

## Emotional Capabilities of Conversational Agents: A Review

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### Abstract

With the increasing diffusion of conversational agents into our everyday lives, designing conversational agents with features promoting intuitive communication gains more and more importance. A relevant way to facilitate this communication is to design conversational agents with emotional capabilities, given that emotions are a natural way for most humans to interact daily. The integration of emotional capabilities into conversational agents stands in line with the computers are social actors theory (CASA, Nass et al., 1994) stating that there is a positive relationship between human-likeness and users' positive cognitive or affective evaluations. In contrast, another theoretical approach, the uncanny valley effect (Mori, 1970), proposes that increased human-likeness, such as the inclusion of emotional capabilities, of non-human entities results in deanthropomorphism processes leading to reduced positive evaluations of these robots. Only when these entities become almost indistinguishable from real humans, anthropomorphism processes enable the evaluations to become more positive again, leading to a nonlinear relationship between human-likeness and users' evaluations. Previous research has overall shown support for CASA theory in the area of conversational agents, with results suggesting that only for some areas, such as specific visual design features, an uncanny valley effect may arise (Blut et al., 2021; Castro-Alonso et al., 2021; Palomäki et al., 2018).

Against this background, we conducted a literature review to gain insights into a) the technological design approaches with which conversational agents have been designed to adjust emotional capabilities, b) the effects of emotional capabilities on anthropomorphism and deanthropomorphism processes, c) the underlying mechanisms through which these effects may arise, and d) opportunities for future research to design conversational agents and investigate effects of emotional capabilities. We used the search string ("emotion sensitive" OR "emotional capabilities" OR "higher cognition" OR "affective" OR "empathic" OR "empathy") AND ("robot\*" OR "agent\*" OR "avatar\*" OR "chatbot\*" OR "smart personal assistant\*") AND ("uncanny valley" OR "dehuman\*" OR "anthropomorph\*") in the databases PubMed, Science Direct, Scopus, Web of

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Science, and Google Scholar in addition to a backward and forward search. We included publications designing a conversational agent with emotional capabilities, testing a conversational agent in an experiment while manipulating at least one factor related to emotional capabilities, or providing a theoretical perspective on emotional capabilities. The results of the literature review reveal the following outcomes.

First, for emotional expression, the implementations are quite diverse and range from the simple expression of emotional capabilities by textual (Liu & Sundar, 2018) or visual (Kugurakova et al., 2015; Lazzeri et al., 2015) means over designing robots with affective touch (Stiehl et al., 2005) to the expression of different personality traits (Paetzel-Prüsmann et al., 2021).

Second, literature on the mechanisms through which these effects arise is still scarce. Research on the topic of emotional capabilities in conversational agents has mainly focused on comparing a conversational agent with emotional capabilities with a conversational agent without emotional capabilities. Thus, the opportunity to investigate which degree of emotional capabilities and what kind of design is the best for a specific requirement is still unclear. The few studies investigating different degrees of emotional capabilities show mixed results. On the one hand, robots with more emotional capabilities increase deanthropomorphism processes, supporting the uncanny valley effect (Appel et al., 2016). On the other hand, the expression of emotions and understanding seem to facilitate anthropomorphism processes compared to the expression of understanding without emotional expressions, supporting the CASA theory (Liu & Sundar, 2018). Moreover, only a few studies are explaining the underlying anthropomorphism and deanthropomorphism processes.

These results show that future research should investigate the effects of implementations of emotional capabilities for which research up to date is still scarce. For example, there is still little research on conversational agents that respond to the emotional state of the user by using emotion recognition technologies (e.g., through speech or facial recognition algorithms or by using physiological measures via wearables). Additionally, randomized experiments comparing design

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variants with different levels of conversational agents' emotional capabilities are lacking.

Furthermore, future experiments could provide more insights into the circumstances in which the CASA theory or the uncanny valley effect are more suited to explain anthropomorphism and deanthropomorphism processes concerning different implementations of social capabilities. This research could also provide insights into why results related to the uncanny valley effect and the CASA theory have been inconsistent. Finally, the results of this review show that conversational agents designed with emotional capabilities could provide a range of opportunities for practice, for example in the areas of health, work, and education.

*Keywords:* anthropomorphism, emotional capabilities, conversational agents, uncanny valley

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