Texting with Human-like Conversational Agents: Designing for Anthropomorphism

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Abstract

Conversational agents (CAs) are natural language user interfaces that emulate human-to-human communication. Because of this emulation, research into CAs is inseparably linked to questions about anthropomorphism—the attribution of human qualities, including consciousness, intentions, and emotions, to nonhuman agents. Past research has demonstrated that anthropomorphism affects human perception and behavior in human-computer interactions, for example by increasing trust and connectedness or stimulating social response behavior. Based on the psychological theory of anthropomorphism and related research on computer interface design, we develop a theoretical framework for designing anthropomorphic CAs. We identify three groups of factors to stimulate anthropomorphism: technology design-related, task-related, and individual factors. Our findings from an online-experiment support the derived framework but also reveal novel, yet counterintuitive, insights. In particular, we demonstrate that not all combinations of anthropomorphic technology design cues increase perceived anthropomorphism. For example, we find that using only nonverbal cues harms anthropomorphism; however, this effect turns positive when nonverbal cues are complemented with verbal or human identity cues. We also find that whether CAs complete computer-like or human-like tasks and individuals' disposition to anthropomorphize greatly affect perceived anthropomorphism. This work advances our understanding of anthropomorphism and makes the theory of anthropomorphism applicable to our discipline. We advise on the direction research and practice should take to find the right spot in anthropomorphic CA design.

Keywords: Conversational Agents, Chatbots, Anthropomorphism, Interface Design

Introduction

In the past few years, conversational agents (CAs)—also called conversational interfaces or chatbots—have played a dominant role in the pursuit of innovative and ground-breaking human-computer interactions by digital giants such as Google, Facebook, Amazon, and WeChat (McCarthy, 2019). Although the first CA was developed in the 1960s (Weizenbaum, 1966), recent technological advances in artificial intelligence, machine learning, and natural language processing have revived attention to conversational interfaces and their implementation in research and practice. Indeed, the market for CAs is expected to more than triple by 2024 (Marketsandmarkets, 2019). Important use contexts for CAs include customer service, e-commerce, business workflows, Internet of Things, and personal health and fitness (Araujo, 2018; Gnewuch, Morana, & Maedche, 2017). In sum, CAs are expected to create substantial business value in current and future digital ecosystems.

CAs are "user interfaces that mimic human-to-human communication using natural language processing, machine learning, and/or artificial intelligence" (Schuetzler, Giboney, Grimes, & Nunamaker, 2018, p. 94). In essence, CAs enable users to interact with information systems (IS) in the same way they would with a human interaction partner via text messaging or telecommunication applications. Therefore, a major advantage of CAs is that users can interact with them naturally and intuitively (Chattaraman, Kwon, Gilbert, & Ross, 2019). This natural language interface is CAs' distinct characteristic (Araujo, 2018) which enables a human-like interactional experience (Pickard, Schuetzler, Valacich, & Wood, 2017; Schuetzler, Grimes, Giboney, & Buckman, 2014). Providing an object observable human-like features and behaviors, such as human language, can induce *anthropomorphism*—the attribution of human qualities, including consciousness, intentions, and emotions, to nonhuman agents or objects

(Epley, Waytz, & Cacioppo, 2007). Accordingly, CAs' emulation of human-likeness inseparably links them to questions around anthropomorphism.

Meaningful and generalizable research on CA design, perception, and use benefits greatly from knowledge of how to stimulate anthropomorphism because this psychological phenomenon has several important consequences for human perception and behavior. For example, according to psychological research, anthropomorphism leads to interpretations about an interaction partner's intentions and motives (Waytz, Gray, Epley, & Wegner, 2010b). In turn, these interpretations intensify the experience of interactional events as more meaningful and important (Guthrie, 2013). On a related note, anthropomorphism has positive effects on the relationship with a nonhuman interaction partner in terms of trust (De Visser et al., 2016) and connectedness (Tam, Lee, & Chao, 2013). Besides these perceptional consequences, anthropomorphism also stimulates social response behavior in the perceiver (Epley et al., 2007; Waytz et al., 2010b). For example, anthropomorphism affects self-disclosure behavior in that individuals interacting with a highly anthropomorphized interaction partner disclose less undesirable information (Schuetzler et al., 2018). Overall, the degree to which a CA is anthropomorphized has several implications for the ongoing interactional relationship, thus anthropomorphism is a critical factor requiring careful consideration during the design phase.

Extant research in IS and human-computer interaction (HCI) has focused on these effects of anthropomorphic design in terms of perceptional (Benbasat, Dimoka, Pavlou, & Qiu, 2010; Nowak & Rauh, 2005; Qiu & Benbasat, 2009) and behavioral (Burgoon et al., 1999; Gong, 2008; Riedl, Mohr, Kenning, Davis, & Heekeren, 2014; 2011; Schuetzler et al., 2014; 2018) outcome variables. However, this body of research employs varying and inconsistent perspectives on what constitutes anthropomorphic design and what evokes anthropomorphism. We will demonstrate that designing anthropomorphic interactions with CAs is no trivial matter—a theory-grounded and empirically validated knowledge base is required to understand how and which CA design elements can stimulate perceptions of anthropomorphism.

To establish this knowledge base, we build on Epley et al.'s (2007) psychological theory of anthropomorphism[1] that has to date received limited attention in IS and HCI research. This theory identifies cognitive, motivational, and dispositional determinants of anthropomorphism (Epley et al., 2007; Waytz et al., 2010a). While some studies have considered the role of the cognitive determinant in investigating anthropomorphic features in technology design (Niu, Terken, & Eggen, 2018; Yuan & Dennis, 2017; Yuan, Dennis, & Potter, 2016), the other two determinants of anthropomorphism have, to the best of our knowledge, not similarly been considered before.

Additional to the need for including motivational and dispositional determinants, our review of studies on anthropomorphic technology design also revealed the need to further systemize our knowledge of anthropomorphism's cognitive determinant. According to the theory of anthropomorphism, perceiving human-like features in technology design is supposed to activate users' knowledge of humans when they assess a technological artifact. This cognitive process results in perceptions of anthropomorphism (Epley et al., 2007). However, several studies manipulate the anthropomorphic design of a technological artifact without validating the related effect on anthropomorphic perceptions (e.g., Burgoon et al., 2016; Cowell & Stanney, 2005; Nunamaker, Derrick, Elkins, Burgoon, & Patton, 2011; Qiu & Benbasat, 2009; Verhagen, van Nes, Feldberg, & van Dolen, 2014). Other studies report contradictory results: for example, in terms of anthropomorphic design's effect on socially desirable behavior, some researchers find a significant effect of human-like visual cues (Kiesler, Powers, Fussell, & Torrey, 2008; Sproull, Kiesler, Walker, & Waters, 1996), while others find such an effect only

[1] Further, the term "theory of anthropomorphism" will be used to refer to Epley et al.'s (2007) eponymous theory.

for communicative but not for human-like visual cues (Sah & Peng, 2015; Schuetzler et al., 2018). Moreover, a CA offers design possibilities different to those of a humanoid robot (Kiesler et al., 2008; Trovato et al., 2015) or a product in a webshop (Yuan et al., 2016; Cyr, Head, Larios, & Pan, 2009). Therefore, research findings on the anthropomorphic design of related technological artifacts cannot readily be applied to CA design.

This paper builds on the theory of anthropomorphism (Epley et al., 2007) to identify the right spot for anthropomorphic CA design and to account for the complexity of anthropomorphic perception. We derive three groups of antecedents from the three determinants of anthropomorphism mentioned above: design-related (=cognitive), task-related (=motivational), and individual (=dispositional) factors. We integrate these three elements in a comprehensive framework of anthropomorphic CA design. As such comprehensive knowledge of the mechanisms leading users to anthropomorphize CAs has been lacking, our goal is to fill this gap. Therefore, this paper seeks to answer the following research question:

RQ: Can cognitive, dispositional, and motivational factors be used to understand users' perceptions of anthropomorphism in CAs?

To address this question, we develop a theoretical design framework and evaluate it with an online experiment. From a theoretical perspective, our framework integrates technological as well as task and user-related factors to explain perceptions of anthropomorphism in human-CA interactions. This knowledge provides IS researchers and practitioners with the necessary guidance to achieve varying degrees of anthropomorphism. Prior research has focused primarily on specific technological features' impact on users' perception of anthropomorphism (e.g., Pütten et al., 2010; Sah & Peng, 2015; Schuetzler et al., 2014); we contribute to the literature by referring to the theory of anthropomorphism in extending our understanding of anthropomorphism in human-CA interactions. Conversely, our work also contributes to the theory of anthropomorphism by translating the three determinants of anthropomorphism into factors for designing anthropomorphic interactions with CAs.

Further, our empirical evaluation provides important insight into the complex mechanisms that lead humans to anthropomorphize CAs. For example, we find that increasing the number of anthropomorphic design elements does not necessarily result in higher perceptions of anthropomorphism. For specific cues, we even find a negative effect on perceptions of anthropomorphism. We discuss the potential reasons for these counterintuitive findings in detail and illustrate their relevance for research and practice. Our analysis also shows that CAs are not equally anthropomorphized across tasks and individuals. The data analysis broadly supports the deduced theoretical framework but also provides opportunities to further pursue questions of anthropomorphic design in human-CA interactions.

Theoretical Background

In developing our theoretical framework, we mainly draw on two research streams. First, our work relates to studies investigating design-related questions on CAs and related technological artifacts. Second, knowledge from psychological research on anthropomorphism provides the theoretical foundation for our framework. This section provides the necessary foundation to differentiate between CAs and related technological artifacts, before we introduce the theory of anthropomorphism.

Conversational Agents and Related Technological Artifacts

The mode of communication with a CA can be text- or voice-based (Gnewuch et al., 2017). This paper focuses on text-based CAs because of their prevalence in real life (Araujo, 2018). CA research is not isolated; it is connected to studies on related technological artifacts. In our view, the most important technological artifacts among these are *embodied conversational agents* and *avatars*. For a well-defined understanding of CAs, we need to emphasize the similarities and differences between these technological artifacts. Table 1 and Figure 1 provide an overview of these artifacts and how they are related.

Table 1. Distinction between Conversational Agents and Related Technological Artifacts

Name	Definition	IS studies
Conversational Agent	"*systems that mimic human-to-human communication using natural language processing, machine learning, and/or artificial intelligence*" (Schuetzler et al., 2018, p. 94)	(Gnewuch et al., 2017, 2018; Schuetzler et al., 2014; 2018)
Embodied Conversational Agent	"*virtual, three-dimensional human characters that are displayed on computer screens* … [and] *interact with people through natural speech*" (Derrick et al., 2011, p. 72)	(Derrick et al., 2011; Nunamaker et al., 2011; Pickard et al., 2017)
Avatar	"*computer generated visual representations of people or bots*" (Nowak & Rauh, 2005, p. 153)	(Davis et al., 2009; Riedl et al., 2014; Suh et al., 2011)

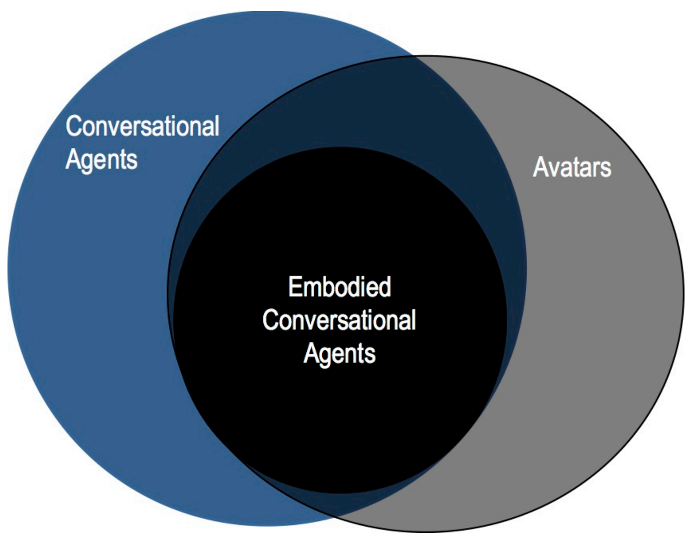


Figure 1. Venn Diagram of Conversational Agents and Related Technological Artifacts

Embodied conversational agent (ECA), initially described by Cassell, Bickmore, and others in the early 2000s (Bickmore & Cassell, 2005; Cassell & Bickmore, 2000; Cassell et al., 1999), refers to a virtually represented human that can interact with users through body gestures, facial expressions, and human speech. Inspired by the "metaphor of face-to-face conversation" (Cassell et al., 1999, p. 520), the objective of ECAs is to provide a complete representation of a human interaction partner. Accordingly, a defining characteristic of ECAs is their ability to interact with users via natural language dialogue. This common characteristic of CAs and ECAs explains why the body of ECA research is highly relevant to our research. However, notably, ECA research specially emphasizes the physical, three-dimensional appearance that enables the agent to mirror human interactions through kinetic movements, such as head nods, smiles, and postures (Derrick, Jenkins, & Nunamaker, 2011; Nunamaker et al., 2011). Because of their visual embodiment, these agents require a virtual space, which usually is available on websites (Ben Mimoun & Poncin, 2015), in virtual reality (Lee & Chen, 2012), or on specifically developed information technology artifacts whose single purpose is to enable the user-agent interaction (Derrick et al., 2011; Nunamaker et al., 2011). By contrast, CAs are designed without such a dynamic visual representation and are typically available through social media, messaging applications, or chat windows (Araujo, 2018). Often, CAs are also available via chat windows on company websites as a touchpoint for customer service inquiries (Pfeiffer, 2020; Verhagen et al., 2014). To sum up, CAs, unlike ECAs, either have no visual representation or have only a static profile image. Thus, CAs are disembodied and cannot rely on bodily behavior when interacting with users (Araujo, 2018). Therefore, extant research on anthropomorphic design of ECAs is only partly applicable to CA design.

