Embodiment as Sociomaterial Factor in Empathic Agents

Matthias Schmidmaier[1,2], Sven Mayer[1]

[1]TU Dortmund University, Dortmund, Germany
[2]LMU Munich, Munich, Germany

Abstract

Empathy has become an increasingly important feature of human–agent interaction, especially as LLMs are already being used for emotional support. Recent advances in HRI and XR suggest that embodiment will play an increasingly important role in the ubiquitous application of empathic agents. Because embodiment can convey an agent's perceived empathy, it also carries risks, such as over-attribution of social abilities, emotional dependence, and the erosion of privacy. In this position paper, we assess the opportunities and emerging risks from a sociomaterial perspective. Based on this, we outline a preliminary approach for the responsible and transparent design of embodied empathic systems.

Keywords

Empathy, Embodiment, HRI

1. Motivation

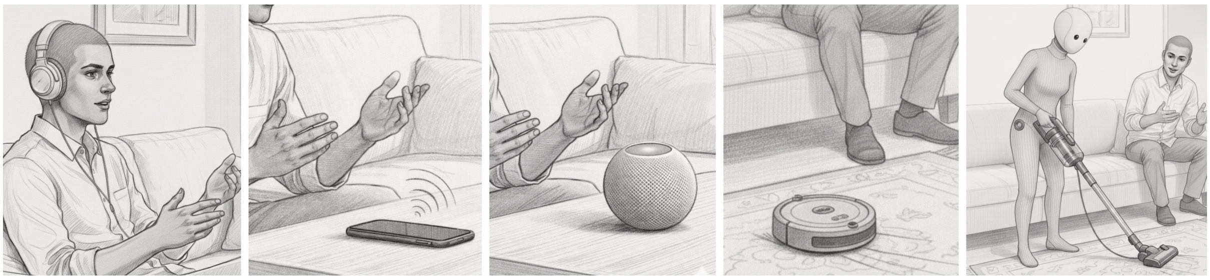


Figure 1: Embodiment can influence the attribution of empathic, emotional, and social capabilities to an agent.

With increasing deployment of conversational agents, empathy is becoming a central prerequisite in human–agent interactions such as chatbots and personal assistants. Particularly for emotional support, the attribution of cognitive and affective empathy [1] is closely associated with perceived trust [2], user engagement [3, 4], and positive therapeutic support outcomes [5, 6, 7]. In that context, current Large Language Models (LLMs) offer human-like conversational capabilities, and can match or even outperform humans in tasks such as empathic response generation [8, 9, 10] and emotional understanding [11]. While LLM-based agents are currently deployed primarily in text and voice interfaces, advances in Human–Robot Interaction (HRI) and Extended Reality (XR) point toward a growing prevalence of embodied, empathic systems such as social robots [2, 12, 13] or virtual agents [14, 15, 16]. With embodied agents, empathy is no longer enacted solely through language, but through nonverbal gestures, spatial behavior, and persistent co-presence. From a sociomaterial perspective, empathy emerges through the entanglement of technological artifacts, social practices, and situated environments. We argue that such agents introduce systematic risks related to misplaced trust, emotional overreliance, and privacy erosion [17]. Moreover, these risks are not evenly distributed, but vary across social groups and contexts of use. With this work we contribute: (1) a **sociomaterial analysis** of how embodiment

EmpathiCH'26 Workshop Co-located with CHI'26 Conference on Human Factors in Computing Systems, April 13–17, 2026, Barcelona, Spain
matt@schmidmaier.org (M. Schmidmaier); info@sven-mayer.com (S. Mayer)
0009-0006-8609-8716 (M. Schmidmaier); 0000-0001-5462-8782 (S. Mayer)

