A RESEARCH REVIEW AND PROSPECTS ON ARTIFICIAL INTELLIGENT AGENT EMPATHY

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ABSTRACT. *As an emerging research topic, artificial intelligent agent empathy has received more and more attention from scholars. The study presents the connotations of artificial intelligent agent empathy and discusses its dimensionalities. We develop a conceptual framework of artificial intelligent agent empathy. Affective computing and anthropomorphic characteristics of agent are identified as antecedents of artificial intelligent agent empathy. Consumers' psychological perceptions and behavioral tendencies are summarized as the consequences of artificial intelligent agent empathy. The above impact depends on consumer factors (e.g., emotional state) and environmental factors (e.g., task complexity). Finally, the paper summarizes the research results and proposes management implications and future research prospects, with a view to providing a reference for future research and practice.*
Keywords: Artificial intelligent agent empathy, Human-computer interaction (HCI), Emotion, Psychological perception, Behavioral tendency

1. **Introduction.** With the continuous development of big data, the application of artificial intelligence is becoming more and more widespread and has penetrated into every aspect of people's lives. At the same time, enterprises have adopted agent for human-computer interaction services [1-5]. For example, some of the shops of Haidilao hot pot are completed by fully intelligent robots from food preparation to serving, and e-commerce platforms such as Alibaba and Jingdong have introduced intelligent customer service systems as well as Huazhu Group has deployed intelligent service robots in hotels. Advances in technology have led to the rapid development of artificial intelligence, but the capabilities that intelligent agent embodies are clearly not enough to meet people's needs [6]. An important aspect is the lack of a 'human touch' in HCI, which makes it difficult to understand and respond appropriately to human emotional needs [6,7]. As a result, scholars have begun to explore how to link emotions with intelligent agents, giving rise to 'affective computing' [8], which adopts computational modelling to recognize human speech and images, thus providing the basis for a harmonious human-computer relationship [9]. As an important ability in interpersonal communication, empathy has received a lot of attention from researchers [10-13]. However, current research on empathy has focused more on interpersonal interaction scenarios and less on HCI.

Based on the above background, this paper aims to investigate the emerging artificial intelligent agent empathy, and at the same time, to systematically describe the existing theoretical and empirical studies related to it. To be specific, we try to answer two research questions: *How to understand artificial intelligent agent empathy?* and *What are the conceptual framework of artificial intelligent agent empathy?* This paper finds that

artificial intelligent agent empathy has not been defined in a unified way, but its connotations can be divided into three dimensionalities: cognitive, affective and behavioral empathy. Affective computing and anthropomorphic characteristics are the antecedents of artificial intelligent agent empathy, while consumers' psychological perceptions and behavioral tendencies are the consequences. The above impact depends on consumer factors (e.g., emotional state) and environmental factors (e.g., task complexity).

By discussing the above questions, our results contribute to research and practice. First, it goes beyond previous empathy research based on interpersonal relationship by studying empathy in HCI, and puts forward new ideas of agent in research design and practical application. Second, it explores the connotations of artificial intelligent agent empathy and deepens the understanding of it by researchers and practitioners. Finally, we reveal the internal mechanism of artificial intelligent agent empathy, and remind the service industry to properly use agent empathy to influence consumers' psychology and behavior.

The paper is structured as follows. In Section 2, we present the connotations of empathy and further extend the connotations of artificial intelligent agent empathy. Section 3 presents the dimensionalities of artificial intelligent agent empathy. Section 4 contains the antecedents of artificial intelligent agent empathy, while Section 5 focuses on the consequences and the moderator variables. In the final section, we present the conclusions, the managerial implications, and the future prospects.

2. Connotations of Empathy and Artificial Intelligent Agent Empathy.

2.1. **Connotations of empathy.** The German philosopher Robert Vischer first coined the term "Einfühlung" in 1873, a transliteration of the Greek word "empatheia" and the etymology of the English word "empathy". Empathy originally referred to the projection of human feelings towards the natural world [14]. "Einfühlung" remained a concern of aesthetics for a long time thereafter, until it was introduced into the field of psychology by Theodor Lipps in the early 20th century, and first translated by the British psychologist Edward Titchener in 1909 as "empathy" [14].

It can be seen that the exploration of empathy theory can be traced back to the late nineteenth century in Europe, and the study of empathy gradually began in the mid-twentieth century afterwards. In recent years, empathy has been applied to disciplines such as philosophy, aesthetics, psychology, sociology and biological neuroscience. In different disciplines, empathy has been given different connotations of value. Table 1 lists a few representative connotations of empathy under different disciplines.