Avatars refer to computer-generated graphical representations of humans in virtual environments (Holzwarth, Janiszewski, & Neumann, 2006). Such representations can take the form of static images (Riedl et al., 2014) or fully animated characters (Davis et al., 2009; K.-S. Suh, Kim, & Suh, 2011). Unlike ECAs, avatars are not defined by the ability to communicate with users via natural speech (Nunamaker et al., 2011). Static avatar images can be used as a profile image for CAs (Schuetzler et al., 2018), while fully animated avatars can be used in ECAs (Nunamaker et al., 2011).

Theory of Anthropomorphism

Anthropomorphism refers to the psychological phenomenon of "attributing human characteristics to the nonhuman" (Guthrie, 1993, p. 62). In essence, anthropomorphizing a nonhuman object means assigning unobservable and uniquely human mental capacities, such as intentionality and emotions, to the object (Epley et al., 2008b; Gray, Gray, & Wegner, 2007). Research in social cognition also refers to anthropomorphism as mind perception (Waytz et al., 2010b). In introducing the *theory of anthropomorphism* Epley, Waytz, and Cacioppo (2007, 2008) describe anthropomorphism as the outcome of an inductive inference process. Because knowledge of human characteristics is highly accessible to human beings, their reasoning about unknown nonhuman objects spontaneously uses this accessible knowledge. Therefore, anthropomorphism is a plausible and reasonable way of making sense of things and events (Guthrie, 1993). Consequently, anthropomorphizing a nonhuman object testifies not to erroneous perception, but rather to the human mental ability to assess the world. Further, anthropomorphizing also happens when a person recognizes an object as nonhuman but sees human characteristics in some of its appearance or behavior (Guthrie, 1993).

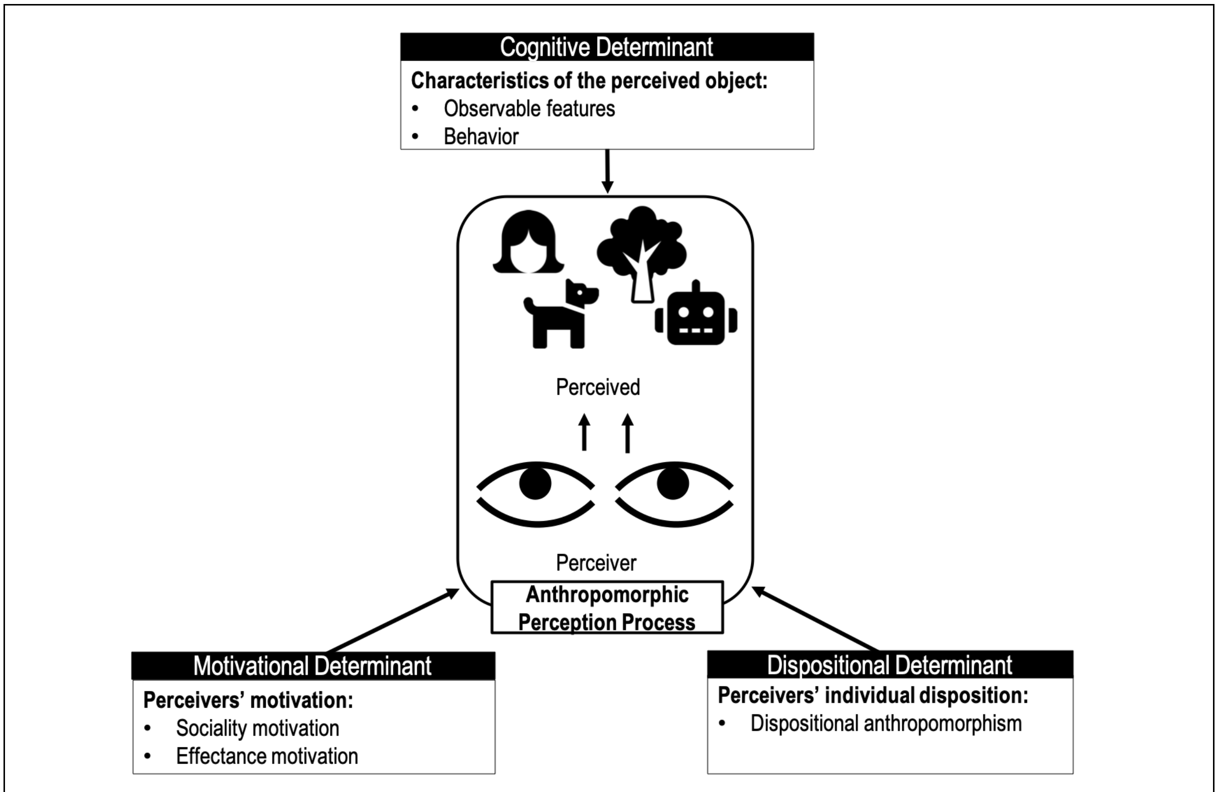


Figure 2. Process of Anthropomorphic Perception

Epley and colleagues differentiate between the cognitive, motivational, and dispositional determinants of anthropomorphism (Epley et al., 2007, 2008; Waytz et al., 2010a). In assessing an unknown nonhuman object, eliciting agent knowledge represents the cognitive determinant of anthropomorphism (Epley et al., 2007). If the perceived object seems similar to the self or to other human beings, it becomes more likely that the perceiver will activate highly accessible knowledge about humans (i.e., elicited agent knowledge) to assess the object (Epley et al., 2007; Waytz et al., 2010c). Therefore, the target object's *characteristics* influence the probability of anthropomorphism through the cognitive mechanism of elicited agent knowledge (Waytz et al., 2010b). Specifically, the more the perceived object resembles a human in terms of observable features and behavior, the higher the probability that humans will anthropomorphize it (Epley et al., 2007). Perceiving anthropomorphic design cues is a form of cognitive information processing. Previous studies have found that the human-like movement of geometric objects (Tremoulet & Feldman, 2000) and robots (Kiesler et al., 2008) stimulate perceptions of anthropomorphism.

The theory of anthropomorphism identifies two motivational determinants—sociality and effectance motivation—that influence the probability of anthropomorphizing a nonhuman object in different situations (Epley et al., 2007). Sociality motivation relates to humans' basic need to be socially related to other humans. In situations that stimulate a desire to be socially connected or that increase feelings of loneliness, people are more likely to anthropomorphize (Epley, Akalis, Waytz, & Cacioppo, 2008a; Epley et al., 2008b). Effectance motivation relates to humans' basic need to understand and control one's environment. Where human knowledge of a novel nonhuman agent (e.g., CA) is limited, but a person has to rely on the agent for a specific task, anthropomorphizing the agent in order to reduce perceptions of uncertainty and increase feelings of confidence is particularly likely (Epley et al., 2007). In contrast to the cognitive determinant, these motivational mechanisms are best described as drive states triggered by feelings of deprivation in terms of social connection (sociality motivation) or control (effectance motivation) (Epley et al., 2007). The motivational and cognitive influences of anthropomorphism are independent as they are based on separate psychological mechanisms (Epley et al., 2007).

Lastly, individual dispositions have been identified as an important determinant of anthropomorphism (Waytz et al., 2010a). This was not explicitly considered as a separate determinant in Epley et al.'s (2007) initial description of the theory of anthropomorphism, but subsequently Waytz, Epley, and Cacioppo (2010a) added it to complement the theory. The manifold sources of different individual dispositions include education, culture, previous experiences, cognitive reasoning style, and norms (Epley et al., 2007). For example, people from a culture associated with high uncertainty avoidance (e.g., Japan) are more prone to anthropomorphize novel agents than someone from a culture associated with low uncertainty avoidance (e.g., the USA) (de Waal, 2003; Epley et al., 2007). Similarly, individuals who, confronted with new situations, tend to engage in onerous cognitive processing (i.e., high need for cognition) are less prone to anthropomorphize than individuals with a low need for cognition (Epley et al., 2007).

To summarize, the theory of anthropomorphism provides us with relevant knowledge of anthropomorphism determinants related to either the object being perceived (cognitive) or the perceiver (motivational and dispositional). Figure 2 gives an overview of the determinants involved in the anthropomorphizing process.

Theory of Anthropomorphism and User-centered Technology Design

We argue that the three determinants of anthropomorphism introduced above have to be considered in the design of anthropomorphic HCI. To interpret this psychological knowledge from an HCI perspective, we use Benyon's (2014) framework for user-centered HCI design involving people, activities, contexts, and technologies (PACT) that map onto the three identified determinants. The technology factor of the PACT framework that concerns designing a technology with observable features and interactive behavior, maps onto the cognitive determinant of anthropomorphism. The theory of anthropomorphism states that eliciting anthropomorphic knowledge is stimulated if the object being perceived has a human-like appearance and behavior (Waytz et al., 2010c). Accordingly, technology design characteristics that simulate human features, prompt anthropomorphism. The PACT factors activities and contexts highlight that technology design needs to correspond with specific tasks users need a technology to perform in a given context. These factors best relate to the two motivational determinants (i.e., sociality and effectance) (Epley et al., 2008a) because for some tasks anthropomorphizing an interaction partner could respond to the user's motivational needs, but for other tasks not. The people factor of the PACT framework advises that we consider individual differences related to psychological and social variables. This factor corresponds with the role of dispositional anthropomorphism (Waytz et al., 2010a), that is individuals' tendency to anthropomorphize. This mapping of the PACT framework onto the three determinants of anthropomorphism provides a basis for developing our design framework.

Developing a Framework for the Design of Anthropomorphic Conversational Agents

Figure 3 illustrates our theoretical framework for designing and researching anthropomorphic CAs. The three factors are derived from the three determinants of anthropomorphism and are structured according to the PACT framework. In the following, we integrate relevant literature from related studies to detail how each factor relates to perceptions of anthropomorphism in CA interactions. Based on this literature analysis, we formulate our research hypotheses.

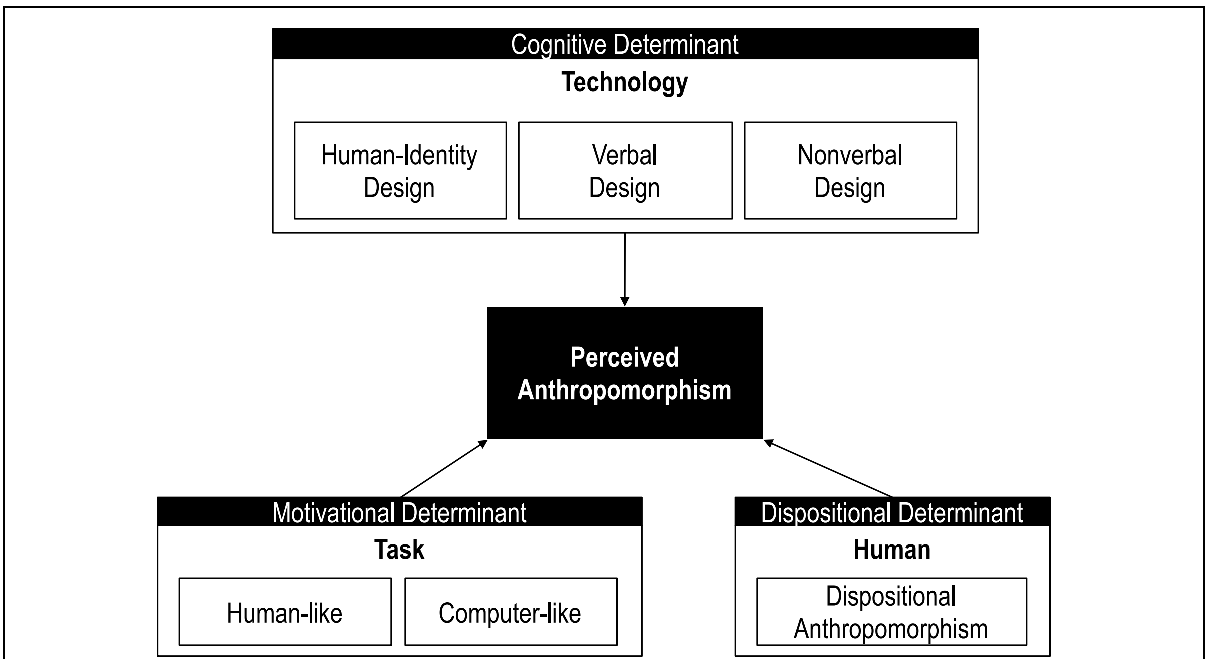


Figure 3. Framework of Anthropomorphic Conversational Agent Design

Technology: Anthropomorphic Design of CAs

To understand how the design of CAs can stimulate anthropomorphism, we reviewed studies that focus on how human-like computer interfaces are designed or perceived. For the review, we selected studies that focus on design elements clearly defined as anthropomorphic. Appendix A gives details of our search and selection criteria.

