

How Embodiment Shapes Human–AI Interaction: Evidence from Real-World Deployment of Holographic and Screen-Based Systems

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ABSTRACT

Artificial intelligence (AI) is increasingly moving into physical environments through kiosks, avatars, and holographic systems. While significant research has focused on model performance, less is understood about how the *form* of AI systems influences human interaction. This study examines the impact of embodiment by comparing user interactions with a holographic AI assistant and a screen-based avatar deployed at CES. Observational and interaction data reveal that the holographic system consistently elicited longer engagement, more exploratory questioning, and greater user interaction than the screen-based system. Notably, these differences occurred despite both systems using the same underlying AI model. The findings suggest that embodiment shapes user behavior independent of system functionality. This work contributes a practical framework for evaluating embodied AI systems and highlights the importance of considering physical form in the design of future human–AI interactions. This work presents a behavioral evaluation framework for embodied AI systems that leverages interaction time, question style, user behavior, and language use.

Keywords: Artificial intelligence; human–AI interaction; embodiment; holographic interfaces; conversational agents; user behavior; interaction design; presence; relational AI; multimodal systems

INTRODUCTION

AI is no longer confined to mere text-based interfaces; it is increasingly becoming physical and visible through kiosks, avatars, and holographic systems. While substantial research has examined both model performance and human–AI interaction, there is limited empirical work comparing how different physical forms of AI shape user behavior in real-world settings. Specifically, the problem is that researchers know how AI models respond, but do not yet understand how people behave differently when interacting with AI presented in different embodied physical forms. This study addresses this gap by comparing how users interact with the same AI system presented in two different forms: a holographic display and a screen-based interface. Consequently, we compare a holographic AI avatar assistant and a screen-based AI avatar assistant deployed in a real-world setting at the annual Consumer Electronics Show¹ (CES) in January of 2026, holding the underlying AI system constant across both conditions. Our findings demonstrate that the form of embodied AI hologram versus screen significantly influences how humans engage, explore, and interact. This work contributes real-world empirical evidence, a direct comparative analysis, and new behavioral insights into the role of embodiment in human–AI interaction.

Related Work

Prior research on conversational AI interactions has mostly focused on system performance, response quality, and task completion (Bansal, 2024; Johnson et al., 2025; Marconi et al., 2026). Research on avatars and virtual agents explored how visual representation and interface design influence user engagement, while studies in embodiment and presence suggest that physical or perceived presence can shape interaction dynamics (Aljaroodi et al., 2019; Seinfeld et al., 2021). This body of research highlights the importance of both system capability and user experience in human–AI interaction. To our knowledge, there is limited empirical research examining

¹ CES is a major annual technology event held in Las Vegas, Nevada where companies showcase new products and innovations across areas like AI, robotics, consumer tech, automotive, and immersive systems.

differences in real-world interactions between embodied and non-embodied AI systems, particularly in uncontrolled public environments (van Vugt, 2009).

System Overview

The study compared two interaction setups: a screen-based interface and a holographic display, while keeping the underlying AI system constant to isolate the effect of embodiment on user interaction.



Figure 1: Screen-Based Interaction

Example of user interaction with the screen-based AI assistant during deployment at CES 2026. Interactions in this setup were typically brief and task oriented.



Figure 2: Holographic Interaction System

Holographic AI assistant at CES 2026, demonstrating the embodied form that elicited longer, more exploratory user interactions.

The same AI assistant was presented in both forms, using identical backend capabilities, including the same Gemini large language model, conversational logic, and response-generation pipeline.

In the screen-based setup, the AI assistant appeared on a standard display, where users interacted with a digital avatar in a familiar conversational format.

In the holographic setup, the same assistant was presented as a projected hologram, creating a more physically embodied interaction experience.

Across both setups, system functionality remained constant. The only difference was the form of presentation, allowing for a direct comparison of how embodiment influences user interaction.

METHODOLOGY

Environment

The study was conducted during a live deployment at CES, a large-scale public technology event, January 6-9, 2026. The system was selected for exhibition at Eureka Park, a curated program showcasing early-stage technologies with innovation and functional prototypes. This selection process, administered by the Consumer Technology Association (CTA), emphasizes technological novelty, feasibility, and real-world applicability.

