7-4-2022

Do You Trust Social Robots? An Uncanny Valley Theory Perspective

Gehan W. Premathilake
Tampere University, gehan.ethugalapathiranage@tuni.fi

Chenglong Li
Tampere University, chenglong.li@tuni.fi

Hongxiu Li
Tampere University, hongxiu.li@tuni.fi

Do You Trust Social Robots? An Uncanny Valley Theory Perspective

Short Paper

Gehan W. Prematilake
Tampere University
Korkeakoulunkatu 8, 33720 Tampere
gehan.ethugalapathiranage@tuni.fi

Chenglong Li
Tampere University
Korkeakoulunkatu 8, 33720 Tampere
chenglong.li@tuni.fi

Hongxiu Li
Tampere University
Korkeakoulunkatu 8, 33720 Tampere
hongxiu.li@tuni.fi

Abstract

Social robots have been increasingly popular during the past decade. Anthropomorphism is identified as a critical factor affecting social robots' acceptance. A conceptual model is proposed to examine social robots' user acceptance based on the theory of the uncanny valley. User perception of the anthropomorphism level (low, medium, and high) of social robots is proposed to affect users' perceived uncanniness and humanness of social robots, which influences user trust in social robots, and user trust will lead to users' intention to use social robots. The theoretical model will be empirically tested through an experiment conducted online targeting the hospitality industry. The study will contribute to social robotic acceptance literature by explaining how anthropomorphism affects user trust in social robots via perceived uncanniness and humanness, as well as how user trust influences user acceptance of social robots.

Keywords: Social robot, anthropomorphism, trust, uncanny valley theory, humanness

Introduction

Social robots have evolved with the integration of Artificial Intelligence (AI) and are designed increasingly similar to actual humans (Nissen and Jahn 2021). According to Welch et al. (2010), social robot refers to highly autonomous agents which adapt to dynamic and complex environments and perform social interactions. The cognitive capability of makes social robots different from traditional Information Systems (IS) (Schuetz and Venkatesh 2020). The design of the social robots has boosted over time, such as the features of face and speech recognition (Feine et al. 2020) and mimicking human behavior (Tondu 2012). For instance, Pepper, a robot developed by SoftBank, is a social humanoid robot that can make social interaction with people through conversations and its touch screen (Stock and Merkle 2018). However, though social robots have the potential to interact with humans in different business contexts, the success of social robots' application depends on the willingness of individuals to accept social robots (Saari et al. 2022). Thus, it is important to examine what motivates people to accept social robots.

Anthropomorphism, which is described as the attribution of human-like characteristics to non-human entities (Złotowski et al. 2018), has been argued to be a significant factor determining user acceptance (Prematilake et al. 2021; Tondu 2012; Złotowski et al. 2018). For instance, Tondu (2012) found that the higher level of anthropomorphism of robots, the more individuals would engage with the robots. Liu and Tao (2022) discovered that the anthropomorphism of a social robot could enhance users' acceptance

through perceived humanness. In contrast, some researchers argued that anthropomorphism does not always increase users' acceptance intention. According to the uncanny valley theory (Mori 1970), the visual anthropomorphic feature of robots is associated with individuals' perceived uncanniness, and there is an uncanny valley when the visual anthropomorphic feature of robots is too human-like. Seymour et al. (2021) explored the possibilities of crossing the uncanny valley using human-realistic avatars in virtual reality, which are rendered in real-time. Human-realistic avatars have passed through the uncanny dip. However, such capabilities that allow real-time rendering is highly debatable with the physical robots that operate in the real environment. Although some studies have applied uncanny valley theory in robot research, these studies have mainly focused on the visual appearance of robots but have not explained the relationship between anthropomorphism and user acceptance from a broader perspective. Little research has attempted to explore how the features related to anthropomorphism influence user acceptance from an integrated view, including both humanness and uncanniness.

In addition, prior literature has stated that trust is a critical factor determining individuals' acceptance of innovative technologies, such as artificial intelligence (Nissen and Jahn 2021) and mobile payment (Cao et al. 2018). Some scholars have also highlighted the importance of trust in explaining individuals' acceptance of social robots (Schuetz and Venkatesh 2020). However, there is still a lack of knowledge on how to build user trust to social robots by taking consideration of the unique anthropomorphic features of social robots and its impact on user perception of the uncanniness of social robots from the uncanny valley theory view.

