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Review of Factors Influencing the Acceptance of Anthropomorphism: A Case Study of Service Robots

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Abstract. The phenomenon of anthropomorphism in human-computer interaction, with a focus on service robots such as intelligent assistants. This review on anthropomorphism identifies key factors influencing the perception of artificial intelligence anthropomorphism, emphasizing user characteristics (personality, demographic information, knowledge) and aspects of agents (appearance, social role, behavior). The study highlights the different impacts of hedonic and utilitarian tasks during the anthropomorphism process and calls for future work to focus on developing assessment models for the degree of service robot anthropomorphism.

Keywords: Anthropomorphism;Artificial Intelligence;Service Robots;Acceptance

1. Introduction

Anthropomorphism, the tendency to attribute human characteristics to non-human entities, is a widely observed phenomenon in human-computer interaction[1]. How do anthropomorphic service robots, such as intelligent assistants and virtual characters, influence our acceptance of service robots? This article aims to explore the answers to these questions.

Early research focused on the impact of anthropomorphism on user behavioral intentions, indicating that people unconsciously apply social rules, such as politeness and reciprocity, to computers that display social cues[2]. Studies have shown that anthropomorphism plays a significant role in enhancing perceived humanness, interaction, and various other dependent variables (such as trust, perceived ability, and social motivation)[3].

However, the anthropomorphism of service robots has also raised a series of questions and contradictions. On one hand, anthropomorphic design adds a sense of warmth at the psychological level, changing consumers' perception of mystery and fear, thereby promoting interactivity between people and the design[4]. On the other hand, excessive anthropomorphism may lead to unrealistic expectations of service robots, triggering the uncanny valley effect[5].

This study systematically reviews and analyzes the recent research achievements on anthropomorphism in service robots. Firstly, when constructing the literature search strategy, this study clearly defined keywords and terms related to intelligent customer service to ensure the accuracy and relevance of the search results, including "artificial intelligence", "Anthropomorphism"; "intelligent customer service" and "service robot"; retrieving papers related to anthropomorphism published from October 2014 to October 2024 over the past decade, covering journal articles, conference papers, and reviews. Then, the abstracts and contents of the above literature samples were manually screened. After eliminating duplicates and excluding literature on "literature" and "animals", a total of 31 relevant articles were analyzed.

Since 2018, research dynamics related to anthropomorphism have been significantly active, showing an exponential growth trend. This change may be partly attributed to the advancement of related technologies based on artificial intelligence. The rapid progress of this technology not only promotes the increasingly widespread application of service robots in multiple fields but also provides more abundant research opportunities.

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2. The Factors Influencing Anthropomorphism

2.1 User Factors

2.1.1 Implicit Personality

Implicit personality refers to the stable psychological characteristics and behavioral patterns that an individual exhibits unconsciously[6]. Implicit personality theory posits that essentialism and incrementalism are two primary attribute theories[7]. The essentialist viewpoint advocates that individual personality traits remain stable and unchanging, with behavior exhibiting consistency; whereas the incrementalist perspective views personality as mutable and adaptable, with behavior varying with the environment[8]. Unlike essentialists (fixed individuals), incrementalists (malleable individuals) hold a more tolerant view towards entity changes[9]. In contexts where service failure is known, compared to service robots apologizing, apologies from human employees are more likely to facilitate forgiveness from essentialists[10].

2.1.2 Demographic Factors

Studies have shown that gender has a significant impact on the perception and acceptance of service robot anthropomorphism. Research results indicate that in interactions with chatbots, women, compared to men, are more sensitive and responsive in establishing relationships through dialogue quality and social influence[11].Lourenço et al. (2020) showed that, under otherwise identical conditions, older consumers are less satisfied with the use of automated tools than younger consumers[12]. Research also finds that people from different regions accept and process information differently, invoking different elicited subjective knowledge. Cui Han (2010) believes that in the context of Western culture, humans preserve their dignity by deliberately alienating and opposing robots, masking their fear of technology; whereas in Eastern cultural contexts, humans maintain an inclusive attitude towards technology in the process of integrating and accepting robots[13].

2.1.3 Elicited Agent Knowledge

Epley et al. proposed a three-factor theory of anthropomorphism, which identified three key factors from the perspectives of cognition and motivation: elicited agent knowledge, effectance motivation, and sociality motivation[1]. Zhang Yi et al. (2022) found that when users from higher social strata have knowledge related to artificial intelligence, they are more inclined to perceive service robots with higher levels of anthropomorphic appearance as having higher perceived intelligence levels and are more willing to use them[14]. Studies show that consumers with a superficial understanding of products often lack the ability to seek intrinsic information, thus they tend to base their evaluations and decisions on surface-level presentations[15]. Other studies emphasize that individuals with stronger professional capabilities paradoxically exhibit distrust towards AI suggestions.

