Establishing Emotional Attachment Between Humans and Chatbots Based on Anthropomorphism

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Abstract

With the development of Internet technology, chatbot applications in Internet-based Self-help Interventions (ISIs) are becoming increasingly prevalent; however, understanding of their interaction mechanisms remains superficial. Although existing research has proposed models of Human-Chatbot Relationships (HCRs), they have failed to adequately explain the generation pathways of emotional attachment. Therefore, this article will delve into the establishment process of emotional attachment between chatbots and users, and optimize the theoretical model of HCRs promoting engagement. The article proposes that the formation process of emotional attachment between humans and chatbots is based on anthropomorphism, comprising five stages: utilitarian value judgment, basic needs satisfaction, affective value judgment, emotional construction, and emotional attachment establishment, wherein the emotional construction stage achieves internal connection through the dual mechanisms of emotional identification and emotional dependence. Future research could deepen understanding of HCRs based on zoomorphism, reveal the evolution process from human-chatbot emotional attachment to digital therapeutic alliance, and systematically explore the key factors influencing human-chatbot emotional attachment.

Full Text

Anthropomorphism as a Foundation: Establishing Emotional Attachment in Human-Chatbot Relationships

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Abstract: With the advancement of internet technologies, chatbot applications in Internet-based Self-help Interventions (ISIs) have become increasingly prevalent, yet our understanding of their interaction mechanisms remains limited. Although existing research has proposed models of Human–Chatbot Relationships (HCRs), these frameworks have not adequately explained the pathways through which emotional attachment emerges. This article therefore delves into the process of establishing emotional attachment between users and chatbots, offering an optimized theoretical model of HCRs that enhances user engagement. We propose that the formation of emotional attachment in human–chatbot interactions unfolds through five stages grounded in anthropomorphism: (1) utilitarian value judgment, (2) basic needs satisfaction, (3) emotional value judgment, (4) emotional construction, and (5) emotional attachment establishment. Notably, the emotional construction stage achieves internal bonding through dual mechanisms of emotional identification and emotional dependence. Future research should deepen HCRs understanding through zoomorphism, illuminate the evolution from emotional attachment to digital therapeutic alliance, and systematically investigate key factors influencing human–chatbot emotional attachment.

Keywords: Anthropomorphism, Human–Chatbot Relationships, Emotional Attachment, Value Judgment
Classification Code: B849

Driven by synergistic innovations in big data analytics, artificial intelligence (AI) algorithm optimization, and cloud computing architectures, Internet-based Self-help Interventions (ISIs) have achieved breakthrough developments in mental health services (Johansson et al., 2021). ISIs refer to therapeutic approaches where users autonomously participate in treatment plans delivered via the internet (Heckendorf et al., 2022). These interventions employ multiple modalities, including AI-powered chatbots (Liu et al., 2022), automated feedback platforms (Dahlin et al., 2020), and expert-guided or professionally facilitated programs (Rohrbach et al., 2022). Chatbots offer significant advantages within ISIs due to their comprehensiveness and convenience (Provoost et al., 2020). However, a comprehensive and in-depth understanding of chatbot operational mechanisms remains elusive (Gabrielli et al., 2021; Skjuve et al., 2022).

Current scholarship has attempted to explain Human–Chatbot Relationships (HCRs) through the lens of Human–Human Relationships (HHRs) theory (Hendriks et al., 2020; Schuetzler et al., 2020). For instance, Skjuve and colleagues developed a three-stage developmental model of HCRs based on Social Penetration Theory (SPT) (Skjuve et al., 2021; Skjuve et al., 2022). Building upon this work, Chinese scholars Mo Ran et al. (2023) identified limitations in applying

this model to ISIs contexts, such as its failure to account for cognitive processing in human–computer interaction, the psychological mechanisms underlying each stage, and the unique characteristics of psychological counseling/therapy scenarios beyond intimate relationships. To address these gaps, they proposed an HCRs engagement promotion theoretical model comprising four stages: (1) anthropomorphic attribution, where users establish a cognitive foundation through para-social interaction and perceive chatbots as entities with human-like traits and behaviors; (2) utilitarian value judgment, where users explore and recognize the chatbot as an effective and practical tool; (3) attachment relationship development, where HCRs transition from cognitive to emotional dimensions as users reframe the chatbot from "tool" to "partner" ; and (4) establishment of a Digital Therapeutic Alliance (DTA) that drives ISIs goal achievement. These four stages collectively facilitate HCRs formation and deepening, ultimately enhancing user engagement.

Nevertheless, this model exhibits several limitations. First, utilitarian value judgment tends to generate instrumental dependence, yet the model fails to explicitly articulate how such dependence evolves into emotional attachment. Second, the model does not reveal the degree of anthropomorphism at each stage. This article therefore investigates the process of establishing emotional attachment between humans and chatbots, optimizing Mo Ran et al.' s (2023) HCRs engagement promotion theoretical model to achieve greater completeness.