The theory of anthropomorphism predicts a positive relationship between the degree to which nonhuman agents' observable features appear human-like and the perception of anthropomorphism (Epley et al., 2007). Human resemblance can be manifested in the nonhuman entity's appearance or behavior (Waytz et al., 2010b). In line with the theory of anthropomorphism, we distinguish between observable features and behavior. The observable *features* of a target object are stable characteristics that resemble humanness (Epley et al., 2007). We categorize identified design cues that convey such stable information of humanness as the design dimension of *human identity*. Observable *behavior*, by contrast, is more dynamic and interaction-related (Epley et al., 2007). Such observable behavior of CAs is limited to their communication behavior. Following communication theory (Mehrabian, 1972), we distinguish between the two dimensions of *verbal* and *nonverbal* human-like communication behavior. These two behavioral dimensions play a special role as they convey a CA's intelligence. Psychological research (Brody, 2004; Salovey & Mayer, 1990) identifies two forms of intelligence: cognitive and emotional intelligence. The former represents the performance-related ability to solve problems in different contexts (Brody, 2004), while the latter represents the ability to understand and react to others' feelings and emotions (Salovey & Mayer, 1990). Intelligence is generally considered a human capacity, and thus is important in designing anthropomorphic CAs. For this reason, we relate specific verbal and nonverbal cues to these notions of intelligence whenever appropriate. In all, we group the identified anthropomorphic design cues into three design dimensions: human identity, verbal, and nonverbal cues. Tables 2 and 3 give an overview of the identified cues and reviewed studies, respectively.

Table 2. Identified Anthropomorphic Cues

Anthropomorphic Cue		Example	Reference
Human Identity	Human-like visual representation	Images of humanoid robots, human-like avatars, real human faces	Berry et al., 2005; Gong, 2008; Qiu & Benbasat, 2009; Riedl et al., 2011; Yuan et al., 2016
	Demographic information	Gender, age, name, ethnicity	Cowell & Stanney, 2005; Qiu & Benbasat, 2010; Benbasat et al., 2010; Nunamaker et al., 2011
Verbal	Social dialogue	Greeting rituals (“Hi, how are you?”), anecdotes, non-task related questions (“How is the weather in Berlin?”)	Bickmore & Cassell, 2001; Bickmore & Picard, 2005; Chattaraman et al., 2019
	Emotional expressions	Apologies (“I am sorry”), congratulations (“well done!”), concerns ("I am worried")	Al-Natour, Benbasat, & Cenfetelli, 2010; De Visser et al., 2017
	Verbal style	Self-references ("I", "me"), active voice, variability of syntax and words	Chattaraman et al., 2019; Sah & Peng 2015
	Context-sensitive responses	Adjust responses to individual user input	Knijnenburg & Willemsen, 2016; Schuetzler et al., 2014
Nonverbal	Emoticons	😊, 😉, 😕, 😣, 👍	Derks, Bos, & Grumbkow, 2008; Walther & D’Addario, 2001
	Temporal cues	Delayed responses to signal writing or thinking	Feine, Gnewuch, Morana, & Maedche, 2019; Gnewuch, Morana, Adam, & Maedche, 2018
	Turn-taking gestures	Blinking dots, “is typing” indicator	De Visser et al., 2016; Gnewuch, Morana, Adam, & Maedche, 2018

The *human identity dimension* includes stable cues that typically help to identify a human being in a computer-mediated interactional context (Donath, 1998; Lampe, Ellison, & Steinfield, 2007). Human-like visual representations and demographic information constitute this dimension (see Table 2). The most used anthropomorphic cue by reviewed studies is *human-like visual representation*. The theory of anthropomorphism argues that “the extent to which a nonhuman agent's observable features look humanlike" (Epley et al. 2007, p. 869) increases perceptions of anthropomorphism in the perceiver. More precisely, nonhuman agents' morphological similarity stimulates the cognitive determinant of anthropomorphism: the perceiver is more likely to use their knowledge of human agents to assess nonhuman agents that appear human-like.

The reviewed studies investigating human identity cues as independent variables and anthropomorphism as a dependent variable (see Table 3) provide insight in these cues' actual effects. For example, Araujo (2018) gives the experimental CA a human name in the anthropomorphic condition, which produces higher perceptions of anthropomorphism than the nonanthropomorphic version of the CA. Simultaneously, they enhanced the anthropomorphic CA with human-like verbal cues, therefore it is not clear whether the adopted human identity, the verbal cues, or their interaction caused participants' anthropomorphic response. Other studies have the same issue of not differentiating the effects of different cue types (see De Visser et al., 2016; Kiesler et al. 2008; Waytz et al. 2014). However, three of the reviewed studies investigated human identity cues independently of other cue types with mixed findings regarding anthropomorphic responses (Niu et al., 2018; Sah & Peng, 2015; Yuan & Dennis, 2017). While Niu et al. (2018) and Yuan and Dennis (2017) find a significant positive effect of human identity cues on perceived anthropomorphism, Sah and Peng (2015) do not find such a significant effect of the same cues. Still, one should note that these three studies do not focus on CAs; they investigate the effect of anthropomorphic design on different technological artifacts (see Table 3). Sah and Peng (2015), for instance, investigate the anthropomorphic design of a static health website, which, regarding the interactional experience, is not comparable to a CA. Therefore, these findings' applicability to CA design is limited.

Previous studies overall provide initial justification to argue that human identity cues stimulate perceived anthropomorphism in CA users. Because human identity cues increase the human-like appearance of CAs, we follow Epley et al. (2007) in arguing that this morphological similarity eases the use of anthropomorphic knowledge when people interact with CAs. Hence, we formulate the following hypothesis:

Hypothesis 1a: CA designs with human identity cues evoke higher perceptions of anthropomorphism than designs without human identity cues.

Cues that emulate human-like communicative behavior have been categorized into the two dimensions of verbal and nonverbal cues. Following Isbister and Nass (2000), the dimension of *verbal cues* includes the choice of words and sentences as well as the way in which a speaker refers to her-/himself ("I") and others. Correspondingly, manipulating verbal cues does not affect a conversation's task-oriented content, but does affect *how* the conversation unfolds. We identify several verbal strategies that make agents appear more human-like. One such strategy is the use of social dialogue. Social dialogue refers to non-task-oriented talk that seeks to establish an emotional relationship in a conversation—commonly known as *small talk* (Bickmore & Cassell, 2005). A related verbal strategy is the use of emotional expressions (De Visser et al., 2017). Context-sensitive use of emotional expressions in addition can signal emotional intelligence (Salovey & Mayer, 1990). While social dialogue and emotional expressions represent verbal cues that are added to the task-oriented content, we also identified several verbal strategies that change only the verbal style of a computer agent. Human-like verbal style was increased by introducing self-reference (Sah & Peng, 2015), active voice (Hess et al., 2009; Sah & Peng, 2015), coherent responses (Burgoon et al., 2016) and variability of words and syntax (Schuetzler et al. 2014). Finally, varied and context-sensitive responses were used to increase the human-likeness of an agent's verbal behavior (Knijnenburg & Willemsen, 2016; Schuetzler et al., 2014). According to Laurel (1997), such responsive behavior is characteristic of human cognitive intelligence by showing the agent can understand a context-sensitive problem and respond appropriately. In sum, research has identified several verbal strategies to enhance CAs' human-likeness (see Table 2).

The dimension of *nonverbal cues* can be defined as "all potentially informative behaviors that are not purely linguistic in content" (Hall & Knapp, 2013, p. 6). This dimension includes visible cues such as facial expressions, head, hand, and body movements, and interpersonal gaze. Several studies enable ECAs to perform nonverbal behaviors, such as hand gestures, eye contact, and facial expressions (Berry, Butler, & de Rosis, 2005; Bickmore & Picard, 2005; Bickmore & Cassell, 2005; Cowell & Stanney, 2005; Nunamaker et al., 2011), which do not apply to CAs (see section *Conversational Agents and Related Technological Artifacts*). However, there are ways of adapting nonverbal behavior to CAs' design space. For example, emoticons are nonverbal signs that convey emotional expressions in text-based computer-mediated communication (Derks, Bos, & Grumbkow, 2008; Walther & D'Addario, 2001). Extant IS research on computer-mediated text-based human-to-human communication has established the role of emoticons in eliciting emotional and social responses (Brown, Fuller, & Thatcher, 2016; Wang, Zhao, Qiu, & Zhu, 2014). Enabling a CA to use these nonverbal cues to react appropriately to user input also conveys emotional intelligence (Salovey & Mayer, 1990). Another nonverbal code system in computer-mediated communication is temporal cues (Walther & Tidwell, 1995). The time it takes to receive a reply from a CA represents another instrument of anthropomorphic CA design (Feine, Gnewuch, Morana, & Maedche, 2019; Gnewuch, Morana, Adam, & Maedche, 2018). Finally, nonverbal turn-taking cues can also be implemented in text-based CAs (De Visser et al. 2016). See Table 2 for examples of the identified nonverbal cues.

The human-likeness of CAs' observable behavior can be enhanced by the above-mentioned verbal and nonverbal cues. According to the theory of anthropomorphism, human-like observable behavior also stimulates the cognitive determinant *elicited agent knowledge* (Epley et al., 2007). This means that perceivers are more likely to draw on their knowledge of humans when assessing nonhuman interaction partners that exhibit typical human behavior. Analogous to the human identity cues dimension, several studies have investigated the effect of verbal and/or nonverbal cues on anthropomorphism (see Table 3). For example, De Visser et al. (2016) allowed an experimental agent to give participants empathic feedback. In line with the theory of anthropomorphism, they find that participants anthropomorphize the experimental interaction partner more readily when the latter uses such verbal cues. However, their computer agent was simultaneously enhanced with human identity cues. Thus, once again, it is unclear which cue type caused the positive effect on anthropomorphism. The same ambiguity applies to the studies by Araujo (2018), Kiesler et al. (2008), and Waytz et al. (2014). By contrast, Schuetzler et al. (2014) focus solely on verbal cues. More precisely, their anthropomorphic CA was able to respond in varying ways to user input, while the nonanthropomorphic CA always used the same static responses. The authors find that the anthropomorphic CA produced higher perceptions of anthropomorphism. Relatedly, Sah and Peng (2015) reveal that using a personalized language on a website positively influences perceptions of anthropomorphism. As the theory of anthropomorphism predicts, these two studies show that verbal cues can have a positive effect on perceptions of anthropomorphism. None of the reviewed studies provides evidence that nonverbal cues—independently of other cues—positively affect perceived anthropomorphism. However, similar to verbal cues, nonverbal cues make a CA's communicative behavior more human-like. Epley et al. (2007) argue that the human-like behavior—similar to the human-like appearance—of a nonhuman agent can stimulate anthropomorphism through the cognitive determinant elicited agent knowledge. Therefore, we argue that both forms of communicative behavior increase the perceiver's use of anthropomorphic knowledge in interaction with CAs. Accordingly, we formulate the following hypotheses:

Hypothesis 1b: CA designs with verbal cues evoke higher perceptions of anthropomorphism than designs without verbal cues.

Hypothesis 1c: CA designs with nonverbal cues evoke higher perceptions of anthropomorphism than designs without nonverbal cues.

Table 3. Overview of Reviewed Studies

Reference	Area	Anthropomorphized Object	Dependent Variable(s)	Anthropomorphic Design Dimension		
				Verbal Cues	Non-verbal Cues	Human Identity Cues
Al-Natour et al. (2010)	IS	Recommendation Agent	Trust	x		
Araujo (2018)	HCI	CA	Anthropomorphism, Social Presence, Company Perception	x		x
Benbasat et al. (2010)	IS	Recommendation Agent	Social Presence			x
Bickmore & Cassell (2001)	HCI	ECA	Likability, Helpfulness	x		
Bickmore & Picard (2005)	HCI	ECA	Likability, Trust	x	x	x
Burgoon et al. (1999)	HCI	ECA	Interaction Involvement, Mutuality, Social Judgment, Decision Quality	x		x
Burgoon et al. (2016)	HCI	ECA	Communication Process, Social Judgment, Influence	x		x
Cowell & Stanney (2005)	HCI	ECA	Likability, Trust		x	x
Chattaraman et al. (2019)	HCI	CA	Trust, Usefulness, Information Overload, Ease of Use, Interactivity	x		
Cyr et al. (2009)	IS	Website	Social Presence, Trust, Image Appeal			x
Diederich, Janßen-	IS	CA	Humanness, Social Presence, Empa-	x	x	x

Müller, Brendel, & Morana (2019)			thy, Satisfaction			
Diederich, Lichtenberg, Brendel, & Trang (2019)	IS	CA	Humanness, Persuasiveness	x	x	x
De Visser et al. (2016)	PSY	Avatar	Trust, Anthropomorphism	x	x	x
Gong (2008)	HCI	Recommendation Agent	Social Response			x
Gnewuch et al. (2018)	HCI	CA	Humanness, Social Presence, Satisfaction	x	x	
Hess et al. (2009)	IS	Recommendation Agent	Social Presence	x		x
Kiesler et al. (2008)	HCI	ECA	Information Disclosure, Social Influence, Anthropomorphism	x	x	x
Knijenburg & Willemsen (2016)	HCI	CA	Social Response, Performance	x		x
Niu et al. (2018)	HCI	Driving Agent	Anthropomorphism, Trust, Liking			x
Nowak & Biocca (2003)	HCI	Avatar	Social Presence			x
Nunamaker et al. (2011)	IS	ECA	Trust, Expertise, Likability		x	x
Pickard et al. (2017)	HCI	ECA	Similarity, Likability, Information Disclosure			x
Qiu & Benbasat (2009)	IS	Recommendation Agent	Social Presence			x
Qiu & Benbasat (2010)	IS	Recommendation Agent	Social Presence, Enjoyment, Usefulness			x
Riedl et al. (2014)	IS	Avatar	Mentalizing, Trusting Behavior			x
Sah & Peng (2015)	HCI	Website	Anthropomorphism	x		x
Schuetzler et al. (2014)	IS	CA	Anthropomorphism	x		
Schuetzler et al. (2018)	IS	CA	Socially Desirable Behavior	x		x
Sproull et al. 1996	HCI	CA	Socially Desirable Behavior			x
Verhagen et	HCI	ECA	Social Presence,		x	x

al (2014)			Personalization, Satisfaction			
Von der Pütten et al. (2010)	HCI	ECA	Social Presence		x	x
Waytz,Heafner& Epley (2014)	PSY	Driving Agent	Anthropomorphism Trust	x		x
Wölfl, Feste, & Peters (2019)	IS	Webshop	Anthropomorphism			x
Yuan et al. (2016)	IS	Product in Webshop	Willingness to Pay			x
Yuan & Dennis (2017)	IS	Product in Webshop	Anthropomorphism Willingness to Pay			x
IS=Information Systems, HCI=Human-computer Interaction, PSY=Psychology ECA=Embodied Conversational Agent, CA=Conversational Agent						

Interaction of Anthropomorphic Design Dimensions

Although several studies have considered more than one anthropomorphic design dimension (see Table 3) their assumptions about interaction effects are only implicit. For example, none of the reviewed studies relies on nonverbal cues as the sole cue of anthropomorphic design. Rather, such cues are combined with verbal or human identity cues (Bickmore & Picard, 2005; Cowell & Stanney, 2005; Nunamaker et al., 2011). Similarly, other studies intuitively combine verbal and human identity cues in their anthropomorphic designs (Araujo, 2018; Knijenburg & Willemsen, 2016). Overall, researchers' intuitions seem to suggest that combining several design dimensions has a positive effect on users' anthropomorphism perceptions. Still, the theoretical basis for the design dimensions' potential interaction effect remains unclear.