2.2. **Connotations of artificial intelligent agent empathy.** Artificial intelligence is the technical support for artificial intelligent agent empathy. It is found that the key technologies of AI can be divided into three phases: input, analysis and output [8]. The input phase includes technologies such as computer vision, speech recognition and natural language understanding. Such technologies transform complex external data into a comprehensible, structured and complete representation of the machine itself by acquiring and recognizing all types of information input from people. The analysis phase mainly involves machine learning techniques, including many intelligent algorithms. Machine learning techniques not only learn complex features from data and extract implicit knowledge, but also learn from their own processes, constantly extending the stored knowledge with new concepts or facts to make intelligent decisions or predictions. The output phase mainly includes techniques such as natural language generation and image generation. Such technologies convert the data obtained from machine learning and analysis into human-understandable forms such as text, images or sound as the output. These outputs can be used to inform corporate decisions or used for intelligent tasks in service activities, such as intelligent customer service responses and interactions [18].

TABLE 1. Connotations of empathy under different disciplines

Scholars	Connotations of empathy	Disciplines
Robert Vischer (1873)	Empathy refers to the projection of human feelings towards the natural world [14].	Philosophy
Theodor Lipps (1906)	Empathy refers to the satisfaction an individual gets from being immersed in an artistic experience [14].	Aesthetics
Edward Titchener (1909)	Empathy is the emotional experience of an individual actively trying to enter the inner world of another person [14].	Psychology
Hoffman (2001)	Empathy is an emotional response to another person's situation rather than one's own [15].	Sociology
Decety & Svetlova (2012)	Empathy is the ability to feel and understand the emotional state of another person by putting oneself in their shoes or position [16].	Neuroscience
Parasuraman et al. (1988)	Empathy refers to caring for consumers and providing them with personalized services [17].	Marketing

Agent is an important concept in the field of artificial intelligence. Researchers define agent as a computational entity that can operate independently and autonomously. This entity integrates multiple channels of input information to perceive and interact with its surroundings, and then completes the expected tasks in the environment it is placed in based on existing knowledge or through autonomous learning [19]. This paper argues that artificial intelligent agent empathy refers to the ability of an intelligent entity to understand and infer the possible feelings, motivations and needs of the other party and make appropriate behavioral feedback after recognizing the emotions expressed by human semantics, speech and expressions in the process of human-computer interaction.

3. **Dimensionalities of Artificial Intelligent Agent Empathy.** Previous researchers have shown inconsistencies in the conceptual and dimensional delineation of empathy. However, as research has progressed, scholars have generally agreed that empathy encompasses both affective and cognitive dimensions [8,20,21]. Affective empathy is an individual's ability to feel another person's emotions, as demonstrated by the individual's ability to perceive the other person's emotional state and react with a similar emotional state [22,23]. Cognitive empathy is an individual's ability to understand and judge others' feelings, thoughts, and motivations based on self-cognition, as demonstrated by the individual's ability to understand the other person's feelings, thoughts, and motivations, and then judge or infer the other person's needs [13,23]. However, some scholars believe that in addition to the cognitive and affective components, a behavioral component should also be included [13,23,24]. Behavioral empathy is an individual's intention to adopt or implement practical actions to respond to the emotional needs of others accordingly [13]. Combined with relevant research on HCI services, this paper argues that artificial intelligent agent empathy contains the above three components, i.e., artificial intelligent agent not only has the empathic ability to recognize and understand emotions, but also has the empathic ability to express them. Specifically, after recognizing the emotions expressed by human semantics, speech and expressions in the process of human-computer interaction, an agent understands and infers the possible feelings, motivations and needs of the other party, and makes appropriate behavioral feedback, such as specific actions or appropriate reply language.

4. **Antecedents of Artificial Intelligent Agent Empathy.** By combing through the relevant literature, it is found that scholars have conducted less research on the antecedents of intelligent agent empathy. Some qualitative literature covers antecedent research, but they mainly revolve around the technical basis. Some scholars have mostly explored the impact results produced by the application of intelligent agent empathy through empirical research. Based on relevant studies, this paper explores the antecedents of intelligent agent empathy in terms of both affective computing and anthropomorphic properties of intelligent agent.

4.1. **Affective computing.** Emotion is an important channel for information interaction. Building an emotional computing model is an important underlying technical support in HCI and the basis for an intelligent body to exert its empathic ability [8,25]. Professor Minsky (one of the founders of artificial intelligence) at MIT University first proposed in 1985 to give computers the ability to emote and achieve emotional HCI. In 1997, Professor Picard's team at the MIT Media Lab formally proposed this concept, aiming to make computers more intelligent by giving them the ability to recognize, understand and express human emotions. Then, they pioneered the sub-discipline of affective computing, which combines the disciplines of computer science, neuroscience and artificial intelligence. It has driven the continued development of affective intelligence that combines emotion recognition and analysis with AI technology [9]. Emotional intelligence is still limited in the application of empathy to intelligences due to its race-age and gender-specific expression, the need for high-quality sample data, and the subjective nature of emotion annotation [26,27]. Today, emotional intelligence is still in its early stages of development, and current intelligences can understand and respond to a "limited" range of emotions, with a focus on multi-layer semantic analysis, and still need to be developed to achieve human-computer empathy in terms of emotion application and emotion expression [26].

