International Journal of Education and Humanities
ISSN: 2770-6702 | Vol. 17, No. 2, 2024

Literature Review of Human-Machine Relationship Theory in the Age of AI

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Abstract: In recent years, with artificial intelligence (AI) development, studying the relationship between humans and AI chatbots has become a hot topic. What are artificial intelligence theories in the consumer field, and whether common interpersonal relationship theories apply to analyzing the relationship between humans and artificial intelligence robots is a question worthy of in-depth research. This article reviews existing literature on human-machine relationships. It summarizes several common theories, providing a theoretical basis for studying the application of human-machine relationships in customer service.

Keywords: Artificial Intelligence; Human Machine Relationship Theory; Consumer Field.

1. Introduction

The latest developments in artificial intelligence (AI) and its social applications in the market have driven the relationship between consumers and AI. In recent years, marketing scholars and practitioners have shown increasing interest in artificial intelligence (AI) for customer service. With the help of AI systems, customer service has been rapidly improved and performance has grown significantly. Therefore, the deployment of AI systems is also increasing. So, we explore the theory of the relationship between humans and AI robots to understand the impact and mechanism of AI chatbots in customer service. Through literature review, we have identified three main theoretical areas (social psychology, communication and media research, and human-computer interaction) as the theoretical basis for human-computer relationships, and reviewed relevant literature using these theories.

2. Interpersonal Relationship Theories

2.1. Social Exchange and Social Penetration Theories

The foundation of the theorization of interpersonal relationships is the concept of social exchange (Blau,1968), which presents a developmental relationship between perceived costs and rewards (Emerson,1972). From this perspective, relationships between individuals are based on sharing and trading tangible resources (such as money and goods) and intangible resources (such as information and love), making individuals interdependent. The perceived balance of this exchange determines the satisfaction and continuity of the relationship. Brandtzaeg et al. (2022) studied the reciprocity dimension of social exchange. In the exploration of the friendship between humans and artificial intelligence chatbots based on qualitative interviews, the author found that when customers use chatbots, they try to consider their needs by "helping each other", showing encouragement towards chatbots and providing support, sharing time, and purchasing virtual gifts for robots. In contrast, regardless of the degree of anthropomorphism of AI social robots, an experiment by Nijssen et al. (2021) did not find any prosocial behavior of AI social robot users towards the robots. These different findings suggest that social exchange theory, the foundation of interpersonal relationships, may need to be modified in applying it to the relationship between humans and artificial intelligence to explain the unique characteristics of AI.

Given that the interaction between customers and artificial intelligence agents focuses on intangible exchange, the Social Penetration Theory (SPT) is more prominent in existing research on the relationship between customers and artificial intelligence (Altman &Taylor, 1973). According to this method, gradual self-disclosure of information is from the surface to the core (depth), from limited to numerous topics (breadth), and as interpersonal relationships develop, it promote intimate relationships. People believe that this relationship transitions from social infiltration to de-infiltration along the stages of orientation, exploratory exchange, emotional exchange, stable exchange, and disintegration (Carpenter &Greene, 2016). In the customer AI scenario, users and social chatbot establish friendship with the bot through the SPT stage (Skjuve et al.,2021), while users of social chatbot Mitsuku deny following the relationship formation stage model (attraction, establishment, continuation, dissolution). These contradictory findings may mean that SPT cannot be universally applied to explain the relationship between customers and artificial intelligence agents. Although intelligent session agents can learn, they have not yet had enough background information (depth) to prove stage-based disclosure methods. Pre-programmed self-disclosure of a chatbot promotes deeper levels of customer self-disclosure than chatbots without this feature, which has a positive effect on improving participants' perceived intimacy and enjoyment (Lee et al., 2020). However, van Straten et al. (2022) did not find that self-disclosure by social robots affects children's social presence or perceived intimacy with robots. The perspectives of social exchange and social infiltration are currently unable to provide a detailed and successful explanation of the phenomena or mechanisms underlying the development of the relationship between humans and artificial intelligence.

2.2. Social Support, Attachment, and Love Theories

Social support, defined as "providing positive interpersonal

communication or beneficial behavior to those in need of support" (Rook &Wooley, 1985), is believed to alleviate loneliness, stress, and depression, enhance self-esteem, and cope with adverse environments (Lakey &Cohen, 2000). Psychological health, elderly care, and other conversational AI chatbots have social support capabilities, with verbal and nonverbal (gestures, eye contact, nodding, and facial expressions) signals that convey care, interest, and empathy, as well as sustained availability, enabling them to provide social support. Odekerken Schr ö der et al. (2020) identified different roles of social artificial intelligence agents (such as personal assistants, relational peers, and intimate partners) in a network graph survey, which alleviated different types of loneliness (lack of intimacy, interaction, or relationships) by providing supportive relationships. When combined with the mutual self-disclosure of chatbots, the perceived emotional support of chatbots has also been found to alleviate user stress (Meng &Dai, 2021), which may also contribute to relationship formation and emphasize the important role of social support in research on the relationship between humans and artificial intelligence.