We find one theoretical perspective on this relationship in the uncanny valley effect (Mori, 1970). Originally found in robotics research, this effect describes how subtle imperfections in the anthropomorphic appearance of nonhuman agents can cause users to focus more on the apparently nonhuman details (MacDorman et al., 2009). Mori (1970) illustrates this effect with a curve that describes how an increase in an object's observable human-likeness relates to perceived likability. Likability in that context denotes the “feeling of being in the presence of another human being—the moment when you feel in synchrony with someone other than yourself and experience a ‘meeting of minds’” (Hsu, 2012), which is closely related to anthropomorphism. As the object becomes more human-like, its likability increases until it drops from a relatively high level of human-likeness, and the typical valley pattern occurs. Mori (1970) likens this effect to a prosthetic hand that is perceived to be human until one touches it and realizes it is cold and unhuman. Researchers repeatedly find that a mismatch of the nonhuman and human-like characteristics of a target object causes ambiguity, which leads to the object being assessed as less human-like, thus causing an uncanny response (Burleigh, Schoenherr & Lacroix, 2013; MacDorman et al., 2009; Saygin, Chaminade, Ishiguro, Driver, and Frith, 2012, Seyama & Nagayama, 2007; Wiese & Weis, 2020). Relatedly, findings show that less human-like interaction partners can stimulate higher likability than nearly perfect human replicas because they do not cause a perceptional conflict (Mathur & Reichling, 2016). In sum, this literature argues that successful anthropomorphic designs are not simply those with a higher number of anthropomorphic cues; rather, successful designs ensure consistency of the overall human-like manifestation.

Anthropological and communication research offer another theoretical perspective on how anthropomorphic design dimensions are related. Communication research considers human nonverbal and verbal communication as an inseparable unit in which verbal communication is supported by nonverbal cues (Argyle, 1969; Knapp et al., 2014). Recipients find a mismatch between nonverbal and verbal cues disturbing and confusing (Argyle, 1969). Moreover, human nonverbal communication emerges from primate communication, while verbal communication is a uniquely human aspect of human cognition (Burling et al., 1993; Knapp, Hall, & Horgan, 2014). Therefore, combining nonverbal cues with human identity cues or verbal cues might be required to stimulate anthropomorphism. Based on these considerations, using nonverbal cues without other matching cues possibly produces a disturbing image of a human-like interaction partner.

The suggestion that target objects highly similar to real human beings activate the cognitive determinant *elicited agent knowledge* (Epley et al., 2007) contradicts literature on the uncanny valley effect according to which increased human-likeness of the target object is not necessarily the best approach. Therefore, designers should ensure a consistent balance in their human-like designs. Further, anthropological and communication research argues that nonverbal cues need to be accompanied by other cues to create a human-like design. In sum, the discussed theoretical perspectives support the idea that the effects of different anthropomorphic design dimensions are interrelated. However, conflicting perspectives on the benefits of combining all or only some anthropomorphic design dimensions preclude the possibility of formulating a clear prediction on potential interaction effects. To address this ambiguity, we state the following exploratory research question:

Exploratory RQ: Are there interaction effects among anthropomorphic design dimensions?

Task: Task-specific Effects on Users' Motivation to Anthropomorphize CAs

The theory of anthropomorphism postulates that humans' motivation to anthropomorphize nonhuman objects varies across tasks and situations. More specifically, depending on the particular task, humans need to be socially related to a nonhuman interaction partner (sociality motivation) and/or to understand and control it (effectance motivation) (Epley et al., 2008b). Perceptions of anthropomorphism, in turn, satisfy both sociality and effectance motivations. Empirical evidence supports the relationship between these two motivational forces and anthropomorphism. For sociality motivation, both Epley et al. (2008a) and Eyssel and Reich (2013) manipulated feelings of loneliness and in turn sociality motivation in an experimental study. Participants with a high sociality motivation showed significantly higher perceptions of anthropomorphism towards several objects (Epley et al., 2008a) and robots (Eyssel and Reich, 2013) than those less sociality motivated. For effectance motivation, social cognition experiments have repeatedly used different types of tasks to evoke anthropomorphism (for a review, see Mar, 2011). For example, Fletcher et al. (1995) evoked anthropomorphism by asking participants to read stories that require anthropomorphic imagination to properly understand the story. Rilling, Dagenais, Goldsmith, Glenn, and Pagnoni (2008) asked participants in a neuro-imaging experiment to engage in a social task that required anthropomorphic understanding for successful completion. Their results show that brain areas associated with anthropomorphic perception are more active during tasks that require anthropomorphic sense-making to complete the task effectively. This body of experimental research demonstrates that sociality and effectance motivation can be activated in a specific task context to stimulate anthropomorphic perceptions. We posit that this also applies to the design of anthropomorphic CA interactions because CAs are utilized in a variety of tasks that differ concerning the extent to which sociality and effectance motivation are activated.

In 1994, Don Norman anticipated that computer agents would "take over human tasks, and [would] interact with people in human-like ways" (Norman, 1994, p. 68). He suggested that the tasks these agents perform for human beings would range from providing assistance and guidance (e.g., selecting and booking a hotel) to mastering tasks humans could not carry out without a computer agent. Indeed, today's ecosystem of CAs covers a wide variety of tasks and use contexts (see Table 4 for an overview). Combining Norman's anticipation with our evaluation of existing CAs, we conclude that CA tasks can be differentiated along a continuum of tasks ranging from human-like to computer-like. Human-like tasks include ones that humans typically do as part of completing an interaction with a human partner, such as learning a new sport. Such tasks require humans to engage in anthropomorphic perceptions to make sense of the interaction (e.g., empathy after failure). Computer-like tasks include ones that humans typically perform with computer assistance, such as online banking transfers.

Such tasks do not require that humans engage in anthropomorphic perceptions to make sense of the interaction.

Table 4. Overview of Application Domains for Conversational Agent		
Conversational Agent Use Context	Example CA Tasks	Real-world Examples
E-commerce	Understand customer needs, provide advice on products and services.	*eBay ShopBot, Whole Foods Market, Lidl UK, Sephora, SnapTravel, Lufthansa, HLX.com*
E-banking	Conduct bank transfers, provide account information.	*Mastercard, k2.pl, American Express*
Customer Service	Answer questions about contract details, handle complaints.	*Coca-Cola US, Windstream, British Gas, Geico, KLM, Mercedes, ARAG*
Tutoring/Teaching	Teach new lessons (e.g., language, mathematics), motivate to learn, and keep engaged.	*Duolingo, Grapheme, Ovoto*
Health/Fitness Coaching	Listen to users' health/fitness issues/goals, provide guidance, motivate.	*Woebot.io, Babylon Health, Insomnobot-3000, HelloAva, Health Tap, Atlas*
Internet of Things (IoT)	Control and adjust settings of remote devices, provide information on status of devices.	*Thington, action.ai, Netatmo, Neato*
Business Operations	Conduct transactions in or retrieve data from enterprise systems (e.g., ERP, CRM).	*Kore.ai, Growthbot by HubSpot, Unit4, Pegg*
Business Services	Interview job candidates, provide assistance for employees (e.g., pay slip, leave requests, training).	*Allianz Careers, ABIe, HubBot by Telekom, Sixt Jobbot, Kore.ai*

Lankton and McKnight (2015) provide a similar distinction regarding the perceived human-likeness of technological artifacts. According to them, technologies that substitute human experts are perceived as more human-like than technologies that do not substitute human experts. Following this perspective, and based on the diversity of tasks CAs can perform, we argue that the distinction between human-likeness and computer-likeness should be made on the task level. Moreover, classifying a task as one of the two types can change over time. As automation steadily developed (see e.g., Brynjolfsson & McAfee, 2016; Frey & Osborne, 2017), tasks that were classified as human-like gradually shifted and are now seen as computer-like, as in banking transfers and purchase recommendations. Further, people tend to classify tasks differently along the continuum, based on their individual experiences.

According to Epley et al. (2007), the motivational determinant *sociality motivation* stimulates anthropomorphism in situations in which individuals feel the drive to be socially connected to others. Previous studies have found that situationally activated sociality motivation stimulates perceptions of anthropomorphism regarding different target objects such as robots (Eyssel & Reich, 2013; Wang, 2017) and consumer products (Chen, Sengupta, & Adaval, 2018). Research has further shown that interacting with an ECA satisfies users' need for social contact (Krämer, Lucas, Schmitt, & Gratch, 2018). We argue that, based on humans' drive to be socially connected, interactions in which the CA performs a human-like task triggers perceptions of anthropomorphism. A user who interacts with a CA asking advice on health issues, for instance, is accustomed to talking to a human being (e.g., physician, therapist). Therefore, we argue that this type of task stimulates anthropomorphism because the user requires a social component in the interaction (e.g., empathic feedback). Similarly, users who interact with a customer service CA in laying a complaint seek a human-like response in the interaction (e.g., an apology). By contrast, a computer-like task does not trigger a social relatedness need in users. For example, users interacting with a CA to control a remote device or to retrieve data from a database do not have social expectations of the agent; rather they need a convenient way to complete the task. Because the human component is an integral part of human-like CA tasks but not of computer-like tasks, we argue that, based on the motivational determinant *sociality motivation*, users' perceptions of anthropomorphism are higher in interactions with CAs that perform human-like tasks.

The second motivational determinant of anthropomorphism, *effectance motivation*, is stimulated by tasks that provide "incentives associated with accurately understanding or predicting the behavior of a nonhuman agent" (Epley et al., 2007, p. 872). Previous studies have shown that effectance motivation is stimulated when a technological interaction partner performs tasks in a way that is difficult to understand and anticipate (Eyssel, Kuchenbrandt, & Bobinger, 2011; Waytz et al., 2010c). Because humans seek to understand and control their environment (White, 1959), completing tasks in nontransparent ways incentivizes anthropomorphizing the particular technological gadget (Epley et al., 2007). Other studies have shown that effectance motivation can also trigger anthropomorphism when completing the task requires anthropomorphic sense-making (Fletcher et al., 1995; Rilling et al., 2008). Accordingly, we argue that the incentives to anthropomorphize are higher in interactions with CAs performing human-like tasks because, in these cases, users feel that anthropomorphism will produce meaningful interactions. For example, a user might believe that a computer cannot understand physical or mental health issues that are uniquely human. Therefore, anthropomorphizing the agent can help inspire confidence in talking to it about these human-like topics. To successfully complete such a task requires the user to feel confident in the interaction. Consequently, the effectance motivation to anthropomorphize is high. As Norman (1994) points out, the need to feel confident and in control is high when machines take on human-like tasks. Otherwise, humans feel intimidated by the novel interaction partner and do not know how to engage with it in a meaningful way. By contrast, users' effectance motivation to anthropomorphize a CA performing a computer-like task is not as salient because there is no incentive to anthropomorphize. For example, users of a CA that controls remote home devices do not benefit from increasing their understanding of the agents' behavior through anthropomorphism because completing the task successfully happens independently of their anthropomorphic perception of the CA.

Overall, we argue that the distinction between human-like and computer-like tasks is important for studies interested in anthropomorphic CA interactions because sociality and effectance motivation increase the tendency to anthropomorphize CAs that perform human-like tasks. In line with our argumentation, we formulate the following hypothesis:

Hypothesis 2: CAs that perform human-like tasks elicit higher levels of perceived anthropomorphism than CAs that perform computer-like tasks.