The system operated in an open, real-world environment, allowing for natural, unscripted interactions with a diverse set of users speaking over 18 languages. This setting enabled observation of authentic user behavior rather than controlled laboratory conditions.

Data and Measures

Data were collected from approximately 278 interactions across both the screen-based and holographic setups. Fifteen languages were accessed for questions and translation. Interaction logs were recorded and supplemented with observational notes that captured patterns in user engagement and behavior.

Qualitative analysis focused on several key dimensions of interaction. This included interaction length and the type of questions asked. User behavior was categorized as either exploratory or transactional, based on the nature and depth of the interaction. Additional dimensions included interaction tone, classified as neutral, emotional, or adversarial, and instances of language switching during conversation. Observational patterns were identified through review of interaction logs and field observations.

RESULTS

Interaction Time

Interactions in the holographic setup were consistently longer than those in the screen-based setup. Across all interactions, the average duration was approximately 3 minutes and 24 seconds; however, this average was driven largely by longer engagements in the holographic setup.

In the screen-based setup, interactions were often brief, frequently lasting under one minute and commonly limited to one or two conversational turns. In contrast, interactions with the holographic system frequently extended several minutes, with observed examples exceeding five to eight minutes of sustained engagement.

Users in the holographic setup more often engaged in extended exchanges, asking follow-up questions and continuing beyond their initial query. This pattern was observed consistently across interactions. While both systems used the same underlying AI, the holographic form appeared to encourage sustained engagement and deeper interaction.

These results suggest that the system's form, rather than its underlying capability, plays a distinct role in shaping user engagement. Of note, some holographic interactions lasted several times longer than typical screen-based exchanges.

Question Style

The type of questions asked differed notably between the two setups. In the holographic setup, users were more likely to ask exploratory, open-ended questions that often extended beyond a single topic or purpose. These interactions frequently involved multiple follow-up questions, hypothetical scenarios, and attempts to probe the system's capabilities. This pattern is reflected in longer exchanges, with some interactions containing 10–20+ conversational turns.

In contrast, interactions in the screen-based setup were more frequently transactional. Users typically asked direct, task-oriented questions, such as requesting specific information or simple assistance, with limited follow-up or expansion. Many of these interactions were brief, often consisting of only a few conversational turns.

Across all interactions, the system averaged 18.1 messages per interaction, indicating high overall engagement; however, longer multi-turn exchanges were more common in the holographic setup.

This difference suggests that the holographic form encourages a more exploratory style of interaction, while the screen-based form supports a more efficient, goal-directed use of the system. Notably, these differences emerged despite both systems using the same underlying AI, demonstrating that the form of presentation plays a distinct role in shaping how users frame their questions. In several holographic interactions, users transitioned from simple queries to broader, exploratory questioning within the same exchange.

User Behavior

User behavior differed notably between the two setups. In the holographic setup, users displayed higher levels of visible engagement, including laughter, expressions of surprise, and sustained visual attention. Many users appeared captivated by the interaction, maintaining focus on the system for extended periods and reacting with more expressive, emotional responses.

In contrast, interactions with the screen-based system were generally more neutral and task-oriented, with fewer visible emotional reactions and shorter periods of focused attention.

Additionally, users interacting with the holographic system appeared more likely to treat the assistant as a more “real” or agent-like presence. This was reflected in their behavior, including more natural conversational flow, increased responsiveness, and a greater tendency to engage beyond the initial task.

Language Use

Multilingual interaction was a prominent feature of user engagement across both setups. Of the 278 total interactions, 136 (48.9%) involved at least one non-English language, and 48 interactions included multiple non-English languages within a single exchange.

Despite this overall capability, differences emerged in how multilingual interaction occurred. In the holographic setup, users were more likely to initiate language switching spontaneously and engage in multilingual exchanges as part of natural interaction. In contrast, multilingual use in the screen-based setup more often occurred as part of structured or prompted demonstrations of system functionality.