2.2 Robot Factors

2.2.1 Extrinsic Level

Studies have shown that virtual agents with higher levels of anthropomorphism can enhance professionalism and attractiveness, leading customers to feel a greater sense of social presence, which in turn affects consumers' positive attitudes and behaviors[16]. Compared to neutral-acting robots, robots that exhibit empathetic behaviors such as facial expressions and verbal expressions are rated higher in perceived friendship[17]. Avatars, as a social attribute, can convey some social cues of humans, such as identity, professionalism, and reliability[18]. However, inconsistencies between anthropomorphic appearance and behavior can lead to uncertainty in effects[19].

2.2.2 Social Role Level

Based on a two-dimensional classification system of "expression form" and "relationship status," anthropomorphic images are summarized into four types: "partner," "assistant," "admirer," and

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"servant" [20]. In the context of service failure, the partner role intelligent voice assistant is less affected by humorous styles; whereas under the servant role, self-deprecating humor can better promote users' appreciation of humor and increase tolerance for failure[21].

2.2.3 Behavioral Level

Behavioral anthropomorphism is a strategy that endows intelligent customer service with human characteristics such as voice, communication style, and emotional responses[9]. At present, the main research mainly divides the communication styles of voice assistants into social and task-based[22]. Compared with task oriented voice assistants, social oriented voice assistants are more popular among the elderly in terms of trust, ability, and technological acceptance[23]. Wang Haizhong (2021) believes that communication style can play a moderating role in the event of service failure[9]. Research has shown that the communication styles of intelligent assistants can be divided into two types: cute and formal[24]. According to the stereotype content model, these communication methods are further divided into competence based and warmth based[25].In the event of service failure, self-deprecating humor can effectively increase users' tolerance for failure, while self-enhancing humor has a poorer effect[21].

In summary, Table 1 summarizes the research perspectives, variables, and findings on the similarity between artificial intelligence and humans.

Table 1. Summary of existing research on the similarity between artificial intelligence and humans

Literature	Perspective	Method	Anthropomorphic form	Dependent variable	result
De Cicco et al. (2020)	A,C	E	No profile picture (low)		N
			Have profile picture(high)		O
Wang Haizhong et al.(2021)	A	E	Cartoon image, unnamed intelligent customer service (low)	Willingness to reuse after service failure	NI
			Real person image, named intelligent customer service (high)		N
Zhang Yi et al.(2022)	A	E	Low degree anthropomorphic robot in appearance	Perceived intelligence, willingness to use	O
			Moderately anthropomorphic robot in appearance		O
			High degree anthropomorphic robot in appearance		N
Miao et al. (2022)	A,C		ING's Dutch Ingelheim (low)	Satisfaction, credibility, sponsorship intention	N
			Cora from Natwest Bank (middle)		N
			Post traumatic stress disorder therapist Ellie (middle)		O
			Daniel from Swiss Bank (high)		O
Qi Haifeng et al.(2023)	B,C	E	Partner based intelligent voice assistant	brand attachment	O
			Servant type intelligent voice assistant		N
Zhang Chubing et al. (2024)	B,C	E	Partner Role Intelligent Voice Assistant	Humorous apprecia“tion, tolerance for failure	NI
			Servant role intelligent voice assistant		O

a. In the "Perspective" column, A denotes Appearance; B denotes Expression; C denotes Behavioral Expression; D denotes Social Characteristics.

b. In the "Method" column, E denotes Experimental Method; QI denotes Qualitative Interview Method; ER denotes Empirical Research Method.

c. In the "Outcome" column, O denotes Positive; N denotes Negative; NI denotes No Impact.

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2.3 Task Factors

The different task orientations of intelligent services can influence customer behavior. Davenport et al. (2020) classified artificial intelligence tasks into two major categories based on the nature of data processing: numerical and non-numerical[26]. On the other hand, Wirtz et al. (2018) categorized the task orientation of service robots into two major categories from the perspective of cognitive analysis and emotional social interaction[27].

Research in recent years can be divided into hedonic tasks and utilitarian tasks. In the face of utilitarian tasks, recommendations from intelligent agents are as effective as those from humans[28]. Similar to recommendation mechanisms, in the context of e-commerce customer service communication, when the product attributes emphasized are functional, artificial intelligence customer service achieves higher customer satisfaction than human frontline customer service[29]. The article summarizes based on the classification of service robot anthropomorphism task types, as shown in Table 2.