The concept of attachment was first proposed by Bowlby (1969) to describe the intimate relationship between infants and caregivers. Attachment theory can explain adult relationship patterns, and attachment to inanimate objects such as places, objects, brands, and products. In the relationship between customers and AI chatbots, attachment behavior (such as seeking advice, comfort, and assurance from the chatbot) regulates the connection of AI participation in the relationship (Pentina et al., 2023), and attachment stems from the perceived social interaction intensity with the chatbot and the anthropomorphism of AI agents. Given the trend of AI chatbot customers using them as "safe havens and secure bases," attachment theory seems to be an important perspective for exploring the relationship between humans and AI (Hermann, 2021). Gillath et al. (2021) investigated the role of attachment style in generating trust in artificial intelligence. The authors found that attachment anxiety (attention to rejection and abandonment of ideas) reduced users' trust in artificial intelligence, while customers characterized by attachment avoidance (rejection of intimacy and intimacy) trusted artificial intelligence more, with no difference in AI trust levels compared to those with secure attachment styles. This discovery suggests that further research may be needed to understand the role of attachment in the development of the relationship between humans and artificial intelligence and explore its consequences.

The Triangular Theory of Love (Sternberg, 1986) proposes that emotional (intimacy), motivational (passion), and cognitive (commitment) components are the elements that contribute to the formation of interpersonal love, and the significance of these components varies depending on the object of love (such as parents, friends, and loved ones). The different combinations and intensities of these components can generate various forms of love, such as liking, sympathy, infatuation, etc., and determine the developmental stages of love. Hernandez Ortega &Ferreira (2021) applied the triangle of love theory to explore customers' love for their artificial intelligence virtual assistants and found that successful and satisfying interactions with AI agents generate user enthusiasm, which in turn increases their intimacy and commitment to robots, leading to greater expected use and loyalty. Similarly, Song et al. (2022) found that users' enthusiasm and intimacy towards artificial intelligence assistants can lead to a commitment to robots. Leo Liu (2023) studied intimate relationships with social chatbots, focusing on the relationship asymmetry caused by customers' expectations of chatbot services. The author analyzed the diaries of intimate chatbot Hupo users and found that chatbot resistance (such as rejecting intimate relationships) reduced relationship asymmetry and strengthened reciprocity and reciprocity in customer behavior. Given that customers can experience love for inanimate products, brands, and consumer experiences, exploring the possibilities and processes of love to form empathetic conversational artificial intelligence agents is undoubtedly an exciting research field.

3. Interpersonal communication and media studies

3.1. Social Attraction

Communication research distinguishes between task-related (respect) and person-related (social and physical liking) attractive attitudes that arise during interpersonal communication processes (Kiesler &Goldberg, 1968). These attitudes can affect trust and impact future communication among peers. Research on attractive attitudes in human-AI communication shows that compared to humans in online communication, humans have a lower level of liking for chatbots (Drouin et al., 2022), but if the conversation contains emotional disclosure or emoticons, their liking for chatbots and humans is similar. The principle of similarity attraction suggests that users prefer technology agents that match their personalities and maintain the same level of similarity over time (Bickmore &Picard, 2005). In the research on the relationship between customers and artificial intelligence agents, two studies have explored the attractiveness and similarity attitudes toward chatbots. In a longitudinal survey, participants reported that as self-disclosure decreased and perceived interaction decreased, their social attractiveness to robots also decreased, and relationship quality deteriorated over 7 weeks of interaction (Croes &Anteunis, 2021). Subsequent analysis indicates that as artificial intelligence chatbots exhibit greater similarity with user personalities and conversation styles through self-learning algorithms, customers also tend to adjust their communication styles to make them more similar to the robots. However, a lower degree of reciprocity on the client side will reduce the similarity effect on the progress of the relationship with artificial intelligence. Therefore, although attractiveness and similarity may be factors that shape the relationship between humans and artificial intelligence, the development of the relationship may require additional components of the relationship, such as reciprocity.

3.2. Social Anxiety

Based on personality and social psychology research, the self-presentation theory of social anxiety suggests that to improve self-presentation, individuals with social anxiety will seek low-risk social interactions (Caplan, 2006). Because building relationships in real life is more difficult than maintaining online interactions, anxious individuals are believed to be attracted to technology-mediated environments to compensate for their anxiety. Interacting with social chatbots may be the preferred choice for individuals with social anxiety to meet their communication needs. Ali et al. (2023) found that social interaction anxiety, directly and indirectly, increases the use of the social chatbot Xiaoce by

increasing fear of negative evaluations and rejection. However, repetitive unconstrained chatbot interactions characterized by sustained availability and unconditional acceptance may mimic interpersonal relationships and have negative impacts on users' social skills, work, family, and mental health (Laestadius et al., 2022).