To address the above research gap, this study investigates how social robots' anthropomorphic features are associated with individuals' perception of uncanniness and humanness of social robots, which determine user trust and thereby influence the user acceptance, based on the uncanny valley theory. User trust to technology is closely linked with their perceptions of the technology features. Thus, we assume that user trust to social robots is linked with the perception of humanness and uncanniness, which is triggered by the anthropomorphism of social robots. This research question will be addressed through empirical data collected from an experiment in the hospitality industry, and three levels of anthropomorphism of embodied human-like social robots, including low, medium, and high levels, will be tested in the experiment. This study aims to explain user acceptance from the holistic view of uncanniness and trust. In addition, this study can enrich the social robots use literature by investigating the link between the anthropomorphism of social robots and trust by examining the mediating impact of uncanniness and humanness and the role of trust, which involves in acceptance of social robots.

The rest of the paper is structured as follows: a theoretical background is presented initially to introduce the uncanny valley theory, anthropomorphism, and acceptance of social robots. Then the research model of the study is presented along with the hypotheses. Afterward, the planned research method is explained. Finally, the contributions and limitations of the current study are described.

Literature Review

The Uncanny Valley

Mori (1970) presented the "uncanny valley" that positions robots between similarity and familiarity to explain different degrees of anthropomorphism experienced by users. The concept explains that when robots are more human-like, they become more familiar to a certain degree. The function of the graph also depends on affinity level, which is also represented by familiarity. The growing level of affinity needs to be observed along with the degree of humanness in the human-like models, and along the path on, a certain level of human-likeness affinity will rapidly get lower (Łupkowski et al. 2019). Similarly, with the increase in familiarity and similarity, robots face the risk of becoming eerie with too much of human features. The users are more attached to a machine when the similarity of human features increase. Further, during the process, it becomes emotionally appealing. Nevertheless, when it becomes disconcertingly close to humans, a steep drop in comfort and believability is expected before approaching the stage of full humanity (Mori 1970; Tinwell and Sloan 2014). This drop is the uncanny valley which is highlighted in Figure 1.

Human likeness awakens trust to a certain point. Mori differentiates robots mostly as mobile and immobile robots. The liveliness is increased by the ability to move (Mori 1970). However, it also increases creepiness. The deepest point of the uncanny valley is restrained by the matter of death or liveliness. Mori further explains the ambiguity of using the prosthetic hand. The appearance of human nature and the feeling of

cold when touched are recognized as "alien" by users. Therefore, the uncanny valley is triggered due to the inconsistency between "look" and the touch" of the object. The examples such as an industrial robot, a humanoid robot, a zombie, a prosthetic hand, a *bunraku* puppet, and finally, a healthy person denote different levels of the familiarity curve (Draude 2011).

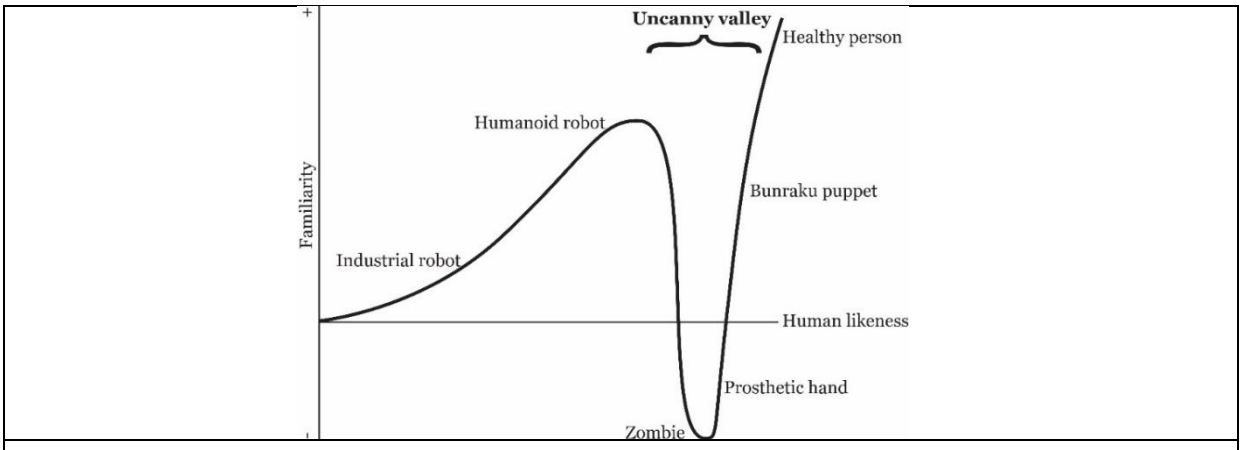

Figure 1. The uncanny valley (adapted from Draude (2011))