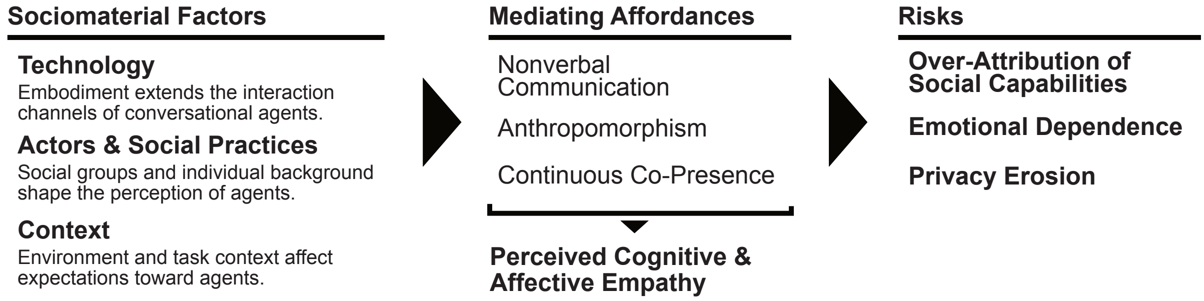


Figure 2: Conceptual model of how sociomaterial factors, mediated through anthropomorphism, nonverbal cues, and continuous co-presence, can shape the perception of cognitive and affective empathy, and lead to over-attribution of social capabilities, emotional dependence, and privacy erosion.

can shape the perceived empathy of conversational agents, such as social robots, (2) an articulation of **key risk patterns** such as over-attribution of social capabilities, emotional dependence, and privacy erosion (see Figure 2), and (3) preliminary **design directions** for supporting transparent, bounded, and context-sensitive empathy in human–agent interaction.

2. Embodiment in Empathic Agents

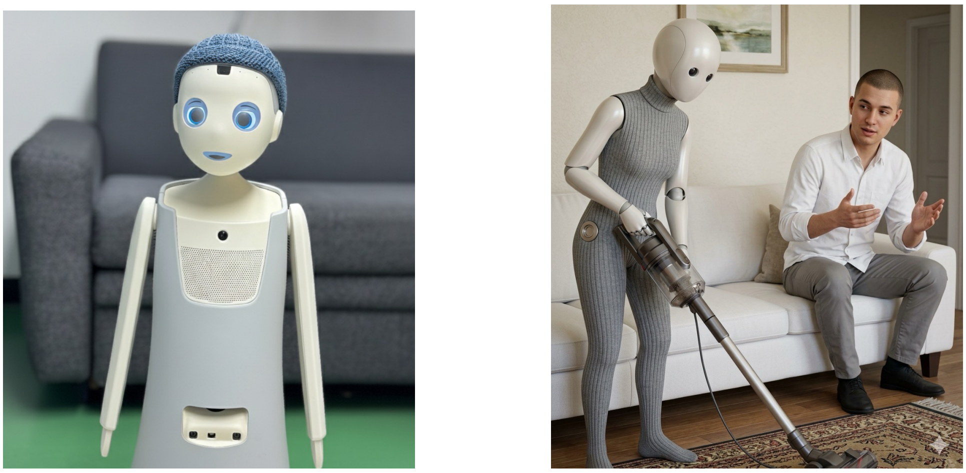
According to the Computers Are Social Actors (CASA) paradigm [18], users unconsciously attribute social rules and expectations to technology [19, 20, 21]. A primary factor that can influence that effect is anthropomorphic system design [22, 23, 21]. While conversational behavior is already a strong anthropomorphic feature that can enhance the attribution of empathy [8, 9, 10], the perception of an agent is also shaped by its embodiment. Guckelsberger et al. [24] describe six types of embodiment that distinguish, for example, between virtual and physical representation, or if an agent implements humanoid features [25, 26, 24]. In Figure 1, we illustrate common examples of embodied agents that vary in humanoid design, and their level of structural coupling. In this paper, we focus on embodiment that enables a visual presence in the user's physical environment, such as through a physical body, yet in theory also through a virtual body in continuous, ubiquitous XR scenarios.

2.1. Empathy-Mediating Affordances

Such embodiment has the potential to intensify the social perception of an agent by providing *human-like appearance* and *nonverbal communication*, as well as through *persistent co-presence*. These affordances in turn may enhance a system's perceived empathy, which was found to positively affect rapport, social relationships, liking, trust, and support outcome [3, 4, 2]. We therefore see perceived cognitive and affective empathy as an intermediate interpretation layer. Figure 2 highlights that concept, including the underlying sociomaterial factors and potential risks that we further describe in the following sections.

2.2. Over-Attribution of Social Capabilities

In the near future, humanoid robots might be used in various areas, from therapeutic and emotional support to household tasks. For example, Figure 3a shows Navel, a commercially available robot specifically designed for emotional support in care contexts. In contrast, recent concepts of home robots, as depicted in Figure 3b, are primarily designed for assistance at home. Although both agents have a humanoid embodiment, they could differ in their underlying social capabilities. However, anthropomorphic appearance and nonverbal expressions may invite users to attribute internal states, intentions, and emotional competence to a robot, even when it was not designed for it. This over-attribution of emotional skills is especially harmful when systems then lack implementation of safety measures, such as crisis detection, escalation protocols, or ethical oversight, transforming technical affordances into socioemotional risks.