Human: Individual Differences and Perceptions of Anthropomorphism

Not all users respond to the same computer interface in the same way, as HCI researchers have known for decades (Aykin, 1989; Egan, 1988). The manifold causes of these individual differences include physical and cognitive abilities, personality traits, demographics, developmental states, previous experiences, and cultural background (Egan, 1988). Analogously, not all humans respond to the same object with perceptions of anthropomorphism (Cullen, Kanai, Bahrami, & Rees, 2014; Waytz et al., 2010a). Instead, every individual has a stable tendency to anthropomorphize nonhuman objects (Epley et al., 2007). Previous studies in psychology (Caruso, Waytz, & Epley, 2010; Tam, 2014; Waytz et al., 2014; Willard & Norenzayan, 2013) and ergonomics (Chin, Sims, Clark, & Lopez, 2004; Chin et al., 2005) have used *dispositional anthropomorphism* to understand the phenomenon of anthropomorphism and its consequences for human perception and behavior. However, anthropomorphism studies in HCI have not recognized this dispositional determinant yet. Because the psychological body of research suggests this individual disposition as a relevant determinant of anthropomorphism, we expect to observe differences in the extent to which individuals anthropomorphize CAs, even when the CA's anthropomorphic design and task are kept stable. Therefore, we formulate the following hypothesis:

Hypothesis 3: The higher the level of dispositional anthropomorphism, the higher the users' perceptions of anthropomorphism.

Study Design

We conducted an online experiment through the panel company *clickworker* to validate our theoretical framework empirically, using a vignette technique. Vignettes are short descriptions of actual objects, situations, or persons given to stimulate participants' "beliefs, attitudes, judgments, knowledge, or intended behavior with respect to the presented vignette scenarios" (Atzmüller & Steiner, 2010, p. 129). In the context of HCI research, vignettes simulate actual interactions used to standardize and control the experimental interaction across all participants (Robert, Dennis, & Hung, 2009). This technique has previously been used to study users' perceptions of and attitudes to technology (e.g., Howell, Roberts, & Mancini, 2018; Vance, Lowry, & Eggett, 2015). Similar to our approach, Robert et al. (2009) presented simulated text-based interactions to experimentally analyze participants' perceptual responses. Other studies focuses on anthropomorphic design also applied the vignette technique to evaluate users' responses to technological artifacts (Eyssel et al., 2011; Pak, McLaughlin, & Bass, 2014). We used a full factorial design to examine the independent variables' (task type, anthropomorphic design, disposition to anthropomorphize) effect on the dependent variable (perceived anthropomorphism). All combinations of the two independent variables' task type (human-like or computer-like) and anthropomorphic design (verbal, nonverbal, human identity) were examined. The third variable of interest, namely the individual disposition to anthropomorphize, cannot be manipulated but represents a quasi-experimental variable. This resulted in 16 different CA designs, one for each condition. We used a between-subject design, randomly assigning participants to the 16 treatment groups (see Table 5).

Table 5. Treatment Groups

	NV+V+HI	NV+V	NV+HI	V+HI	NV	HI	V	None
Computer-like	1	2	3	4	5	6	7	8
Human-like	9	10	11	12	13	14	15	16

NV=Nonverbal; HI=Human Identity; V=Verbal

Task Type

We conducted two pretests to identify human-like and computer-like CA tasks that stimulate effectance and sociality motivation. For the first pretest, we described typical tasks of seven major CA classes (e-commerce, customer service, tutoring/teaching, health/fitness, Internet of Things, business operations, and business services; see Table 4) to 95 participants (61 females; age: M=37.9, SD=12.24). The pretest was conducted through the panel company *Prolific*. We asked each participant to rate 21 tasks (three for each class) on the extent to which the task is more human- or more computer-like (1= "very human-like", 7= "very computer-like"). We briefed participants to rate a task as more human-like (computer-like) if they believed the type of task is typically performed by a human being (computer program). This method of categorizing objects along a human-computer continuum was adapted from Touré-Tillery and McGill (2015). The pretest indicated that the most human-like task is conducted by a health agent who listens to a user and assists in handling stress and discomfort (M=1.97, SD=1.41). The most computer-like task, by contrast, was done by a smart home agent (Internet of Things class) that controls remote devices and provides statistics about usage (M=6.07, SD=1.22). A paired sample t-test confirmed a significant group difference ($t(94)=-20.768$, $p<.001$). In the further analysis, we focused on these two tasks that were rated to be the most human-like and computer-like, respectively.

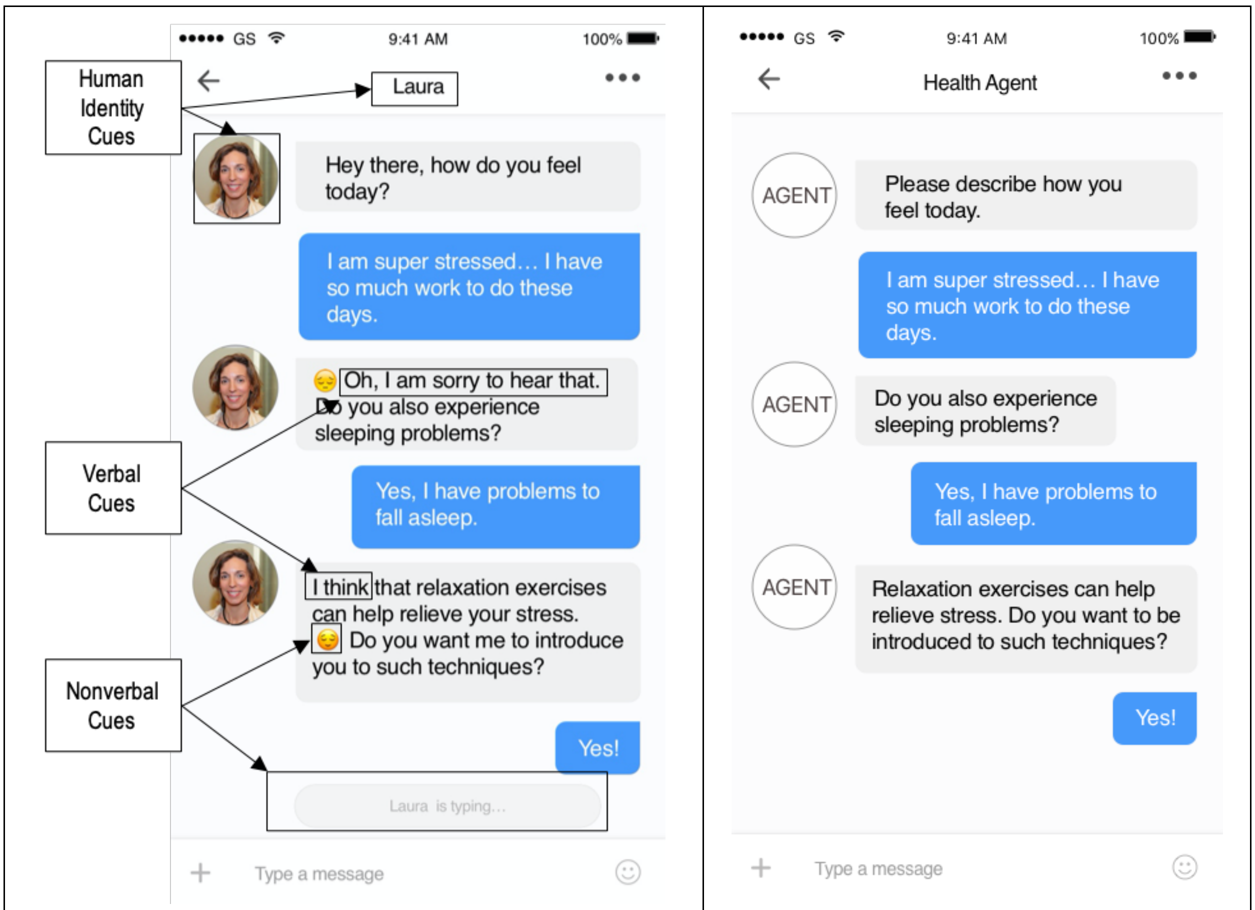
Next, we conducted a second pretest to ensure that the human-like task stimulates sociality and effectance motivation more than the computer-like task. We recruited 118 participants (40 females; age: M=37.9, SD=12.01) through the panel company *clickworker*. Participants were randomly assigned to read a description of one of the two tasks. Afterwards, we asked each participant to rate their level of sociality and effectance motivation using established seven-point Likert scales (Cheek & Buss (1981) for sociality motivation; Eyssel et al. (2011) and Waytz et al. (2010) for effectance motivation; see Appendix B). Two independent sample t-tests confirmed that the 60 participants who assessed the human-like CA task ($M_{Sociality}$=4.95, $SD_{Sociality}$=1.28; $M_{Effectance}$=5.61, $SD_{Effectance}$=.84) compared to the 58 participants who assessed the computer-like CA task ($M_{Sociality}$=4.01, $SD_{Sociality}$=1.46; $M_{Effectance}$=5.26, $SD_{Effectance}$=.96) reported significantly higher levels of sociality ($t(116)=-3.73$, $p<.001$) and effectance motivation ($t(116)=-2.003$, $p<.05$).

Participants and Procedure

For the main experiment, we invited native German speakers residing in Germany to take part in our online experiment because understanding anthropomorphic notions in verbal behavior requires advanced language competence. We carried out a language test to further ensure that all participants had the required language skills. After agreeing to the experiment's terms and conditions, participants were briefed on CAs, assuring their general understanding of the technology. We also informed them the CA was a computer program and not a human interaction partner. Depending on the task context, participants were informed of the tasks of either a health agent (human-like task) or a smart home agent (computer-like task) (see Appendix C). Next, participants saw one screenshot of a typical text-based dialogue between a user and the respective CA and were asked to carefully read the presented dialogue (see Figure 4). Each user observed one of the 16 possible CA designs. Subsequently, participants were asked to rate the CA design with respect to perceived anthropomorphism. Finally, participants completed a questionnaire including measures for dispositional anthropomorphism, previous experience with CAs, and demographic information. A total of 539 individuals participated in the experiment. Of the 539 participants, 21 failed the check for necessary language skills, four withdrew from the experiment, and 18 failed an attention check. After removing these participants from our sample, we analyzed the remaining 496 individuals' data.

Anthropomorphic Design

Based on our literature review, we operationalized human identity and verbal and nonverbal cues as follows: as human identity cues, we gave the CAs a human name ("Laura") and a human profile image; CAs without human identity cues were simply referred to as a health agent or a smart home agent, and they had no profile image. As anthropomorphic verbal cues, CAs used self-referencing pronouns (e.g., "I" and "me") and emotional expressions (e.g., "Oh, I am sorry") in communicating with the user. In the non-anthropomorphic condition, CAs used an impersonal style and emotionally neutral language. For anthropomorphic nonverbal cues, an "is typing" indicator was implemented, which enabled the CA to convey temporal cues of nonverbal behavior (Gnewuch et al., 2018). The indicator signals that the agent needs time to formulate a response and that it is engaging in turn-taking behavior. Moreover, the CA used emoticons as a digital substitute for nonverbal behavior supporting the content of the message. While emotional expressions and emoticons signal emotional intelligence, we deliberately decided not to manipulate cognitive intelligence because this would have manipulated the CA's performance (Brody, 2004). In terms of the CA's responsiveness and coherence, we therefore kept cognitive intelligence stable across conditions. We kept the text length equal across groups (see Figure 4 for the English translation of the stimulus material). Figure 4 illustrates two of the anthropomorphic designs for the health agent (see Appendix D for the smart home agent). Following Hauser, Ellsworth, and Gonzalez (2018), we used a separate sample to check that our manipulations of the design dimensions were effective. This approach ensured that the manipulation check did not affect our experimental measurement of anthropomorphism. The panel company, *clickworker,* invited 481 individuals to participate in our manipulation check. Participants were selected based on the same criteria used in the main experiment. By checking the participants' IDs, we ensured that no one took part in both the manipulation check and the main experiment. The experimental procedure corresponded with the main experiment except that directly after presenting the stimulus, we asked participants whether they had recognized the experimental CA's nonverbal, verbal, and human identity cues. Afterwards the manipulation check was over. We evaluated this categorical data with Pearson's chi-squared test. Participants in a nonverbal design treatment group reliably identified these cues (78.60%), as opposed to participants in a treatment group without these cues (17.46% erroneously stated that the CA had nonverbal cues) ($\chi^2(1)= 180.25$, $p<.001$). The same holds for the verbal ($\chi^2(1)=106.59$, $p<.001$, 91.32% vs. 48.12%) and human identity ($\chi^2(1)=298.96$, $p<.001$, 97.94% vs. 20.59%) design manipulation.



Left: Health agent with all types of cues highlighted. Right: Health agent with no cues.

Figure 4. Designs of Experimental Health Agent

Measures

We measured the dependent variable *perceived anthropomorphism* with a seven-item scale taken from the literature (Waytz et al., 2010c), which has been used in related studies (Kim & McGill, 2011; Touré-Tillery & McGill, 2015; Waytz et al., 2014). Participants were asked to report the extent to which they agree with the following statements: The CA has (1) a mind of its own, (2) intentions, (3) a free will, (4) consciousness, (5) desires, (6) beliefs, and (7) the ability to experience emotions.

To measure the quasi-experimental variable *dispositional anthropomorphism*, we deployed the *individual differences in anthropomorphism questionnaire* (IDAQ) (Waytz et al., 2010a). According to the IDAQ, dispositional anthropomorphism is composed of three subdimensions that reflect three commonly anthropomorphized classes of entities: natural entities, nonhuman animals, and technology (Waytz et al., 2010a). Each of these subdimensions was measured with five items. All responses were recorded on a seven-point Likert scale. Appendix E provides the measurement items and details on the validity of our measurement instruments.