Table 2. Summary of existing research on the similarity between artificial intelligence and humans

Table Head	Table Column Head
Wirtz et al. (2018)	Cognitive analytical tasks refer to undertaking heavy or unpleasant, difficult, or even dangerous tasks that can be challenging for individuals[27].
	Emotional social tasks refer to generating solutions that involve high levels of flexibility, ready-made thinking, and creative problem-solving[27].
Davenport et al. (2020)	Number data refers to the processing of structured and digitized data[26].
	Non number data refers to the processing of data such as sounds, expressions, images, etc[26].
Wu Jifei et al. (2020)	The task of recommending highly creative products reflects a product's high level of novelty and practicality[30].
	Low creativity product recommendation task refers to a type of product recommendation task with a lower level of creativity[30].
De Cicco et al. (2020)	The social oriented interaction style emphasizes the establishment and maintenance of interpersonal relationships, focusing on emotions, trust, and cooperation[18].
	The task oriented interaction style focuses more on achieving goals and solving problems[18].
Cian et al. (2022)	Hedoni refers to attributes related to the pleasant experience of a product or service, such as taste, appearance, etc[31].
	Utilitarianism refers to attributes related to the practical function of a product or service, such as nutritional value, price, etc[31].

3. Summary

There are many influencing factors, including user factors, agent factors, and task factors. User factors need to consider users' implicit personality, demographic factors such as age and gender, as well as subjective knowledgeability factors, which directly affect people's acceptance of artificial intelligence systems. Agent factors, such as the social role the agent plays, its behavioral level, and appearance expressions, pose new challenges for the development and application of service robot anthropomorphism technology.

Taking this into account, this study organizes and evaluates the existing literature related to service robot anthropomorphism services. The article first provides an overview of the definition and main research trends of service robot anthropomorphism. Subsequently, the article outlines various factors that may affect consumer feelings and acceptance in anthropomorphic service interactions with artificial intelligence, and systematically categorizes and classifies these factors, as shown in Figure 1.

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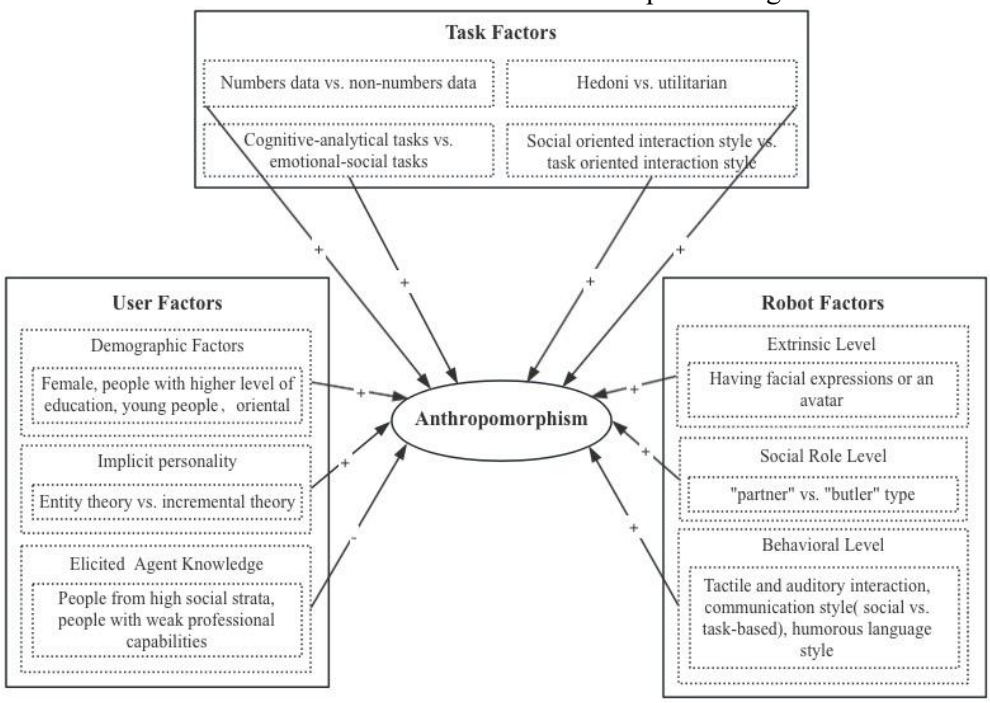

Fig. 1 Factors affecting the acceptance of anthropomorphism discussed in existing literature

While this study has identified several factors that may influence the relationship between anthropomorphization and user acceptance of service robots, it is acknowledged that a clear causal chain has not been established. The correlational nature of the current analysis limits the ability to draw definitive conclusions about causality. Therefore, it is recommended that future research employs experimental designs to explore the causal effects of anthropomorphism on user acceptance.

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