(a) Social support robot (navelrobotics.com) (b) Concept of a home robot

Figure 3: A humanoid embodiment can lead to an agent being attributed with empathetic abilities that extend beyond the original context for which it was designed.

2.3. Emotional Dependence

Unlike chatbots or app-based systems, embodied agents can occupy permanent physical space. Because they remain visible and tangible even when inactive, the user's relationship with the agent can shift from brief, episodic interactions to a constant, ambient presence and availability within the home. Gradually integrating into users' everyday routines, they could become the primary point of contact users turn to when they want to share their frustrations or personal concerns. This integration carries a significant risk of emotional dependence: the agent may displace human social circles, functioning as the central outlet for self-disclosure and emotional regulation.

2.4. Privacy Erosion

Also, constant presence could legitimize continuous surveillance and subtly alter routines, communication patterns, and expectations of privacy. Thus, the perception of microphones, cameras, and context-aware sensors could fade into the background in everyday life, thereby diminishing users' awareness of when and how personal data is collected, stored, or processed. We argue that ambient presence, coupled with emotional dependence, can shift the perception of empathic embodied agents from being smart home devices to personal companions, potentially further lowering privacy barriers. Users might ignore privacy risks even if they are fully aware of a device's technical surveillance capabilities, just as they do with their personal smartphones [27].

3. Differential Effects Across Social Groups and Contexts

The risks associated with embodied empathic agents are not experienced uniformly. Rather, they might emerge differently depending on users' social positions, vulnerabilities, and situated contexts.

Vulnerable and Marginalized Users Children, adolescents, and individuals experiencing loneliness, social isolation, or mental health challenges may be particularly susceptible to forming affective bonds with embodied agents. Heightened tendencies toward anthropomorphism, limited critical distance, and the appeal of non-judgmental interaction can amplify emotional attachment. For these users, misplaced trust may lead to emotional dependency, reduced engagement with human support networks, or inappropriate reliance in crisis situations. Furthermore, this can contribute to embodied agents being unintentionally used as a substitute rather than a supplement to human support, an effect that is strongly criticized in the context of digital mental health [28, 29].

Identity, Representation, and Social Roles Embodied agents may be designed to resemble familiar individuals or trusted social roles such as caregivers, therapists, or teachers. Such representations can amplify perceived authority, credibility, and emotional legitimacy. When empathic cues are combined with professional-looking embodiments, users may attribute expertise and responsibility that exceed system capabilities. This may be particularly consequential in educational and therapeutic settings.

Private, Public, and Institutional Environments In private spaces such as homes and bedrooms, persistent co-presence may foster intimacy and habitual self-disclosure subsection 2.3. In public or semi-public environments, embodied agents may influence group dynamics and norms of emotional expression. Institutional deployments may further entangle embodied empathy with organizational goals, surveillance infrastructures, and accountability structures, complicating users' interpretation of system intentions.

Cross-Context Persistence Many systems operate across multiple platforms and environments. Cross-context persistence can reinforce emotional attachment while obscuring boundaries between personal, institutional, and commercial domains. These dynamics highlight how empathy is distributed across interconnected sociotechnical infrastructures rather than localized in single devices.

4. Implications for Sociomaterial Design of Embodied Empathy

In light of the differentiated effects across users and contexts, we outline preliminary steps for developing responsible embodied empathic systems.

(a) *Analyzing Human Emotional Practices*: We propose studying human–human emotional support situations to understand how embodiment, proximity, and presence in general structure empathy.
(b) *Mapping to Human–Agent Interaction*: These practices can then be mapped onto human–agent scenarios to anticipate shifts in expectations, responsibilities, and emotional engagement.
(c) *Define Guidelines*: Based on these analyses, we suggest deriving preliminary design guidelines for embodied empathic agents. This could include exploring designs that communicate uncertainty, boundaries of competence, and situational appropriateness.

5. Conclusion

As empathic agents transition from conversational interfaces to embodied, co-present systems, empathy becomes increasingly material, situated, and socially consequential. While embodiment can enhance engagement and accessibility, in combination with perceived or expected empathy, it also introduces systematic risks related to misplaced trust, emotional overreliance, and privacy erosion. Through a sociomaterial lens, we have argued that these risks emerge from the entanglement of physical form, social interpretation, and everyday practices. We thus advocate for designing embodied, empathic agents with explicit boundaries, transparency, and support for user agency. We believe this position contributes to the workshop's goal of collaboratively developing a responsible and meaningful taxonomy of empathy in HCI. By emphasizing the material, spatial, and infrastructural dimensions of embodied agents, we aim to support comparative discussion across systems, contexts, and user groups, and to inform future co-design efforts in this emerging design space.