4.2. **Anthropomorphic characteristics of intelligent agent.** Anthropomorphism is defined as the attribution of human-like characteristics, behaviors or mental states to non-human entities, such as objects, brands, and animals. It has recently been applied by scholars to the study of intelligent agents, such as intelligent customer service, service robots, and self-service devices [5,28]. Anthropomorphism can be applied to non-human entities in a variety of ways, from the appearance and gender settings to the different psychological states unique to humans, such as reasoning, making moral judgments and emotional experiences [20]. Drawing on research on how brand anthropomorphism can influence brand trust and brand commitment in marketing, scholars have recently explored the impact of anthropomorphic characteristics of agent on consumer acceptance of AI and trust based on consumer perceptions of agent anthropomorphism, including the use of agent empathy as a mediating variable [20]. Experiments have demonstrated that consumers' perceptions of the anthropomorphic characteristics of an intelligent agent can influence consumers' perceptions of intelligent agent empathy, which in turn influences whether consumers trust or accept the intelligent agent [20].

5. **Consequences and Moderators of Artificial Intelligent Agent Empathy.** Research on artificial intelligent agent empathy has benefited from the development of empathic computational models, which can guide an intelligent agent to take empathic actions towards an interaction partner. Studies have shown that empathic agent can increase the trust of the interacting partner [2,29], increase the willingness to interact [30], increase social presence [4,31], help alleviate negative emotions and increase stickiness [32,33]. The empathic agent will enhance consumers' social interactions with educational smart apps, medical assistants, financial assistants, smart customer service, etc., where interaction is particularly important. However, the intelligence of agent can also create

fear in consumers and influence their attitudes and behavior [32]. Consumers are important participants in the business activities, and the application of agent inevitably has an impact on consumers' psychological perceptions and behavioral tendencies. In the following, we will sort out the impact of artificial intelligent agent empathy in terms of both consumers' psychological perceptions and behavioral tendencies.

5.1. **Impact of artificial intelligent agent empathy on consumers' psychological perceptions.** Current research suggests that consumers have both positive and negative psychological perceptions of intelligent agent empathy, and correspondingly, positive and negative behavioral tendencies. As consumers' needs change and technology advances, researchers have begun to develop and explore ways to enhance the empathy of agent to meet consumers' emotional needs. In this process, some consumers are curious and innovative about the manifestation of empathy in agent [2,28], and consider agent with empathy to be novel and distinctive, and are willing to experiment with or accept the technology. As understanding increases, consumers find that interacting with empathic agent feels more and more real and intimate, as if they were interacting with real humans in real life, thus creating a sense of social presence [4]. The deeper change in psychological perceptions changes the consumer's perceptions of psychological distance from the agent and further influences the consumer's trust in the agent [29]. The negative perceptions of empathy in these interactions are mainly due to the 'uncanny valley' theory [34,35], in which agent gradually moves from mechanisation to thinking to emotion, and consumers fear that overly intelligent non-human entities may pose a threat to human [3,32,35].

5.2. **Impact of artificial intelligent agent empathy on consumers' behavioral tendencies.** Empathy is one of the anthropomorphic forms of an agent, which can directly affect consumers' behavioral tendencies [1,2,5]. In addition, from the aforementioned two aspects of consumers' psychological perceptions exist, thus generating both positive and negative behavioral tendencies. Positive psychological perceptions can lead to positive behavioral tendencies, e.g., consumers' trust in the empathic agent can lead to forgiveness of service failures and continued use of the empathic agent [1], which may further lead to product purchase intentions. Negative psychological perceptions can lead to negative behavioral tendencies, e.g., consumers' disgust to empathic agent can exacerbate consumers' negative attitudes towards the service failure [3], leading to the perception that even empathic agent cannot solve real problems and may eventually lead to resistance to the use of intelligent agent [32,35].

5.3. **Moderators of artificial intelligent agent empathy.** Artificial intelligent agent empathy has impacts on consumers' psychological perceptions and behavioral tendencies, which are also moderated by a number of factors. There are two main types of factors that exert an influence. The first is consumer factors such as consumer personality traits (regulatory focus [2], implicit personality [1]), and consumer emotional state [37]. The second is external environmental factors such as task complexity [29], intelligent disclosure [29], and interaction style [1].

As a result, this paper summarizes the conceptual framework of artificial intelligent agent empathy, as shown in Figure 1.