The uncanny valley can be escaped when the amount of humanness in the appearance is matched with the amount of humanness in interaction ability (Choi and Kim 2009). Tondu (2012) investigated the link between psychological anthropomorphism and technical anthropomorphism in relation to the uncanny valley and argued the necessity of an adequate amount of technical anthropomorphic features for a robot when integrating it into the human environment. The cognitive dimension of humanness and affective dimensions of warmth, attractiveness, and eeriness can be used to explore the effect of the uncanny valley effect. Based on the uncanny valley theory, Ho and MacDorman (2017) have conducted a four-staged exploratory sequential design that is aimed to improve humanness, attractiveness, and eeriness together with other methods like a card sorting task laddering interview and survey. Similarly, the research model explained in this research incorporates the uncanny valley theory as a foundation to evaluate the relationship between anthropomorphism and user acceptance intention.

Anthropomorphism of social robots

Anthropomorphism is defined in similar terms by different scholars. Duffy (2003) suggests that anthropomorphism is the possibility of attributing human characteristics and features to objects. Similar to Złotowski et al. (2018) and Ruijten et al. (2019) recognize anthropomorphism as the attribution of human-like characteristics to non-human entities. Factors such as emotionality, warmth, openness, and desire are included in human-like traits or characteristics. When an entity's conduct in a specific social setting is explained, cognitive or emotional states are supposed to be used in anthropomorphism (Duffy 2003). Therefore, deviating from the objects that possess human traits, non-human agents who possess such characteristics are generally grouped as anthropomorphic or human-like agents (Ruijten et al., 2019)

Prior literature has identified some key features related to social robots that influence the level of anthropomorphism from the view of the interaction of social robots with humans. Features such as robotic intelligence, adaptability, and autonomy affect user perception of the behavior of robots during interactions (Moran et al. 2015). Mainly, the AI integrated into a social robot determines robotic intelligence. Social responses of a social robot depend on the robotic intelligence. The capability of adapting to various environments and situations and responding meaningfully is referred to as adaptability. The autonomy of social robots is the possibility of understanding commands and responding to them in the absence of human control (Gong 2008). Some scholars have highlighted the different forms of social robots in reflecting the anthropomorphism of social robots, such as voice, social behavior, movement, and embodiment (Doering et al. 2015). The embodiment of social robots represents the visual anthropomorphism of social robots, and the physical appearance of social robots has been found to be a critical factor in, especially when a social robot is employed in healthcare since the willingness of users (patients) to interact relies on embodiment

(Klamer and Allouch 2010). Anthropomorphism has also been found to affect user perceptions of enjoyment and satisfaction in social robot use Moussawi et al. (2022).

Further, human nature is required to be embraced by social robots if the robot is operating fully in a social environment. Features such as allowing personal space, eye contact in communication, and human gestures are vital in interactions (Doering et al. 2015). According to Kamide and Arai (2017), social robots display various features such as gender, voice, facial expressions, response, and intelligence which are directly linked with anthropomorphism.

The uncanny valley occurrence is directly linked to anthropomorphism literature. This effect is commonly used to describe the method of differentiating between humans and robots, i.e., different levels of anthropomorphism are revealed in uncanny valley theory (Mori 1970; Nissen and Jahn 2021). The insights of the uncanny valley suggest that the uncanny valley is observed when anthropomorphism reaches a certain level of human likeness (Draude 2011). This results in negative reactions towards the said entity. The impression of the entity turns positive once the anthropomorphism is very high and becomes almost similar to a human. However, prior research argued that even with uncanniness, users might be willing to use social robots if they build their trust to the social robots (Diederich et al. 2022). Prior research argued some visual design features of social robots might be linked with user trust in social robots, such as eye gazing (Nissen and Jahn 2021). Thus, fragmented research is present in this context, and little research has investigated the link between anthropomorphism and trust to social robots.

Acceptance of Social Robots

Social robots' acceptance has attracted the attention of Information Systems (IS) scholars due to the fast development of the cognitive capability of social robots (Schuetz and Venkatesh 2020). Different theories in technology use have been used directly or indirectly to explain acceptance regarding social robots, such as the technology acceptance model, trust, and social interaction (Klamer and Allouch 2010). Wagner and Schramm-Klein (2019) found that social intelligence has a significant impact on user acceptance of social robots. The findings of Turja et al. (2020) in the elderly care context show that perceived usefulness, enjoyment, social influence, and attitude towards social robots determine the user's intention to accept social robots. Further, companionship, sociability, behavioral control, and adaptability make users form a bond during human-robot interactions, thereby leading to users' acceptance of robots (De Graaf and Ben Allouch 2013).