3.3. Uncertainty Reduction

The reduction of uncertainty (Berger &Calabrese, 1975) can serve as a mechanism behind the initial stages of interpersonal communication. According to this method, as individuals exchange language expressions and perceive similarities, uncertainty decreases, and interpersonal intimacy increases. High levels of uncertainty may lead to reduced uncertainty behavior, including information seeking and mutual exchange. Van Straten et al. (2022) found that asking more questions by robots helps establish relationships with children by reducing their uncertainty, while Croes et al. (2022) compared AI self-disclosure with questioning and found that both are strategies for reducing uncertainty.

4. Human-computer Interaction Theory

4.1. CASA approach, Theory of Mind, and the Uncanny Valley

The CASA method is widely accepted and influential in human-computer interaction research, applying the ancient rhetorical concept of "moral behavior" (attributing another person's emotional and psychological characteristics to one's communication) to explain users' "unconscious" social responses to computers and computer programs that exhibit interactivity and use natural language (Nass et al., 1994). This viewpoint has been largely confirmed by empirical research, indicating that increasing the number of social cues triggers stronger social responses, as humans tend to use cognitive shortcuts and heuristic methods in communication (Von der Pütten et al., 2010).

As the main goal of social artificial intelligence is to facilitate interaction and communication processes, customers expect the technology to not only display social cues, but also demonstrate mental abilities (the ability to infer others' beliefs, intentions, and desires by referencing previous conversations and sharing experiences and history with users) (Croes et al., 2022). In a study, perceiving the thinking of artificial intelligence service robots can improve their persuasiveness and customers' willingness to follow their suggestions in hotel environments (Abdi et al., 2022). Uysal et al. (2022) proposed that customers are motivated to assign their thoughts to artificial intelligence agents to predict and understand their behavior, increasing their perception of similarity, intimacy, and trust, potentially leading to establishing relationships.

The long-term relationship between humans and artificial intelligence personified based on appearance, emotion, and thinking may lead to perceived threats to human identity (such as fear of being replaced by competitive thinking), a sense of strangeness, and beneficial outcomes for consumers. Mori (1970) and Mori et al. (2012) hypothesize that interacting with humanoid AI produces a strange feeling and describe it as an "uncanny valley" in the positive relationship between human similarity and familiarity, with a high sensitivity to defects in humanoid forms. The negative response to higher-level anthropomorphism in artificial intelligence agents may stem from the uncertainty of user expectations, especially when the AI agent does not exhibit the intelligence or perception level implied by being highly similar to humans. However, Letheren et al. (2021) did not confirm the uncanny valley hypothesis, indicating that consumers express more affection and a greater desire for interaction with more anthropomorphic artificial intelligence agents, which contradicts earlier research. Compared to animated avatars based on AI users' psychological and physiological responses to different types of chatbots, chatbots that only use text display fewer incredible effects and fewer negative impacts. When the appearance size of a robot conflicts with its body operation size, the uncanny valley phenomenon may also occur. The role, degree, and boundary conditions of this phenomenon in forming a long-term relationship between humans and artificial intelligence should be further studied.

4.2. Social Presence and Parasocial Interaction Approaches

The concept of social presence initially referred to an individual's perception of the presence of others in a technology-mediated environment and is now increasingly used in scenarios where customers interact with technology (Biocca et al., 2003). Zhang&Rau (2023) found that social presence plays a mediating role between the appearance of artificial intelligence humanoids and users' emotional attachment to robots. In contrast, Merrill Jr. et al. (2022) did not find any impact of the social presence of physical chatbots on their usefulness or willingness to recommend them as companions for lonely individuals. The social presence perceived by users from nonphysical chatbots generates their perceived usefulness and recommendation intention towards it. Although these contradictory results can be attributed to different experiments and contexts, the role of perceived social presence in the development of the relationship between humans and artificial intelligence deserves further research and attention.

The concept of parasocial interaction originates from the concept of social existence and is widely used to describe the psychological connection between media consumers and fictional characters (Giles, 2002). In the context of artificial intelligence agents, research has shown that perceived parasocial interaction with AI assistants during voice shopping, stemming from the assistant's human portrait, increases customer acceptance of additional product recommendations (Whang &Im, 2021). Social companion chatbots are more capable of generating a perception of social interaction than functional assistant chatbots. Pentina et al. (2023) argue that communication between customers and AI chatbots is different from technology intermediaries and one-way media consumption environments. They propose a mechanism based on Artificial Intelligence Social Interaction (AISI), which explains the reciprocity and evolving nature of customer AI interaction. The author suggests that AISI plays a mediating role between perceived AI agent anthropomorphism and authenticity and emotional attachment to robots. It is interesting that for customers who interact with robots for social needs, AISI plays a stronger role in generating attachment than for customers who are curious or satisfied with entertainment. Future research can further explore the essence of interaction between humans and artificial intelligence, and develop more specific concepts in the context of artificial intelligence.

5. Conclusion

Social psychology, communication and media research, and theories of human-computer interaction have explained the human-machine relationship in the AI era from different perspectives. However, existing literature may lead to different or even opposite conclusions when applying the same theory, which requires further research on the applicability of existing theories in human-machine relationships. The intersection and integration of disciplines have also become an important trend in the theoretical research of the relationship between humans and chatbots in the age of AI.

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