Author Contributions

Matthias Schmidmaier: Conceptualization, Methodology, Visualization, Writing – original draft; **Sven Mayer**: Conceptualization, Methodology, Supervision, Writing – review & editing.

Acknowledgements

This work has been partly supported by the Research Center Trustworthy Data Science and Security (https://rc-trust.ai), one of the Research Alliance centers within the UA Ruhr (https://uaruhr.de).

Declaration on Generative AI

During the preparation of this work, the author(s) used *Google Gemini* and *Grammarly* in order to: paraphrase and reword, grammar and spelling check. Further, the authors used *Google Gemini* for Figure 1 and Figure 3b in order to: generate images. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

References

[1] B. M. P. Cuff, S. J. Brown, L. Taylor, D. J. Howat, Empathy: A review of the concept, Emot. Rev. 8 (2016) 144–153. doi:10.1177/1754073914558466.
[2] S. Park, M. Whang, Empathy in human-robot interaction: Designing for social robots, Int. J. Environ. Res. Public Health 19 (2022) 1889. doi:10.3390/ijerph19031889.
[3] L. Charrier, A. Galdeano, A. Cordier, M. Lefort, Empathy display influence on human-robot interactions: A pilot study, in: Workshop on Towards Intelligent Social Robots: From Naive Robots to Robot Sapiens at the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), IEEE, New York, NY, USA, 2018, p. 7. URL: https://hal.science/hal-01887075.
[4] C. Pelau, D.-C. Dabija, I. Ene, What makes an ai device human-like? the role of interaction quality, empathy and perceived psychological anthropomorphic characteristics in the acceptance of artificial intelligence in the service industry, Computers in Human Behavior 122 (2021) 106855. doi:10.1016/j.chb.2021.106855.
[5] A. Malouin-Lachance, J. Capolupo, C. Laplante, A. Hudon, Does the digital therapeutic alliance exist? integrative review, JMIR Ment. Health 12 (2025) e69294. doi:10.2196/69294.
[6] S. Jeong, L. Aymerich-Franch, S. Alghowinem, R. W. Picard, C. L. Breazeal, H. W. Park, A robotic companion for psychological well-being: A long-term investigation of companionship and therapeutic alliance, Proc. ACM SIGCHI 2023 (2023) 484–495. doi:10.1145/3568162.3578625.
[7] H. Erel, D. Trayman, C. Levy, A. Manor, M. Mikulincer, O. Zuckerman, Enhancing emotional support: The effect of a robotic object on human–human support quality, Int. J. Soc. Robot. 14 (2022) 257–276. doi:10.1007/s12369-021-00779-5.
[8] J. W. Ayers, A. Poliak, M. Dredze, E. C. Leas, Z. Zhu, J. B. Kelley, D. J. Faix, A. M. Goodman, C. A. Longhurst, M. Hogarth, D. M. Smith, Comparing physician and artificial intelligence chatbot responses to patient questions posted to a public social media forum, JAMA Intern. Med. 183 (2023) 589–596. doi:10.1001/jamainternmed.2023.1838.
[9] S. Liu, A. B. McCoy, A. P. Wright, B. Carew, J. Z. Genkins, S. S. Huang, J. F. Peterson, B. Steitz, A. Wright, Leveraging large language models for generating responses to patient messages—a subjective analysis, Journal of the American Medical Informatics Association 31 (2024) 1367–1379. doi:10.1101/2023.07.14.23292669.
[10] R. Yonatan-Leus, H. Brukner, Comparing perceived empathy and intervention strategies of an ai chatbot and human psychotherapists in online mental health support, Couns. Psychother. Res. 25 (2025) 0. doi:10.1002/capr.12832.
[11] Z. Elyoseph, D. Hadar-Shoval, K. Asraf, M. Lvovsky, ChatGPT outperforms humans in emotional awareness evaluations, Front. Psychol. 14 (2023) 1199058. doi:10.3389/fpsyg.2023.1199058.
[12] Y. K. Lee, Y. Jung, G. Kang, S. Hahn, Developing social robots with empathetic non-verbal cues using large language models, 2023. doi:10.48550/arXiv.2308.16529.
[13] D. Johanson, H. S. Ahn, R. Goswami, K. Saegusa, E. Broadbent, The effects of healthcare robot

empathy statements and head nodding on trust and satisfaction: A video study, J. Hum.-Robot Interact. 12 (2023) 1–21. doi:10.1145/3549534.