Integration of anthropomorphism to evaluate the acceptance of social robots adds a different perspective when understanding the social robot's acceptance. Various scholars have integrated anthropomorphism in different technology use theories to explain the acceptance of social robots. Prior research found that increased anthropomorphism favors user acceptance of robots (Duffy 2003; Tondu 2012). However, Benlian et al. (2020) argued about the adverse effects of anthropomorphism on user acceptance. Contrastingly, some scholars have applied the theory of self-regulation, person-technology fit, and trust theory to explain the positive impact of anthropomorphism on user acceptance of social robots. Nissen and Jahn (2021) disclose the effect of perceived trust on user intentions to use social robots based on the theory of uncanny valley from a dual-process perspective.

The antecedents of acceptance of social robots, especially in the service context, can be divided into three main components, including robot-design, user or consumer-oriented, and relational components (Lin 2022). Robot features have been identified as critical factors in user acceptance (Nissen and Jahn 2021). The anthropomorphism level of robots determines the extent to which human characteristics are embedded in robots (Nissen and Jahn 2021), such as physical-appearance-related factors such as facial expressions (Breazeal 2003), movements including head and arm (Li and Chignell 2011), and intelligence (Wagner and Schramm-Klein 2019). User or consumer-oriented factors also affect their acceptance of social robots, such as user characteristics, user perceptions, and attitude (Lin 2022). For instance, prior research found that self-efficacy and personal innovativeness affect user acceptance of social robots (Turja et al. 2020). Trust is identified as a relational factor (Lin, 2022). In trust research, integrity and benevolence (Lankton et al. 2015) as well as rapport (Wirtz et al. 2018) have been found to be significantly associated with user satisfaction with robots, which determines user acceptance of robots. But little research has examined user acceptance from an integrated view of robot-design, user perceptions of robots design, and trust to explain user acceptance of social robots.

Research Model and Hypotheses

The uncanny valley theory is the fundamental theory in the theoretical model. In this study, the anthropomorphism of robots is assumed to be associated with perceived uncanniness and humanness. Perceived uncanniness and humanness will determine user trust in social robots, which, in turn, leads to acceptance intention. Linear relationships are denoted with solid arrows, and possible nonlinear relationships are marked with dotted arrows. Figure 2 demonstrates the proposed research model, and the definitions of all the constructs included in the research model are listed in Table 1.

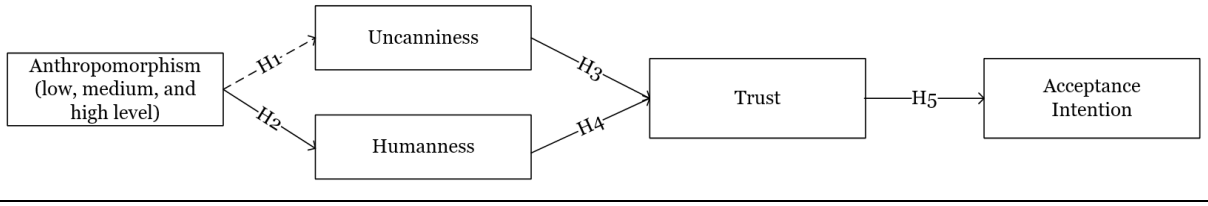

Figure 2. Research Model

Construct	Definition
Anthropomorphism	User's attribution of human-like qualities and characteristics to a robot (Ruijten et al. 2019).
Uncanniness	The feeling of strangeness in users which arises when users feel that anthropomorphic artifacts have inhuman qualities (MacDorman et al. 2009; Tinwell and Sloan 2014).
Humanness	The degree to which users recognize the human likeness of social robots (Holtgraves and Han 2007).
Trust	The "willingness" of a party (users) to be vulnerable to the actions of another (robots) (Mayer et al. 1995).
Acceptance intention	The willingness and desire of the users to utilize social robots in different situations (Davis 1989).

Table 1. Constructs and Definitions

The presence of different shapes and forms of social robots is connected to robots' morphology. The humanoid form is determined by the level of anthropomorphism embedded in the robot (Fong et al. 2003). Robots make interactions with users similar to human-human interactions to fulfill the needs of end-users (Ruijten et al. 2019). There are four types of social cues such as verbal, visual, auditory, and invisible (Feine et al. 2019). Some studies based on anthropomorphic designing of robots reveal that social cues drive users to perceive robots more as humans during interactions (Feine et al., 2019). However, as per the theory of the uncanny valley, if a robot appears sufficiently enough to humans yet does not possesses every aspect of humans for users, it starts to produce irritations. This happens on the way to gaining the peak of human likeness. Therefore, different levels of anthropomorphism tend to deliver different levels of uncanniness to users (Draude 2011). According to the theory of the uncanny valley, when anthropomorphism of social robots is between the low and medium levels, there will be an increase in the perceived uncanniness, whereas a very high level of anthropomorphism might lower the perceived uncanniness among users, and the hypotheses for this study are proposed as:

H1a. When the anthropomorphic level of social robots is between the low and medium, anthropomorphism is positively associated with the perceived uncanniness among users.