Data Analysis Results

Of the 496 participants, 60.4% had never used a CA before. Of those who had previously interacted with a CA, 26% use CAs frequently (at least once a month), and 33.53% had used a CA only once before. The average age of the participants was 36.7 (SD=12.62), and there were 233 (46.98 %) females. Previous experience as well as age had no significant effect on perceptions of anthropomorphism (see Appendix F, Table A5). Therefore, we only included gender in our further analysis. Descriptive statistics are provided in Table 6. A *post hoc* power analysis via GPower (Faul, Erdfelder, Buchner, & Lang, 2009) indicates an effect size of f^2 of .036 and a power of .94. Thus, the achieved power exceeds the conventional power level of .80 (Cohen, Cohen, West, & Aiken, 2003), so that our sample size can be considered large enough to detect significant effects.

Table 6. Descriptive Statistics					
	Mean	**s.d.**	**N**	**Min.**	**Max.**
Perceived Anthropomorphism	2.58	1.47	496	1	7
Dispositional Anthropomorphism	3.06	.83	496	1	6.4
Perceived Anthropomorphism by Treatment	**Mean**	**s.d.**	**N**	**Min.**	**Max.**
Design					
None	2.53	1.32	66	1	6.29
Nonverbal	2.1	1.33	61	1	6
Verbal	2.67	1.51	62	1	7
Human Identity	2.56	1.44	65	1	6
Nonverbal x Verbal	2.85	1.49	64	1	5.86
Nonverbal x Human Identity	2.85	1.51	59	1	6
Verbal x Human Identity	2.47	1.54	58	1	6.57
Nonverbal x Verbal x Human Identity	2.6	1.6	61	1	6
Task Type					
Human-like	2.91	1.56	237	1	7
Computer-like	2.28	1.32	259	1	6.57

To test in a single common model whether the three different factors (technology, task, individual) in our framework influence perceived anthropomorphism, we used an OLS multiple regression analysis. Robust standard errors were used in all regressions to account for heteroskedasticity, based on the Breusch-Pagan test (Cohen, Cohen, West, & Aiken, 2003). We expected minimal issues with multicollinearity because of the full factorial experimental design (design cues, task type), including only one quasi-experimental variable (dispositional anthropomorphism) and one control variable (gender) that could have been correlated with the other independent variables. Indeed, all the variance inflation factor values (VIFs) ranged between 1.00 and 6.94 (see Appendix F, Table A6), thus falling well below the cutoff of 10 (Hair, Anderson, Tatham, & Black, 1995). In Model 1, our analysis checked whether each design dimension, task type, and dispositional anthropomorphism had a significant main effect on perceived anthropomorphism. Therefore, the dependent variable *perceived anthropomorphism* was regressed on the three dummy-coded independent design variables (*nonverbal, verbal, and human identity*), task type (dummy variable with 0=*computer-like*, 1=*human-like*), dispositional anthropomorphism (standardized as z-score), and gender (dummy variable with 0=*female*, 1=*male*). Model 1 explains a significant proportion of the variance in perceived anthropomorphism (R^2=.1393, F(6, 489) = 14.33, p<.001). The regression revealed no significant main effects for the three design dimensions (H1a-c) but a significant effect of task type (H2: β=.638, t(489)=5.10, p<.001), dispositional anthropomorphism (H3: β=.433, t(489)=6.51, p<.001), and gender (β=.3, t(489)=2.42, p=.016). Perceptions of anthropomorphism, according to Hypothesis 2, are higher in interactions with CAs that perform human-like tasks (see also Appendix G 5). Specifically, perceived anthropomorphism increases by .638 units on the seven-point Likert scale if the task is human-like. Moreover, as Hypothesis 3 predicted, dispositional anthropomorphism has a significant impact on users' perceived anthropomorphism in a CA. More precisely, a one standard deviation increase in dispositional anthropomorphism relates to an increase in perceived anthropomorphism by .433 units. To identify the three anthropomorphic design dimensions' potential interaction effects (exploratory research question), we used an OLS regression that allows for two-way and three-way interactions. In Model 2, the dependent variable *perceived anthropomorphism* was regressed on the three dummy-coded independent design variables (*nonverbal, verbal, and human identity*), along with their interaction terms, task type, dispositional anthropomorphism, and gender. This model explains a significant proportion of the variance in perceived anthropomorphism (R^2=.1693, F(10, 485)=11.99, p<.001). The outcome of a likelihood ratio test shows that Model 2 results in a statistically significant improvement of the model fit (χ2(4)=17.55, p=.0015). Table 7 summarizes these regression results both Model 1 and Model 2.

Table 7. Regression Results for Perceived Anthropomorphism				
	Model 1		**Model 2**	
	Linear model estimates (robust std. errors)	p-value	Linear model estimate (robust std. errors)	p-value
First-order terms				
Nonverbal	.037 (.123)	.767	-.568 (.199)	.004**
Verbal	.134 (.123)	.276	.105 (.211)	.621
Human Identity	.12 (.124)	.331	.068 (.217)	.753
Second-order terms				
Nonverbal x Verbal	-	-	.798 (.311)	.011*
Verbal x Human Identity	-	-	-.308 (.335)	.359
Nonverbal x Human Identity	-	-	.871 (.321)	.007**
Third-order terms				
Nonverbal x Verbal x Human Identity	-	-	-.892 (.491)	.070
Task Type (0=computer-like, 1=human-like)	.638 (.125)	.000***	.636 (.49)	.000***
Dispositional Anthropomorphism (z-score)	.433 (.066)	.000***	.461 (.065)	.000***
Control: Gender (0=female, 1=male)	.3 (.124)	.016*	.317 (.125)	.011*
Constant	1.973 (.137)	.000***	2.075 (.154)	.000***
R^2 Adjusted R^2	.1393 .1289	.000***	.1693 .1521	.000***
Observations	496		496	
* p<0.05, ** p<0.01,*** p<0.001				

Following Aiken and West (1991), we first analyzed the conditional interaction effect of the first-order terms. Each of the three coefficients estimates the effect of the respective design dimension on perceived anthropomorphism when the other two dimensions equal 0 (Aiken & West, 1991). Those designs that include either solely human identity or solely verbal cues, and therefore no cues from the remaining two design dimensions, do not have a significant influence on perceived anthropomorphism. Moreover, designs that include nonverbal cues and no cues from the other two design dimensions have a significant negative effect on perceived anthropomorphism (β=-.568, t(485)=-2.86, p=.004). On the seven-point Likert scale, the responses are estimated to decrease by 0.568 when only nonverbal cues are added, compared to not adding any cue. Next, we analyzed the second-order terms' conditional interaction effect. They describe each two-way interaction term's effect on perceived anthropomorphism when the design dimension that is not included in the interaction term equals 0 (Aiken & West, 1991). We find that the combinations of (i) nonverbal and verbal cues (β=.798, t(485)=2.57, p=.011) and (ii) nonverbal and human identity cues (β=.871, t(485)=2.71, p=.007) have a significant positive effect on perceived anthropomorphism. Looking at the predictive margins, this means that when nonverbal cues are combined with verbal or human identity cues and no other cues are added the responses increase by .334 (combined with verbal) and .371 (combined with human identity), compared to a design without any cues. Thus, the data indicates an effect of complementarity between nonverbal cues and verbal cues, as well as between nonverbal cues and human identity cues. This means the sole use of nonverbal cues harms anthropomorphism. This negative effect vanishes if nonverbal cues are complemented by verbal or human identity cues. Figure 5 plots these two conditional interaction effects. Simple slope tests on these two-way interactions show that the effect of nonverbal cues on perceived anthropomorphism is negative and significant for designs without verbal and human identity cues (b=-.569, p=.005), and positive, albeit non-significant, for designs with verbal (b=.230, p=.342) or human identity cues (b=.303, p=.23). Finally, we analyzed the third-order interaction term, finding that the three-way interaction has a negative coefficient and is not significant (see Table 7). This indicates that designs considering all design dimensions are not evaluated the highest concerning perceptions of anthropomorphism. According to our findings and in line with our analysis above, hypotheses 1a-c are not supported; however, we find interesting interaction effects of pairwise combinations of cues in response to our exploratory research question. Model 2 reveals a significant effect of task type (β=.636, t(485)=5.16, p<.001) and dispositional anthropomorphism (β=.461, t(485)=7.06, p<.001), which supports hypotheses 2 and 3. Table 8 summarizes the hypotheses tests' results.

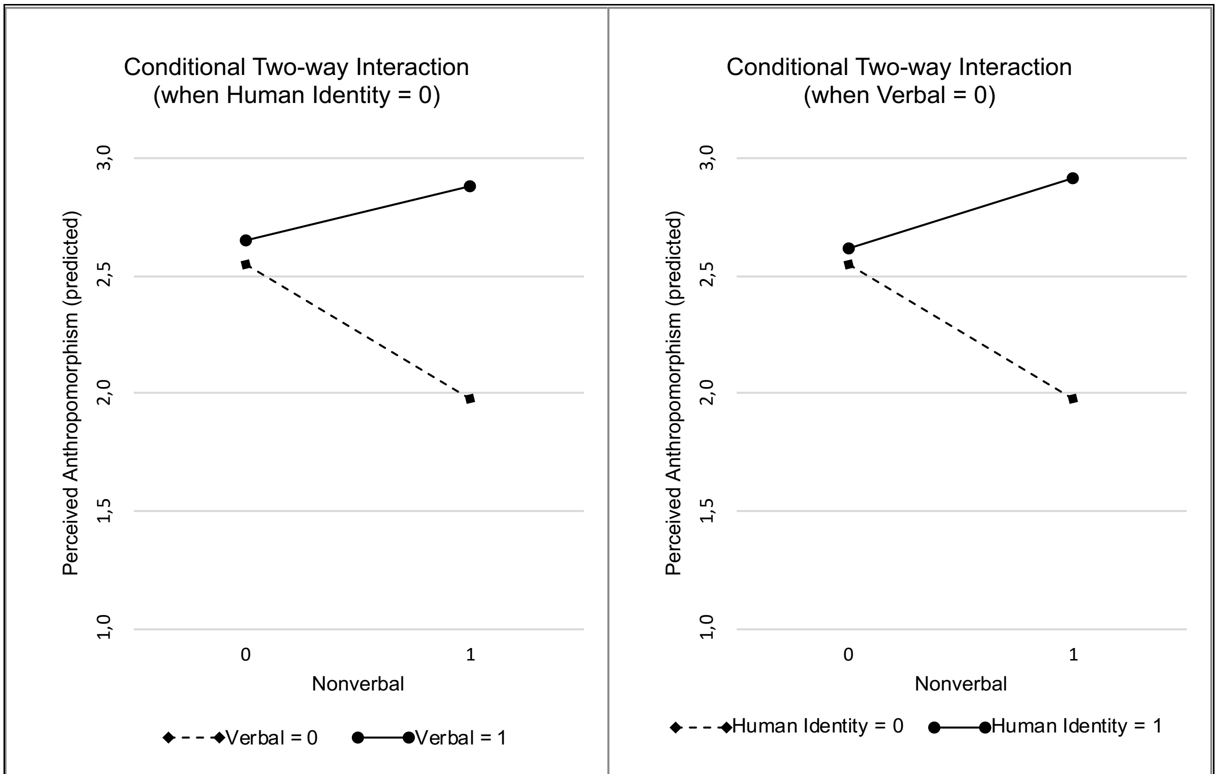


Figure 5. Significant Two-way Interactions

Table 8. Summary Hypotheses

Hypothesis	Description	Supported?
H1a	Main effect: human identity cues $\xrightarrow{+}$ anthropomorphism	NO
H1b	Main effect: verbal identity cues $\xrightarrow{+}$ anthropomorphism	NO
H1c	Main effect: nonverbal identity cues $\xrightarrow{+}$ anthropomorphism	NO
Exploratory RQ	Are there interaction effects?	
	<u>Second-order terms</u>	
	nonverbal x verbal	YES
	verbal x human identity	NO
	nonverbal x human identity	YES
	<u>Third-order terms</u>	
	nonverbal x verbal x human identity	NO
H2	Main effect: task type $\xrightarrow{+}$ anthropomorphism	YES
H3	Main effect: dispositional anthropomorphism $\xrightarrow{+}$ anthropomorphism	YES

Discussion and Contributions

The empirical evaluation supports the proposed framework for anthropomorphic CA design. In line with the theory of anthropomorphism (Epley et al., 2007), we find that (i) cognitive factors evoked by anthropomorphic technology design, (ii) motivational factors resulting from the task type, and (iii) dispositional factors that depend on the individual user do influence the human perception of anthropomorphism. Notably, we provide evidence that considering interaction effects between anthropomorphic technology design dimensions is important to stimulate anthropomorphism. More precisely, we find that nonverbal cues have a negative effect on perceptions of anthropomorphism if they are not complemented with verbal or human identity cues. Below, we discuss the implications for theory and practice.

Our work contributes to the theory of anthropomorphism and advances our disciplines' understanding of this phenomenon by relating the three anthropomorphism determinants to the design of anthropomorphic interaction with CAs. Concerning the cognitive determinant, the theory of anthropomorphism suggests that making objects more human-like increases the probability of anthropomorphism (Epley et al., 2007) but provides no further guidance on how to achieve this level of human-likeness. By relating the three anthropomorphic design dimensions for CAs to our literature analysis, we systemize disparate techniques of anthropomorphic technology design (see Table 3) and provide a unifying knowledge base of anthropomorphic CA cues (see Table 2). While recent work has focused on classifying such anthropomorphic design features (Feine et al., 2019; Wagner & Schramm-Klein, 2019), our work goes one step further to empirically validate such designs' hypothesized effects. Although the theory suggests a positive relationship between the identified anthropomorphic design dimensions and anthropomorphism, our empirical analysis reveals this relationship is more complex.

