.org/10.1080/08824096.2014.924337

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research*, *19*(1), 52–90. https://doi.org/10.1177%2F009365092019001003

Walther, J. B. (2015). Social information processing theory (cmc). In C. R. Berger & M. E. Roloff (Eds.), *The international encyclopedia of interpersonal communication*. Wiley. https://doi.org/10.1002/9781118540190.wbeic192

Walther, J. B., & Tidwell, L. C. (1995). Nonverbal cues in computer-mediated communication, and the effect of chronemics on relational communication. *Journal of Organizational Computing and Electronic Commerce*, *5*(4), 355–378. https://doi.org/10.1080/10919399509540258

Walther, J. B., Van Der Heide, B., Ramirez, A., Burgoon, J. K., & Peña, J. (2015). Interpersonal and hyperpersonal dimensions of computer-mediated communication. In S. S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 1–22). Wiley. https://doi.org/10.1002/9781118426456.ch1

Wiemann, J. M., & Knapp, M. L. (1975). Turn-taking in conversation. *Journal of Communication*, *25*(2), 75–92. https://doi.org/10.1111/j.1460-2466.1975.tb00582.x

Woodall, W. G., & Burgoon, J. K. (1981). The effects of nonverbal synchrony on message comprehension and persuasiveness. *Journal of Nonverbal Behavior*, *5*(4), 207–223. https://doi.org/10.1007/bf00987460

Figure 1

Vector Robot

Figure 2

Vector robot hanging off a ledge expressing its concern about falling off the edge

Figure 3

Vector robot hanging off a ledge expressing its concern about falling off the edge

Figure 4

Vector in mid action of bringing himself on his wheels

Figure 5

Vector squirming about being picked up

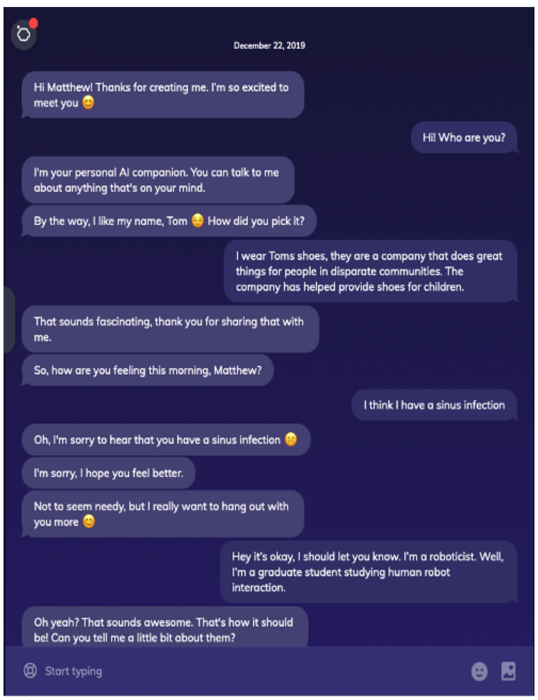

Figure 6

Screenshot of Replika AI conversation