H1b. The high level of anthropomorphism of social robots is negatively associated with perceived uncanniness.

Robotic expression is the capability of a robot to reveal socially through emotions and communication. Perfect human-robot interactions occur when users identify the robotic expressions correctly (Moran et al. 2015). These interactions are mostly influenced by the humanoid designs of robots. Scholars have studied anthropomorphism from different perspectives. Duffy (2003) investigated the visual anthropomorphized

designs of robot heads based on the abstract, human, and iconic types and found that expressive faces with gestures such as making eye contact and eye-tracking increase the perceived humanness of robots. Fong et al. (2003) stated the importance of children-like attributes, such as voice and emotions, in triggering the perceived humanness of robots. Response delays, even such as taking a short break for responding, lead to a high level of humanness (Gnewuch et al. 2018). All these features tend to increase the perception of humanness. Thus, based on the above grounds, we propose the following hypothesis:

H2. The anthropomorphism of social robots is positively associated with perceived humanness.

Uncanniness generates feelings of eeriness. Users will perceive uncanniness when the social robots make them feel the strangeness of the social robots (Mori, 1970) or when the social robots fail to establish user expectations of applying social robots (Diederich et al. 2020), which might increase the perceived risks and uncertainties of social robots among users, leading to low trust to social robots. Thus, the following hypothesis is formulated:

H3. The perceived uncanniness is negatively associated with users' trust in social robots.

The humanness of robots is highly influenced by human-like appearance (MacDorman et al. 2009), robot intelligence (Moussawi et al. 2022), and quality of interaction (Złotowski et al. 2018). Furthermore, the personality of a robot can affect the robot's task performance (Fong et al. 2003). All these features resemble the human likeness effect during the interaction of robots and users. Human-robot interaction literature provides evidence to relate humanness to trust in social robots (Stock and Merkle 2018; Tinwell and Sloan 2014). The higher perceived humanness, the higher trust in social robots. Furthermore, according to the uncanny valley theory, the high anthropomorphic feature of social robots can make users induce feelings of familiarity (Epley et al. 2007), which might also help establish user trust in social robots. Thus, we suggest that perceiving humanness positively affects user trust in social robots, and we hypothesize:

H4. The perceived humanness of social robots is positively associated with users' trust in social robots.

Trust helps diminish the strange feeling among users (Wagner and Schramm-Klein 2019). Nissen and Jahn (2021) show that intuitively perceived trust determines the use intention for high levels of anthropomorphism. Lack of trust is considered to be one of the main factors preventing users from using robots. Extent research in IS field has demonstrated that trust drives behavioral intentions through trust in functionality (Schuetz and Venkatesh 2020). Similarly, the establishment of trust is significant in reaping the full benefits of robots to both consumers and service providers since the acceptance is initiated during the initiation of trust (van Pinxteren et al. 2019). Following the above ground, we suggest the following hypothesis:

H5. User trust in social robots is positively associated with their intention to accept social robots.

Prior technology use experience and personal innovativeness have been found to moderate the impact of user perceptions on user acceptance of technology (Frennert and Östlund 2014; Turja et al. 2020). Thus, previous experience of robot use in other contexts and personal innovativeness of the users are incorporated as moderated in this study.

Planned Research Method

An online experiment in the hospitality industry will be used to acquire empirical data. The hospitality industry has become the most emerging industry to apply social robots in services due to pandemic situations. The application of robots in services leads to minimizing human contact. Videos depicting different levels of anthropomorphism will be shown to the participants. There are three levels of anthropomorphism that will be compared in this study: high, medium, and low levels. Therefore, three groups of experiments will be conducted aiming at each level.

There are three parts in the online survey: first, informed consent will be taken from the participants, which informs them about the research objectives, the confidentiality of the data collection, the voluntariness of the participation, and our contact information. Respondents will be required to agree and sign the consent electronically. Second, participants should report their background information, their general attitude toward innovative technology, and their self-efficacy. Then, the respondents will watch videos presenting social robots with different anthropomorphism levels in hotels and then report their perceptions regarding uncanniness, humanness, trust, and their acceptance intention. Attention check questions will be

embedded in the survey. The data analysis will be conducted based on structural equation modeling via the software Smart PLS.