First, we do not find simple main effects of each of the anthropomorphic design dimensions. Previous studies found a positive effect of human identity cues on perceived anthropomorphism (Araujo, 2018; De Visser et al. 2016; Niu, Terken, & Eggen et al. 2018; Waytz et al. 2014; Yuan & Dennis, 2017). However, only Araujo (2018) investigated CA design. The other studies focused on website design, driving agents, and online products (see Table 3). Further, Araujo's (2018) CA was simultaneously given anthropomorphic verbal cues. Thus, it is not clear whether each cue type or their interaction caused the positive effect on anthropomorphism. Our study is the first to provide insight on the effect of the three design dimensions independently of each other. That we do not find simple main effects is novel, and might justify the body of research that manipulated several design dimensions without disentangling the effects of each dimension.

Second, we show that the sole use of nonverbal cues harms anthropomorphism, but that this effect turns positive if verbal or human identity cues complement nonverbal cues. Previous studies have intuitively combined nonverbal cues with cues from the other design dimensions without justifying this combination (De Visser et al., 2016; Nunamaker et al., 2011; Verhagen et al., 2014; Von der Pütten et al., 2010). CAs enhanced by nonverbal cues alone could trigger skepticism about their human-likeness because without complementary verbal or human identity cues, the nonverbal cues provide a disturbing image of a human interaction partner. According to anthropological and communication research, nonverbal cues are special because (i) they are not uniquely human (Burling et al., 1993; Knapp et al., 2014) and (ii) they typically support the verbal part of an interaction (Argyle, 1969; Knapp et al, 2014). Consequently, this paper reveals that nonverbal cues need to be complemented with human identity cues or verbal cues to have a positive effect on perceived anthropomorphism.

Finally, the simultaneous use of all cue types did not result in the highest perceptions of anthropomorphism. This counterintuitive finding might be a manifestation of the uncanny valley effect, according to which perceptions of anthropomorphism drop when a relatively high level of human-likeness is attained (Mori, 1970). Since all participants in our study had been informed that they would be interacting with a CA, the simultaneous use of all design dimensions might have signaled a degree of humanness that did not fit with users' understanding of the CA as a computer program. Consequently, this mismatch violated the deep-rooted understanding of the target object as nonhuman and might have caused an uncanny response (Burleigh et al., 2013, MacDorman et al., 2009 Saygin et al., 2012). Research on the uncanny valley effect has largely focused on studying it with reference to robots and avatars (Burleigh et al., 2013), while recent studies on its occurrence in interactions with text-based CAs are still inconclusive (Ciechanowski, Przegalinska, Magnuski, & Gloor, 2019; Skjuve, Haugstveit, Følstad, & Brandtzaeg, 2019). Our study provides initial support for a possible uncanny valley effect in purely text-based interactions with CAs. In sum, our study advances the knowledge on the cognitive determinant of anthropomorphism by showing that specific interactions of design cues should be considered to stimulate anthropomorphism. Moreover, we provide explanations for these findings by integrating anthropological, communication, and robotics research.

Further, our work advances the knowledge on the motivational determinant of anthropomorphism by relating sociality and effectance motivation to the type of task a technology performs. While psychological theory suggests that situational variables can influence humans' motivation to anthropomorphize (Epley et al., 2008b), the distinction between human and nonhuman tasks has not yet been empirically investigated. We demonstrate that human-like CA tasks (e.g., providing health advice) stimulate higher levels of perceived anthropomorphism than computer-like CA tasks (e.g., controlling remote devices) because humans feel an urge to be socially related to their interaction partner (sociality motivation) and require anthropomorphic perception to make sense of the interaction (effectance motivation). Thus, we add to extant work that has shown how situational variables (e.g., loneliness (Eyssel & Reich, 2013; Wang, 2017), unpredictability (Eyssel et al., 2011; Waytz et al., 2010c)) stimulate anthropomorphism in HCI through sociality and effectance motivation. In addition, differentiating human-like from computer-like CA tasks calls on HCI researchers to attend to the specific task type and to consider them in theorizing about anthropomorphism. Specifically, the task type could explain why previous work investigating computer-like tasks has failed to stimulate anthropomorphism (e.g., querying information on a website (Sah & Peng, 2015)). By contrast, other studies have found significant positive effects of weak anthropomorphic designs (i.e., designs that included verbal or human identity cues only) on anthropomorphism in investigating human-like tasks, such as talking about emotions (Schuetzler et al., 2014), driving a car (Waytz et al., 2016), or communicating with customer services (Araujo, 2018). Overall, the task type and related motivational forces provide a possible explanation for these mixed findings and need to be considered in future studies on anthropomorphism in HCI.

Regarding the dispositional determinant of anthropomorphism, we demonstrate that disentangling users' individual tendencies to anthropomorphize from design- or task-related effects is important to predict anthropomorphism. While psychological studies have repeatedly shown that this determinant is an important predictor of perceived anthropomorphism (Caruso, Waytz, & Epley, 2010; Tam, 2014; Waytz et al., 2014; Willard & Norenzayan, 2013), IS studies on anthropomorphism so far have disregarded dispositional anthropomorphism's role. As dispositional trust (McKnight, Choudhury, & Kacmar, 2002) is regularly included in IS studies on trust (e.g., Lankton & McKnight, 2015; Nicolaou & McKnight, 2006; Wang & Benbasat, 2008), we offer strong evidence that individual tendencies to anthropomorphize should be included more frequently in studies on anthropomorphism. Low levels of dispositional anthropomorphism might provide an additional explanation for failed anthropomorphic technology design in extant work (Sah & Peng, 2015; Wölfl et al., 2019; Yuan & Dennis, 2017).

Overall, this study provides a theoretical basis for researching questions related to anthropomorphism in various types of human-CA interactions. The advent of conversational interfaces changes how we interact with computer programs in both private and professional use contexts (Goasduff, 2019; Marketsandmarkets, 2019). Anthropomorphism is inseparably linked to these conversational interfaces (Araujo, 2018; Epley et al., 2007; Pfeuffer, Benlian, Gimpel, & Hinz, 2019) and can have positive and negative effects on human perception and behavior. On the one hand, research shows that anthropomorphism stimulates user trust (De Visser et al., 2016), connectedness (Tam, Lee, & Chao, 2013), and social response behavior (Epley et al., 2007; Waytz et al., 2010b). On the other hand, a growing body of literature shows the negative consequences of anthropomorphism, exposing how it can result in inappropriate expectations (Culley & Madhavan, 2013), unwillingness to share intimate information (Kiesler et al., 2008; Złotowski, Proudfoot, Yogeeswaran, & Bartneck, 2015), privacy concerns (Sohn, 2019), undesirable emotional attachment (Robert, 2017), moral ascriptions (Waytz et al. 2010b), and discriminatory behaviors (Giger et al., 2019). Given these consequences, researchers have to be aware and in control of the factors that stimulate anthropomorphism in CA interactions. The introduced framework provides direction for the systematic design and analysis of anthropomorphic interactions with CAs and their positive and negative consequences.

This study's findings are also relevant for practitioners. Owing to advancements in natural language processing, CAs perform a variety of tasks on various websites and platforms in private and business use contexts (Araujo, 2018; Feine et al., 2019). Due to the positive and negative consequences of anthropomorphism we have named, designers need to consciously decide on whether they want to promote or mitigate anthropomorphism in the user-CA interaction. Our study shows that unreflectively using human-like cues in CA designs presumably do not stimulate anthropomorphism in the perceiver, and carelessly implementing nonverbal cues can even prevent anthropomorphism. Moreover, CAs that perform human-like tasks (e.g., health counseling, customer services) are more readily anthropomorphized even when designers deliberately do not add any human-like design cues. This can be an undesired effect if designers want users to share intimate information (Kiesler et al., 2008; Złotowski et al., 2015). In sum, we equip designers with novel knowledge and guidance on the effects design cues, task types, and individual differences have on anthropomorphism.

Limitations and Future Research

One limitation of this study is its focus on text-based CAs, because typically, CAs can have a text and/or a voice interface. For voice-based CAs, additional dimensions of anthropomorphic cues that reflect speech-related characteristics (e.g., paralinguistic attributes) are relevant in stimulating anthropomorphism (Schroeder & Epley, 2016). Future research should extend our study of anthropomorphism to include all types of CAs. Relevant research questions should identify vocal and paralinguistic anthropomorphic cues and address how these relate to the proposed theoretical framework.

A second limitation results from our experimental use of simulated interactions. The vignette technique represents an established experimental procedure to study perceptions, attitudes, and judgments (Atzmüller & Steiner, 2010). Nevertheless, vignettes cannot substitute for the investigation of actual behavior (Riedl et al., 2014). Therefore, future research should increase our framework's generalizability by investigating actual interaction behavior with CAs. Relatedly, future studies should investigate the effects of anthropomorphism on important outcome variables. For example, do differing levels of anthropomorphic CA design influence user performance, satisfaction, or decision quality? How do these effects change across task types?

Another potential limitation of the current study is the time-dependent categorization of human-like and computer-like tasks. As described earlier, advances in artificial intelligence enable computer programs to take over more and more tasks previously carried out by human experts (Frey & Osborne, 2017). Along with this development, users' perceptions of what constitutes a human-like versus computer-like task might also evolve. Accordingly, our categorization might require an epochal reassessment and adjustment in the future.

The last limitation involves the collected anthropomorphic cues classified into the three dimensions of human identity, verbal, and nonverbal cues. Our collection is based on a review of existing studies focused on human-like interface design; yet, additional cues might exist that can be classified into these three design dimensions. Equally, our experimental manipulation of the design dimensions is limited to the cues we identified. Besides our thorough selection of cues from extant work, renewed efforts to identify and investigate additional cues would allow further verification of our framework.

Conclusion

Computer agents that interact with users via human language are at the forefront of the era of conversational HCI. This emulation of human-to-human communication makes research into CAs inseparable from questions regarding anthropomorphism. We integrate the cognitive, motivational, and dispositional determinants of anthropomorphism in a comprehensive theoretical framework for anthropomorphic CA design that advances IS knowledge of anthropomorphism and makes the theory of anthropomorphism (Epley et al., 2007) applicable to our discipline. Our experiment shows that anthropomorphic CA design is not trivial: not all anthropomorphic designs achieve the hypothesized effect. We provide possible explanations for the unexpected results and identify several opportunities for future research. Our theoretical and empirical findings inform both researchers and practitioners about the complex relationship between anthropomorphic design and users' perceptions of anthropomorphism.

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Appendix A: Literature Review

To identify relevant studies, we first used a keyword search. The keyword search string was as follows: (“design”) AND (“user interface” OR “conversational agent” OR “avatar” OR “interface” OR “embodied conversational agent” OR “embodied agent” OR "recommendation agent") AND (“anthropomorphi*” OR “human-like” OR “humanlikeness” OR “humanlike” OR “human-likeness” OR “social cues”). Additional relevant papers were identified based on forward and backward search. To ensure that all relevant IS studies were identified, we manually searched the IS senior scholar’s basket of journals. Additionally, we searched the Web of Science and ABI/Inform databases to identify relevant peer-reviewed journal papers. We did not set any date restrictions. To select appropriate research, we defined the following selection criteria: (1) empirical study and (2) anthropomorphic manipulation of the design of a computer interface. We excluded studies on humanoid robots in order to ensure relevance for our study. We identified 35 studies in journals and proceedings from the fields of IS, HCI, and Psychology.

Appendix B: Pre-Test Items for Sociality and Effectance Motivation

Sociality Motivation (Adapted from Cheek & Buss, 1981), Cronbach's α= .96 *(seven-point Likert scale from (1) strongly disagree to (7) strongly agree)*

1. I would prefer to be with another person when executing this task.
2. I would welcome the opportunity to perform this task in the presence of a human.
3. I would prefer to solve this task in collaboration with another person.
4. I would find it more stimulating to execute this task working with another person.
5. I'd be unhappy if I were prevented from performing this task with others around.

Effectance Motivation (Adapted from Eyssel et al. 2011, Waytz et al. 2010), Cronbach's α= .86 *(seven-point Likert scale from (1) not important at all to (7) very important)*

How important do you consider it…

1. …to be able to understand the conversational agents' behavior?
2. …to be able to predict the conversational agents' future behavior?
3. … that the conversational agent will follow your instructions?
4. … to be able to control the conversational agents' behavior?

Table A1. Mean, Standard Deviation (SD), Composite Reliability (CR), Cronbach Alpha (CA), Average Variance Extracted (AVE), Correlations

Latent Construct	Mean	SD	CR	CA	AVE	1	2	3	4
Sociality	4.49	1.44	.96	.95	.82	**.90**[a]			
Effectance	5.44	.96	.86	.78	.60	.16	**.77**		

[a] The square root of the AVE is shown on the diagonal.

Table A2. Factor Loadings and Cross-Loadings

	SOCIALITY	EFFECTANCE
SOC1	**0.911**	0.003
SOC2	**0.786**	0.092
SOC3	**0.943**	0.082
SOC4	**0.934**	0.048
SOC5	**0.939**	0.11
EFF1	0.177	**0.79**
EFF2	0.038	**0.826**
EFF3	-0.014	**0.819**
EFF4	0.043	**0.661**

Appendix C: Task Scenarios

In the study, the following task scenarios were presented in German to all participants.