These patterns suggest that while multilingual functionality was consistent across both systems, the holographic form encouraged more natural and exploratory multilingual engagement. This difference highlights that embodiment influences not only whether users engage across languages, but also how naturally that engagement occurs.

Adversarial and Probing Behavior

A small number of interactions included adversarial or probing questions, in which users challenged the system's capabilities, consistency, or broader implications. These interactions were relatively infrequent (approximately 2–3 clear cases) but were more commonly observed in the holographic setup.

These exchanges often involved speculative or critical framing, such as questioning the technology's societal implications or testing system boundaries through repetition and contradiction. This behavior suggests that users interacting with the holographic system were more likely to explore not only its functional capabilities but also its conceptual and ethical dimensions. Even when infrequent, these interactions indicate a shift from task-oriented use toward deeper cognitive and conceptual engagement.

Key Finding

Users interact differently with AI depending on its physical form. Across all observed interactions, the holographic setup consistently elicited greater curiosity, engagement, and exploratory behavior, while the screen-based setup supported more efficient, repetitive, and task-oriented use.

Importantly, the underlying AI system remained constant across both setups. The only difference was how the system was presented. Despite this, user behavior changed significantly.

The findings demonstrate that embodiment is not a secondary design feature, but a primary driver of user behavior.

At a behavioral level, a clear pattern emerged:

Hologram user → **curiosity, engagement, exploration**

Screen user → **efficiency, repetition**

This distinction reflects a deeper shift in how users approach the system. Screen-based interactions were typically oriented toward obtaining answers, while holographic interactions more often involved testing, exploring, and probing the system's capabilities and implications.

In essence, when the system appeared as a screen, users sought answers. When it appeared as a hologram, users explored possibilities. The system did not change...but the human did.

DISCUSSION

The observed differences in user behavior can be understood in the context of perceived embodied presence. The holographic system created a stronger sense of physical and social presence, which influenced how users approached the interaction. Users interacting with the holographic assistant often treated it more like a relational entity than a tool, engaging in a more conversational, expressive, and exploratory manner. This increased sense of presence contributed to longer interactions, more open-ended questioning, and greater emotional engagement.

In contrast, the screen-based system aligned with familiar digital interfaces, leading users to approach it more transactionally, with a focus on efficiency and task completion.

These findings suggest that AI design is not solely a function of model capability, but also of how the system is experienced. The physical form of the system plays a distinct role in shaping interaction patterns, influencing not only how long users engage but also how they think, ask questions, and respond.

These results also highlight important considerations for user trust, perception, and system design. While embodied AI may increase engagement and emotional connection, the increased perceived realism and human-like interaction observed in the holographic setup raise concerns about over-trust, anthropomorphism, and inflated user expectations. Systems that appear more present may be perceived as more capable or authoritative than they are, underscoring the need for careful design and clear communication of system limitations.

Implications

The findings of this study have implications for AI system design, industry deployment, and future research.

Design

Embodiment should be an intentional design choice rather than a purely aesthetic one. The results show that the form of an AI system directly influences how users engage, ask questions, and interact. Designers should consider how physical presentation embodiment influences user expectations, behavior, and perception, not just visual appeal.

Industry

These findings are relevant to applications in retail, education, and public-facing interfaces, where user engagement and interaction quality are critical. Embodied AI systems, such as holographic or avatar-based assistants, may enhance user experience by encouraging exploration, increasing engagement time, and supporting more natural interaction.

Research

This work highlights the need to move beyond evaluating AI systems based only on accuracy or task performance. Future research should focus on interaction behavior, including how users engage, explore, and respond to AI systems in real-world settings. Understanding these user dynamics is critical as AI becomes more physically embedded in everyday environments because how users behave, not just how systems perform, will determine the effectiveness, trustworthiness, and impact of these technologies. As AI systems become more visible and interactive, evaluating how humans behave with AI will be as important as evaluating how AI performs.

Limitations

This study has several limitations that should be considered when interpreting the findings.

First, the study was conducted in a real-world environment at CES rather than in a controlled experimental setting. While this allowed for authentic, unscripted interactions, it also introduced variability in user behavior, noise levels, and interaction conditions that could not be controlled.