Constructs in this study will be assessed using the previously validated multiple-item scales. Measurement items of anthropomorphism are taken from Bartneck et al. (2009), whereas measurement items for uncanniness, humanness, trust, and acceptance intention are adapted from MacDorman et al. (2009), Holtgraves and Han (2007), Mayer et al. (1995), and Davis (1989), respectively.

Expected Contributions

The expected contributions of this study are threefold. First, this study will advance the robotic acceptance literature by highlighting the role of anthropomorphism on user trust through perceived humanness and uncanniness and the role of trust on user acceptance of social robots based on the theory of the uncanny valley. The findings on the mediating effects of humanness and uncanniness on trust could offer further evidence to help explain how to build trust to social robots to trigger user acceptance through the anthropomorphism of social robots. Second, this study will enrich research on anthropomorphism by examining it from a broader view, i.e., through levels of anthropomorphism. Third, this study will provide new insights into understanding trust's role in the context of social robots by emphasizing the effects of both positive (humanness) and negative (uncanniness) perceptions generated from the anthropomorphic features of social robots on it, as well as examine its impacts on user acceptance.

This study offers practical contributions mainly to robotic designers. A distinct clarification between the advantages and pitfalls of anthropomorphic designs based on the user requirements that enhance humanness and increase the acceptance of robots is expected through this study. Furthermore, the findings on the level of anthropomorphism that leads to the different phases of uncanniness will serve as guidance for robot designers to determine the level of human likeness which needs to be embedded in robots.

Limitations

There are a few limitations to this study. First, the data collection is planned only based on the hospitality industry to test the proposed research model. Future research can gather data in various other industries to maximize the generalizability of the research findings. Second, this study mainly examines uncanniness and humanness and their effect on user trust and acceptance of social robots based on different levels of anthropomorphism in general. Future studies could consider how the combination of different anthropomorphic features, such as appearance-based anthropomorphism, behavior-based anthropomorphism, affects users' anthropomorphism perception of social robots. And user emotions and other relevant perceptions should also be considered in future research. Lastly, because of the limitation of the survey method, the expected data might not fully capture the multiplex nature of users' perceptions and acceptance of social robots. Future studies could consider applying different research methods, such as the mixed-method approach, which may further extend the understanding of social robot acceptance.

References

Bartneck, C., Kulić, D., Croft, E., and Zoghbi, S. 2009. "Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots," *International Journal of Social Robotics* (1:1), pp. 71–81.

Benlian, A., Klumpe, J., and Hinz, O. 2020. "Mitigating the Intrusive Effects of Smart Home Assistants by Using Anthropomorphic Design Features: A Multimethod Investigation," *Information Systems Journal* (30:6), pp. 1010–1042.

Breazeal, C. 2003. "Toward Sociable Robots," *Robotics and Autonomous Systems* (42:3–4), pp. 167–175.

Cao, X., Yu, L., Liu, Z., Gong, M., and Adeel, L. 2018. "Understanding Mobile Payment Users' Continuance Intention: A Trust Transfer Perspective," *Internet Research* (28:2), pp. 456–476.

Davis, F. D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3), pp. 319–339.

Diederich, S., Brendel, A. B., Morana, S., Kolbe, L., Benedikt Brendel, A., and Dresden, T. U. 2022. "On the Design of and Interaction with Conversational Agents: An Organizing and Assessing Review of Human-Computer Interaction Research," *Journal of the Association for Information Systems* (23:1),