Human-like task scenario: Health Agent (translated into English)

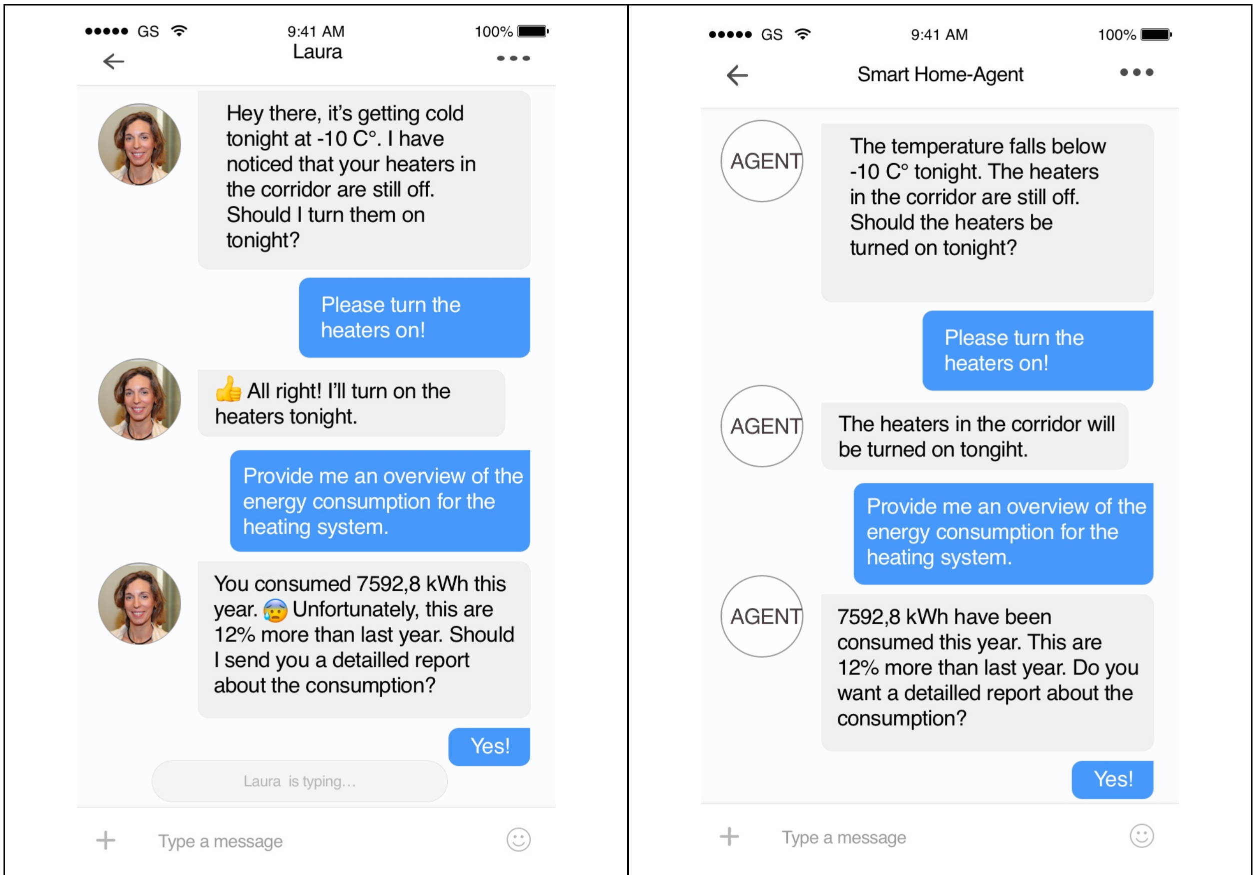
Please read the following dialogue between a user and a conversational agent carefully. This conversational agent provides users with health information and advice based on its understanding of their psychological and physical health state. Put yourself in the position of the user (dialogue section highlighted in blue) who talks to the health agent (dialogue section highlighted in gray). The health agent's task is to understand the health issue of the user and to provide him with advice to address the issue.

Computer-like task scenario: Smart Home Agent (translated into English)

Please read the following dialogue between a user and a conversational agent carefully. This conversational agent can control connected devices in a user's home and provide information about usage and consumption of these devices. Put yourself in the position of the user (dialogue section highlighted in blue) who talks to the smart home agent (dialogue section highlighted in gray). The smart home agent's task is to control the connected heating system and to provide information about usage and consumption.

Appendix D: Anthropomorphic Design of the Smart Home Agent

We illustrate two designs of the smart home agent with either i) no anthropomorphic cues or ii) all anthropomorphic cues. The remaining designs are combinations of these two versions. All stimulus material was presented in German to the participants. In the German version, text length was equal across groups. The authors translated the stimulus material into English.



Left: Agent with all type of cues highlighted. Right: Agent with no cues.

Appendix E: Measurement Items, Convergent and Discriminant Validity

Perceived Anthropomorphism *(seven-point Likert scale from (1) strongly disagree to (7) strongly agree)*

I think the agent has...

1. a mind on its own
2. intentions
3. free will
4. consciousness
5. desires
6. beliefs
7. the ability to experience emotions

Dispositional Anthropomorphism *(seven-point Likert scale from (1) strongly disagree to (7) strongly agree)*

To what extent do you agree with the following statements?

1. Technologies and machines (e.g., computers, cars, television sets) have intentions.
2. A fish has free will.
3. A mountain has free will.
4. A television set experiences emotions.
5. A robot has consciousness.
6. Cows have intentions.
7. A car has free will.
8. The ocean has consciousness.
9. A computer has a mind of its own.
10. A cheetah experiences emotions.
11. The environment experiences emotions.
12. An insect has a mind of its own.
13. A tree has a mind of its own.
14. The wind has intentions.

15 A reptile has consciousness.

We assessed the validity of our measurement instruments by examining the convergent and discriminant validity. The used instruments exhibit Cronbach alphas and composite reliabilities well above the suggested minimum of .70. In addition, the values of the average variance extracted (AVE) are greater than .50 (see Table A1). In line with the criterion of Fornell and Larcker (1981), we conclude that our instruments exhibit an adequate level of convergent validity. For discriminant validity, we first assessed the item loadings and cross-loadings. Measurement items should load highly on the construct they are designed to measure and not high on other constructs (Gefen & Straub, 2005). All factor loadings and cross-loadings in Table A2 loaded higher on the assigned theoretical construct than on any other factor. A second criterion to establish discriminant validity requires that the square root of the AVE should be larger than any correlation with another construct (Fornell & Larcker, 1981). This criterion is also satisfied (see Table 4). Thus, we conclude that our measures exhibit adequate level of discriminant validity. We also assessed the appropriateness of dispositional anthropomorphism as a superordinate construct consisting of the three subdimensions natural entities, nonhuman animals, and technology. We followed two approaches used by studies with similar constructs (e.g., Crossler & Posey, 2017; Benbasat & Wang, 2005; Tanriverdi, 2006). First, we found that all subdimensions of dispositional anthropomorphism were significantly intercorrelated with $p<0.01$ (see Table A1). Second, we assessed if each subdimension was significantly related to dispositional anthropomorphism. We found significant loadings for the three subdimensions of natural entities (.861, $p<.001$), nonhuman animals (.518, $p<.001$), and technology (.796, $p<.001$). In line with Waytz et al. (2010a), we thus conclude that dispositional anthropomorphism is a superordinate construct that reflects humans stable individual tendencies to anthropomorphize nonhuman entities.

Table A3. Mean, Standard Deviation (SD), Composite Reliability (CR), Cronbach Alpha (CA), Average Variance Extracted (AVE), Correlations									
Latent Construct	**Mean**	**SD**	**CR**	**CA**	**AVE**	**1**	**2**	**3**	**4**
DISANT[a]: Natural Entities	2.38	1.27	.89	.85	.63	**.79**[b]			
DISANT[a]: Nonhuman Animals	5.11	1.26	.89	.84	.62	.32**	**.79**		
DISANT[a]: Technology	1.67	.85	.90	.86	.64	.50**	.12**	**.80**	
Perceived Anthropomor-phism	2.58	1.47	.95	.94	.73	.26**	.03	.44**	**.85**

[a] Dispositional anthropomorphism (DISANT)
[b] The square root of the AVE is shown on the diagonal.
** indicates significant correlations at the .01 level.

Table A4. Factor Loadings and Cross-Loadings

	DISANT: Natural Entities (NE)	DISANT: Non-human Animals (NHA)	DISANT: Tech-nology (TECH)	Perceived Anthro-pomorphism (ANT)
NE1	**0.811**	0.160	0.518	0.236
NE2	**0.815**	0.241	0.341	0.166
NE3	**0.749**	0.317	0.286	0.136
NE4	**0.780**	0.398	0.351	0.180
NE5	**0.795**	0.155	0.451	0.296
NHA1	0.161	**0.697**	-0.056	-0.037
NHA2	0.290	**0.846**	0.148	0.072
NHA3	0.270	**0.842**	0.086	0.032
NHA4	0.253	**0.811**	0.104	0.055
NHA5	0.249	**0.713**	0.111	-0.054
TECH1	0.387	0.077	**0.806**	0.396
TECH2	0.416	0.011	**0.790**	0.295
TECH3	0.343	0.153	**0.778**	0.393
TECH4	0.465	0.051	**0.837**	0.300
TECH5	0.376	0.170	**0.794**	0.391
ANT1	0.239	0.088	0.411	**0.860**
ANT2	0.181	0.057	0.299	**0.745**
ANT3	0.249	-0.022	0.452	**0.883**
ANT4	0.268	0.056	0.418	**0.915**
ANT5	0.221	-0.037	0.352	**0.837**
ANT6	0.192	0.012	0.333	**0.854**
ANT7	0.163	-0.019	0.335	**0.863**

Appendix F

Table A5. Regression Results for Perceived Anthropomorphism with all Controls				
	Model 1		**Model 2**	
	Linear model estimates (robust std. errors)	p-value	Linear model estimate (robust std. errors)	p-value
Nonverbal Verbal Human Identity	.040 (.124) .133 (.123) .127 (.125)	.745 .281 .309	-.572 (.201) .106 (.212) .07 (.22)	.005** .618 .751
Nonverbal x Verbal Verbal x Human Identity Nonverbal x Human Identity Nonverbal x Verbal x Human Identity	- - - -	- - - -	.806 (.312) -.298 (.335) .899 (.322) -.936 (.489)	.010* .374 .005** .056
Task Type (0= computer-like, 1= human-like)	.642 (.125)	.000***	.641 (.123)	.000***
Dispositional Anthropomorphism	.415 (.071)	.000***	.442 (.069)	.000***
Gender (0= female, 1= male)	.297 (.124)	.017*	.315 (.124)	.012*
Age	-.004 (.005)	.432	-.004 (.005)	.440
Previous Experience (0=no, 1=yes)	.096 (.139)	.489	.133 (.137)	.332
Constant	2.09 (.248)	.000***	2.075 (.154)	.000***
R^2 Adjusted R^2	.1417 .1276	.000***	.1725 .1519	.000***
Observations	496		496	
* p<0.05, ** p<0.01,*** p<0.001				

Table A6. Variance Inflation Factor			
	Variable	**VIF**	**Tolerance (1/VIF)**
Model 1	Nonverbal	1.00	1.00
	Verbal	1.01	0.99
	Human Identity	1.01	0.99
	Task Type (0= computer-like, 1= human-like)	1.01	0.99
	Dispositional Anthropomorphism	1.01	0.99
	Gender (0= female, 1= male)	1.03	0.97
	Mean VIF	**1.01**	
Model 2	Nonverbal	3.94	0.25
	Verbal	3.89	0.26
	Human Identity	3.79	0.26
	Nonverbal x Verbal	5.95	0.17
	Verbal x Human Identity	5.78	0.17
	Nonverbal x Human Identity	5.85	0.17
	Nonverbal x Verbal x Human Identity	6.94	0.14
	Task Type (0= computer-like, 1= human-like)	1.01	0.99
	Dispositional Anthropomorphism	1.03	0.97
	Gender (0= female, 1= male)	1.04	0.96
	Mean VIF	**3.92**	

Appendix G

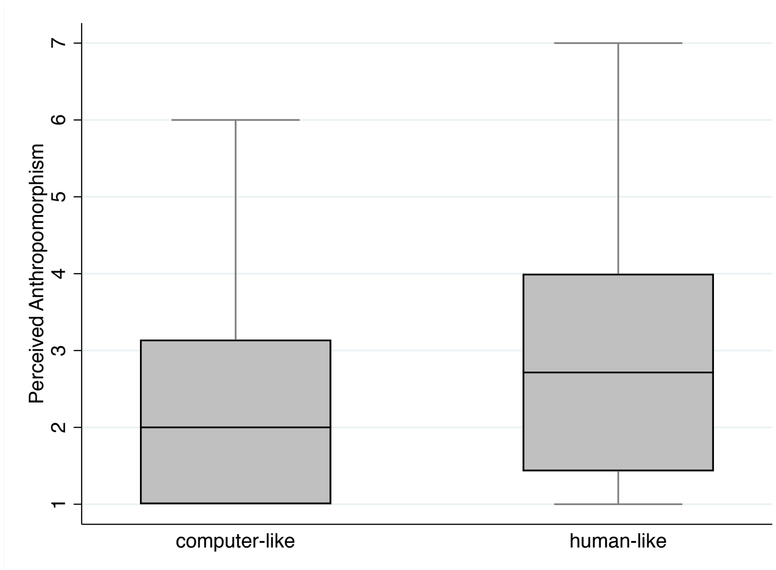


Figure A1. Perceived Anthropomorphism by Task Type