Second, while sufficient for observational insights, the sample size is limited to 278 interactions within a specific event context. As a result, findings may not fully generalize to other environments, user populations, or deployment scenarios.

Third, the analysis is based on observational data and recorded interaction logs rather than controlled experimental measures. As a result, the findings reflect observed patterns in user behavior rather than experimentally validated causal relationships. While patterns in behavior were consistently observed, causal relationships between system form and user behavior cannot be definitively established. Future work using controlled experimental designs and larger, more diverse samples would help validate and extend these findings.

CONCLUSION

The way AI is embodied shapes how people interact with it. Across this study, users engaged differently with the same underlying system depending on whether it appeared as a hologram or a screen. The response differences were reflected not only in interaction length, but in how users asked questions, explored the system, and responded to it.

As AI continues to enter physical and public spaces, understanding embodiment will be critical for designing systems that are not only intelligent but also effective. However, effectiveness alone is not sufficient. As systems become more “present” and “human-like,” users may develop greater trust, emotional engagement, and unrealistic expectations of their functionality.

This transition highlights the need to move toward a more relational perspective on AI design, one that accounts for how users perceive, interpret, and relate to AI systems over time (Johnson et al., 2026). Designing for

relational interaction can support trust calibration, ensuring that users neither under-trust nor over-trust the system.

In a relational context, embodiment should be paired with preventive design measures, including clear communication of system capabilities and limitations, to reduce the risk that hallucinations are misinterpreted as accurate information. As AI becomes more embedded in everyday environments, aligning system design with human behavior will be essential for building systems that are both trustworthy and responsible. Future systems should be designed not only for accuracy and optimization, but for how they will be perceived, interpreted, and trusted in real-world environments.

Ethical Approval: This study involved observational interactions in a public environment without collection of personally identifiable information. No intervention was performed. Based on institutional guidelines, formal IRB approval was not required. All data were handled in accordance with ethical standards for human subjects research.

Conflict of Interest: The author declares no competing interests. The system studied was developed by the author.

Data Availability: The data that support the findings of this study are available from the corresponding author upon reasonable request. Data are not publicly available due to the inclusion of observational interaction logs collected in a public environment.

REFERENCES

1. Aljaroodi, H. M., Adam, M., Chiong, R., & Teubner, T. (2019). Avatars and embodied agents in informationsystems research: A systematic review and conceptual framework. Open Research Newcastle. <https://hdl.handle.net/1959.13/1413609>
2. Bansal, G., Chamola, V., Hussain, A., et al. (2024). Transforming conversations with AI—A comprehensive study of ChatGPT. *Cognitive Computation*, 16, 2487–2510. <https://doi.org/10.1007/s12559-023-10236-2>
3. Johnson, L., Inamdar, A. H., & Yadecha, B. L. (2026). From AI stack to cognitive stack: A semantic–spatial–relational architecture for trustworthy AI. *Trends in Computer Science and Information Technology*. <https://doi.org/10.17352/tcsit.000105>
4. Johnson, L., Sudhir, A. D., & Padmapriya, A. A. (2025). The feel of friendship: Emotional presence and relational authenticity in large language models. *International Journal of Humanities and Social Science*, 15. <https://doi.org/10.30845/ijhss.vol15p29>
5. Marconi, L., Longo, L., & Cabitza, F. (2026). Assessing Interaction Quality in Human–AI Dialogue: An Integrative Review and Multi-Layer Framework for Conversational Agents. *Machine Learning and Knowledge Extraction*, 8(2), 28. <https://doi.org/10.3390/make8020028>
6. Seinfeld, S., Feuchtner, T., Maselli, A., & Müller, J. (2021). User representations in human–computer interaction. *Human–Computer Interaction*, 36(5–6), 400–438. <https://doi.org/10.1080/07370024.2020.1724790>
7. van Vugt, H.C., Hoorn, J.F. and Konijn, E.A. (2009), Interactive engagement with embodied agents: an empirically validated framework. *Comp. Anim. Virtual Worlds*, 20: 195-204. <https://doi.org/10.1002/cav.312>