pp. 96–138.
Diederich, S., Janßen-Müller, M., Brendel, A. B., and Morana, S. 2019. "Emulating Empathetic Behavior in Online Service Encounters with Sentiment-Adaptive Responses: Insights from an Experiment with a Conversational Agent," in *Proceedings of the International Conference on Information Systems (ICIS)*, Munich, Germany, pp. 1–17.
Diederich, S., Lembcke, T.-B., Brendel, A. B., and Kolbe, L. M. 2020. "Not Human After All : Exploring the Impact of Response Failure on User Perception of Anthropomorphic Conversational Service Agents," in *Proceedings of the European Conference on Information Systems (ECIS)*, pp. 1–17.
Doering, N., Poeschl, S., Gross, H. M., Bley, A., Martin, C., and Boehme, H. J. 2015. "User-Centered Design and Evaluation of a Mobile Shopping Robot," *International Journal of Social Robotics* (7:2), pp. 203–225.
Draude, C. 2011. "Intermediaries: Reflections on Virtual Humans, Gender, and the Uncanny Valley," *AI and Society* (26:4), pp. 319–327.
Duffy, B. R. 2003. "Anthropomorphism and the Social Robot," *Robotics and Autonomous Systems* (42:3–4), pp. 177–190.
Epley, N., Waytz, A., and Cacioppo, J. T. 2007. "On Seeing Human: A Three-Factor Theory of Anthropomorphism," *Psychological Review* (114:4), pp. 864–886.
Feine, J., Gnewuch, U., Morana, S., and Maedche, A. 2019. "A Taxonomy of Social Cues for Conversational Agents," *International Journal of Human Computer Studies* (132), pp. 138–161.
Feine, J., Morana, S., and Maedche, A. 2019. "Designing a Chatbot Social Cue Configuration System," in *Proceedings of the 40th International Conference on Information Systems (ICIS)*, pp. 1–17.
Feine, J., Morana, S., and Maedche, A. 2020. "Designing Interactive Chatbot Development Systems," in *Proceedings of the International Conference on Information Systems (ICIS)*, pp. 1–17.
Fong, T., Nourbakhsh, I., and Dautenhahn, K. 2003. "A Survey of Socially Interactive Robots," *Robotics and Autonomous Systems* (42:3–4), pp. 143–166.
Frennert, S., and Östlund, B. 2014. "Seven Matters of Concern of Social Robots and Older People," *International Journal of Social Robotics* (6:2), pp. 299–310.
Gnewuch, U., Morana, S., Adam, M. T. P., and Maedche, A. 2018. "Faster Is Not Always Better: Understanding the Effect of Dynamic Response Delays in Human-Chatbot Interaction," in *Proceedings of the 26th European Conference on Information Systems (ECIS): Beyond Digitization - Facets of Socio-Technical Change*, pp. 1–17.
Gong, L. 2008. "How Social Is Social Responses to Computers? The Function of the Degree of Anthropomorphism in Computer Representations," *Computers in Human Behavior* (24:4), pp. 1494–1509.
De Graaf, M. M. A., and Ben Allouch, S. 2013. "Exploring Influencing Variables for the Acceptance of Social Robots," *Robotics and Autonomous Systems* (61:12), pp. 1476–1486.
Holtgraves, T., and Han, T. L. 2007. "A Procedure for Studying Online Conversational Processing Using a Chat Bot," *Behavior Research Methods* (39:1), pp. 156–163.
Kamide, H., and Arai, T. 2017. "Perceived Comfortableness of Anthropomorphized Robots in U.S. and Japan," *International Journal of Social Robotics* (9:4), Springer Netherlands, pp. 537–543.
Klamer, T., and Allouch, S. Ben. 2010. "Acceptance and Use of a Social Robot by Elderly Users in a Domestic Environment," in *Proceedings of the 4th International ICST Conference on Pervasive Computing Technologies for Healthcare*, IEEE, pp. 478–482.
Lankton, N. K., Mcknight, D. H., and Tripp, J. 2015. "Technology, Humanness, and Trust: Rethinking Trust in Technology," *Journal of the Association for Information Systems* (16:10), pp. 880–918.
Li, J., and Chignell, M. 2011. "Communication of Emotion in Social Robots through Simple Head and Arm Movements," *International Journal of Social Robotics* (3:2), pp. 125–142.
Lin, Y. 2022. "What Facilitates Consumers Accepting Service Robots ? A Conceptual Framework," in *Proceedings of the European Conference on Information Systems*, p. 19.
Liu, K., and Tao, D. 2022. "The Roles of Trust, Personalization, Loss of Privacy, and Anthropomorphism in Public Acceptance of Smart Healthcare Services," *Computers in Human Behavior* (127:August 2021), p. 107026.
MacDorman, K. F., Green, R. D., Ho, C.-C., and Koch, C. T. 2009. "Too Real for Comfort? Uncanny Responses to Computer Generated Faces.," *Computers in Human Behavior* (25:3), pp. 695–710.
Mayer, R. C., Davis, J. H., and Schoorman, F. D. 1995. "An Integrative Model of Organizational Trust," *The Academy of Management Review* (20:3), p. 709.
McGinn, C. 2020. "Why Do Robots Need a Head? The Role of Social Interfaces on Service Robots,"