6. **Conclusions and Discussions.**

6.1. **Conclusions.** As an important technical capability in the intelligent era, the study of artificial intelligent agent empathy can promote the stable development of human-computer interaction. This paper firstly compares the connotations of empathy in different disciplines and draws out the connotations of artificial intelligent agent empathy, suggesting that artificial intelligent agent empathy contains three factors: cognitive, affective and behavioral empathy. Secondly, the antecedents of intelligent agent empathy are
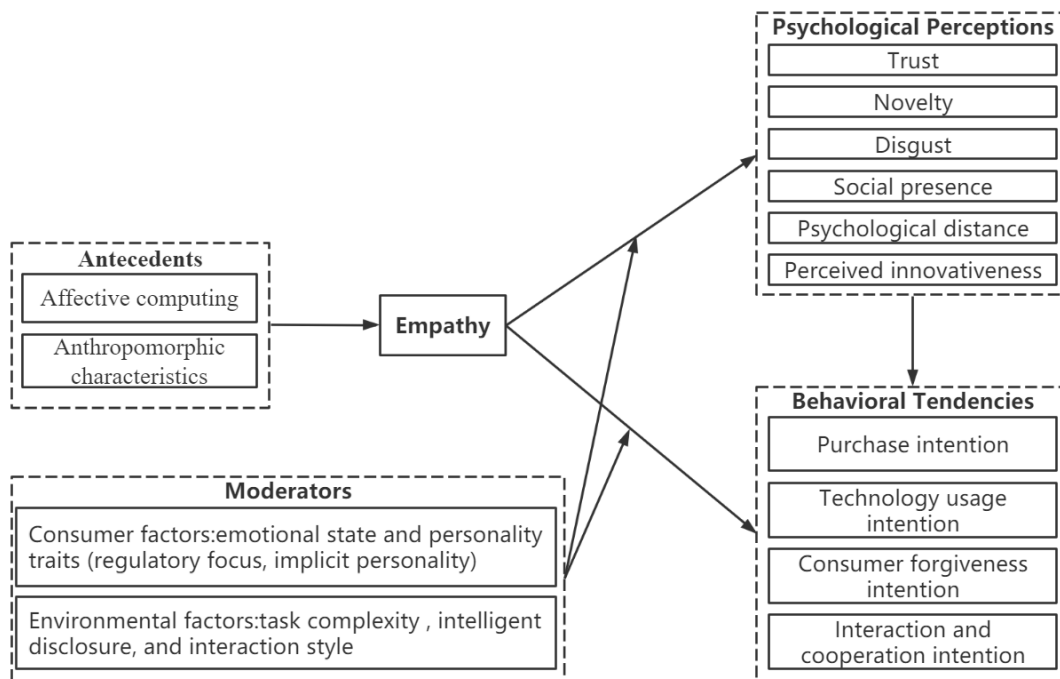
FIGURE 1. The conceptual framework of artificial intelligent agent empathy

summarized, and the influence of affective computing and anthropomorphic characteristics on intelligent agent empathy is sorted out. Finally, the positive or negative effects of intelligent agent empathy on consumers in terms of both psychological perceptions and behavioral tendencies are discussed, and the influence of moderating factors is explored.

6.2. **Managerial implications.** First, managers can employ empathetic agents to interact with consumers. Empathic agents can communicate with consumers at the emotional level, and then realize intelligent information management. Second, our findings highlight to managers the potential consequences of employing empathic artificial intelligent agents in service processes. Artificial intelligent agent empathy has positive or negative effects on consumers, and managers need not worry about the negative effects of the uncanny valley effect if they properly grasp the application degree of empathy. Finally, managers can utilize these findings to identify the responses of consumers with different characteristics to artificial intelligent agent empathy in different service contexts, so as to monitor and evaluate the application effects of empathy.

6.3. **Prospects.** First, the antecedents of intelligent agent empathy still need to be explored. In HCI, there are different forms of agent [5], such as service robots, conversational agent, and social robots. Whether the intelligence characteristics of different forms of agent themselves have an impact on the manifestation of agent's empathy in different HCI contexts [38] needs to be explored in depth. In addition, since in real life both the empathic subject and the empathic object are often humans, and humans have subjective agency, the question of whether humans' energetic perception of agent is a condition for empathy to be effective in human-computer interaction [7] also needs to be considered.

Second, the action mechanism of intelligent agent empathy should be explored in depth. While the emergence of emotion-based robots and human-like agent has brought positive impacts to society, it has also led to a discussion of their ethical issues. Whether robots with emotional capabilities need to have a sense of morality and subjectivity has been a highly controversial issue [7,36]. Whether this ethical dimension affects consumers' perceptions of empathy in agent and whether the subsequent behavioral consequences change could be further investigated in the future.

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