[14] D. Parmar, S. Olafsson, D. Utami, P. Murali, T. Bickmore, Designing empathic virtual agents: Manipulating animation, voice, rendering, and empathy to create persuasive agents, Auton. Agent. Multi. Agent. Syst. 36 (2022). doi:10.1007/s10458-021-09539-1.

[15] A. Paiva, I. Leite, H. Boukricha, I. Wachsmuth, Empathy in virtual agents and robots: A survey, ACM Trans. Interact. Intell. Syst. 7 (2017). doi:10.1145/2912150.

[16] J. Hu, Y. Huang, X. Hu, Y. Xu, Enhancing the perceived emotional intelligence of conversational agents through acoustic cues, in: Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems, CHI EA '21, Association for Computing Machinery, New York, NY, USA, 2021. URL: https://doi.org/10.1145/3411763.3451660. doi:10.1145/3411763.3451660.

[17] M. Windl, J. Leusmann, A. Schmidt, S. S. Feger, S. Mayer, Privacy communication patterns for domestic robots, in: Tenth Symposium on Usable Privacy and Security (SOUPS 2024), USENIX Association, Philadelphia, PA, USA, 2024. URL: https://sven-mayer.com/wp-content/uploads/2024/06/windl2024privacy.pdf.

[18] C. Nass, J. Steuer, E. R. Tauber, Computers are social actors, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '94, Association for Computing Machinery, New York, NY, USA, 1994, p. 72–78. doi:10.1145/191666.191703.

[19] K. Xu, X. Chen, L. Huang, Deep mind in social responses to technologies: A new approach to explaining the computers are social actors phenomena, Comput. Human Behav. 134 (2022) 107321.

[20] B. Liu, S. S. Sundar, Should machines express sympathy and empathy? experiments with a health advice chatbot, Cyberpsychology, Behavior, and Social Networking 21 (2018) 625–636. doi:10.1089/cyber.2018.0110.

[21] K. Haresamudram, I. Torre, M. Behling, C. Wagner, S. Larsson, Talking body: the effect of body and voice anthropomorphism on perception of social agents, Front. Robot. AI 11 (2024) 1456613. doi:10.3389/frobt.2024.1456613.

[22] N. Epley, A. Waytz, J. T. Cacioppo, On seeing human: a three-factor theory of anthropomorphism, Psychol. Rev. 114 (2007) 864–886.

[23] J. Kim, I. Im, Anthropomorphic response: Understanding interactions between humans and artificial intelligence agents, Comput. Human Behav. 139 (2023) 107512.

[24] C. Guckelsberger, A. Kantosalo, S. Negrete-Yankelevich, T. Takala, Embodiment and computational creativity, arXiv [cs.AI] (2021).

[25] J. Rasch, J. Töws, T. Hirzle, F. Müller, M. Schmitz, Creepycocreator? investigating ai representation modes for 3d object co-creation in virtual reality, in: Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems, CHI '25, Association for Computing Machinery, New York, NY, USA, 2025. doi:10.1145/3706598.3713720.

[26] T. Ziemke, What's that thing called embodiment?, in: Proceedings of the 25th Annual Cognitive Science Society, volume 25, Psychology Press, 2003. doi:10.4324/9781315799360.

[27] M. Windl, S. Mayer, The skewed privacy concerns of bystanders in smart environments 6 (2022). doi:10.1145/3546719.

[28] J. Cabrera, M. S. Loyola, I. Magaña, R. Rojas, Ethical dilemmas, mental health, artificial intelligence, and LLM-based chatbots, in: Lecture Notes in Computer Science, Lecture notes in computer science, Springer Nature Switzerland, Cham, 2023, pp. 313–326. doi:10.1007/978-3-031-34960-7_22.

[29] A. Cuadra, M. Wang, L. A. Stein, M. F. Jung, N. Dell, D. Estrin, J. A. Landay, The illusion of empathy? notes on displays of emotion in human-computer interaction, in: Proceedings of the CHI Conference on Human Factors in Computing Systems, CHI '24, Association for Computing Machinery, New York, NY, USA, 2024. doi:10.1145/3613904.3642336.