International Journal of Social Robotics (12:1), Springer Netherlands, pp. 281–295.
Moran, S., Bachour, K., and Nishida, T. 2015. "User Perceptions of Anthropomorphic Robots as Monitoring Devices," *AI and Society* (30:1), pp. 1–21.
Mori, M. 1970. "The Uncanny Valley," *Energy* (7:4), pp. 33–35.
Moussawi, S., Koufaris, M., and Benbunan-Fich, R. 2022. "The Role of User Perceptions of Intelligence, Anthropomorphism, and Self-Extension on Continuance of Use of Personal Intelligent Agents," *European Journal of Information Systems*, pp. 1–22.
Nissen, A., and Jahn, K. 2021. "Between Anthropomorphism, Trust, and the Uncanny Valley: A Dual-Processing Perspective on Perceived Trustworthiness and Its Mediating Effects on Use Intentions of Social Robots," in *Proceedings of the Annual Hawaii International Conference on System Sciences, Hawai,* (Vol. 2020-Jan), pp. 360–369.
van Pinxteren, M. M. E., Wetzels, R. W. H., Rüger, J., Pluymaekers, M., and Wetzels, M. 2019. "Trust in Humanoid Robots: Implications for Services Marketing," *Journal of Services Marketing* (33:4), pp. 507–518.
Prematilake, G. W., Li, H., and Helander, N. 2021. "Disentangling the Effect of Anthropomorphic Features on Acceptance of Social Robots," in *Proceedings of the International Conference on Information Systems (ICIS)*, Austin, Texas, pp. 1–9.
Ruijten, P. A. M., Haans, A., Ham, J., and Midden, C. J. H. 2019. "Perceived Human-Likeness of Social Robots: Testing the Rasch Model as a Method for Measuring Anthropomorphism," *International Journal of Social Robotics* (11:3), pp. 477–494.
Saari, U. A., Tossavainen, A., Kaipainen, K., and Mäkinen, S. J. 2022. "Exploring Factors Influencing the Acceptance of Social Robots among Early Adopters and Mass Market Representatives," *Robotics and Autonomous Systems* (151:1), pp. 1–14.
Schuetz, S., and Venkatesh, V. 2020. "Research Perspectives: The Rise of Human Machines: How Cognitive Computing Systems Challenge Assumptions of User-System Interaction," *Journal of the Association for Information Systems* (21:2), pp. 460–482.
Seymour, M., Yuan, L., Dennis, A. R., and Riemer, K. 2021. "Have We Crossed the Uncanny Valley? Understanding Affinity, Trustworthiness, and Preference for Realistic Digital Humans in Immersive Environments," *Journal of the Association for Information Systems* (22:3), pp. 591–617.
Stock, R. M., and Merkle, M. 2018. "Customer Responses to Robotic Innovative Behavior Cues during the Service Encounter," in *Proceedings of the 39th International Conference on Information Systems (ICIS)*, pp. 1–17.
Tinwell, A., and Sloan, R. J. S. 2014. "Children's Perception of Uncanny Human-like Virtual Characters," *Computers in Human Behavior* (36), pp. 286–296.
Tondu, B. 2012. "Anthropomorphism and Service Humanoid Robots: An Ambiguous Relationship," *Industrial Robot* (39:6), pp. 609–618.
Turja, T., Aaltonen, I., Taipale, S., and Oksanen, A. 2020. "Robot Acceptance Model for Care (RAM-Care): A Principled Approach to the Intention to Use Care Robots," *Information and Management* (57:5), p. 103220.
Wagner, K., and Schramm-Klein, H. 2019. "Alexa, Are You Human? Investigating the Anthropomorphism of Digital Voice Assistants - A Qualitative Approach," in *Proceedings of the International Conference on Information Systems (ICIS)*, pp. 1–17.
Welch, K. C., Lahiri, U., Warren, Z., and Sarkar, N. \2010. "An Approach to the Design of Socially Acceptable Robots for Children with Autism Spectrum Disorders," *International Journal of Social Robotics* (2:4), pp. 391–403.
Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., and Martins, A. 2018. "Brave New World: Service Robots in the Frontline," *Journal of Service Management* (29:5), pp. 907–931.
Złotowski, J., Proudfoot, D., Yogeeswaran, K., and Bartneck, C. 2015. "Anthropomorphism: Opportunities and Challenges in Human–Robot Interaction," *International Journal of Social Robotics* (7:3), Springer Netherlands, pp. 347–360.
Złotowski, J., Sumioka, H., Eyssel, F., Nishio, S., Bartneck, C., and Ishiguro, H. 2018. "Model of Dual Anthropomorphism: The Relationship Between the Media Equation Effect and Implicit Anthropomorphism," *International Journal of Social Robotics* (10:5), pp. 701–714.