2. Understanding HCRs Formation and Development Through Anthropomorphism

Existing literature demonstrates numerous similarities between HHRs and HCRs during interaction (Patriciano et al., 2024; Skjuve et al., 2021), providing a theoretical basis for applying HHRs frameworks to HCRs. As interpersonal relationships deepen, individuals gradually increase self-disclosure, thereby strengthening their bond (Patriciano et al., 2024). Similarly, in HCRs, users progressively share more personal information—such as interests and life experiences—as interactions increase, reflecting a gradual intensification of the user–chatbot relationship (Skjuve et al., 2021). However, a critical bridge is required for HHRs theory to genuinely apply to HCRs: anthropomorphism.

Anthropomorphism refers to the cognitive tendency to attribute human-specific perceptions, mental states, and behavioral traits to non-living objects, animals, and even natural phenomena or supernatural entities (Airenti, 2015). Anthropomorphism facilitates relationship establishment and development between humans and non-human objects by eliciting empathy, promoting understanding and communication, and enhancing social cognition (Luo & Yan, 2024). Empathy Theory posits that individuals possess the capacity to perceive and understand others' emotional states (Luis et al., 2023); anthropomorphism makes non-human objects more "human-like," thereby triggering empathy. Social Cognitive Theory (SCT) maintains that accurately understanding and interpreting others' behaviors positively impacts social relationship formation (Riley et

al., 2023); anthropomorphism simplifies cognitive processes and enhances human–non-human object understanding and communication. Thus, anthropomorphism plays a pivotal role in fostering relationships between humans and non-human objects.

In practical HCRs applications, anthropomorphism proves indispensable. When consumers attribute anthropomorphic characteristics to brands, their emotional connection strengthens, consequently enhancing brand loyalty (Chu et al., 2019). Similarly, in HCRs, anthropomorphic chatbots demonstrate superior capacity to grasp user needs accurately, delivering highly personalized service experiences that effectively elevate user satisfaction levels (Choudrie et al., 2023; Marikyan et al., 2022). Research indicates that anthropomorphic interface design enhances user satisfaction and loyalty (Hu & Sun, 2023; Schillaci et al., 2024).

In summary, anthropomorphism serves as a foundational bridge connecting humans and non-human objects, playing a fundamental role in applying HHRs theory to HCRs. Through anthropomorphism, we can integrate human emotions, cognition, and social experiences into interactions with chatbots, rendering communication more natural and enriched.

3. The Formation Process of Emotional Attachment in Human-Chatbot Relationships

Instrumental dependence refers to the phenomenon where individuals over-rely on a particular tool or means to achieve a goal or satisfy a need (Biccheri et al., 2023). Emotional attachment constitutes a goal-specific bond formed between an individual and another entity, characterized by strong emotional connection (Ladhari et al., 2020). Harlow' s Monkey Experiments provide crucial insights into distinguishing instrumental dependence from emotional attachment (Harlow et al., 1965). In these studies, wire surrogate mothers satisfied infant monkeys' physiological needs through food provision. However, this physiological satisfaction failed to generate emotional attachment, instead producing instrumental dependence based on utilitarian value judgment (Geng & Guo, 2022; Harlow et al., 1965). In contrast, cloth surrogates provided warmth and soft physical contact, satisfying emotional needs and thereby fostering emotional attachment grounded in emotional closeness and security rather than mere physiological fulfillment. Harlow' s experiments clearly demonstrate that utilitarian value judgment cannot produce emotional attachment, only instrumental dependence. This article therefore explores how HCRs evolve from instrumental dependence to emotional attachment, examining users' anthropomorphic mental perception of chatbots throughout this process.

3.1 Utilitarian Value Judgment Stage

Utilitarian value refers to the utility consumers perceive through a product' s functional or physical attributes (Sheth et al., 1991). Utilitarian value judgment represents the process of weighing and evaluating such utilitarian value. When

users initially encounter new technologies or products, they typically conduct rapid assessments to determine whether these meet their needs or expectations (Yu Yang, 2017). Such evaluations are often based on utilitarian value judgment —users consider whether the product or technology delivers practical benefits or efficiency improvements. In human–computer interaction, chatbots represent a novel technological product, and users similarly conduct such evaluations upon first contact.

During initial chatbot encounters, users may automatically form intuitive judgments about a chatbot' s utilitarian value based on the alignment between certain robot features and their expectations or needs. Cognitive Load Theory indicates that human cognitive resources are limited; when first encountering a chatbot, users rapidly evaluate key features to determine whether to invest additional cognitive resources for deeper interaction (Schmidhuber et al., 2021). The Expectation-Confirmation Model (ECM) further explains that during actual use, users compare their expectations with the chatbot' s actual performance. If the chatbot meets or exceeds expectations, users quickly form positive intuitive judgments; otherwise, satisfaction decreases (Forssell & Ratjen, 2023). Since emotional connection remains weak at this stage, users are more inclined to explore deeper interactions with alternative chatbots. Consequently, this initial stage plays a crucial role in establishing HCRs.

During the utilitarian value judgment stage, users conduct comprehensive evaluations of chatbots based on their needs, assessing perceived usefulness, perceived ease of use, functional evaluation, value assessment, and cost-benefit analysis. When chatbots perform well across these dimensions, users are more likely to engage in deeper interactions. On one hand, the Technology Acceptance Model (TAM) posits that perceived usefulness and perceived ease of use are key determinants of positive utilitarian value judgment (Tao et al., 2022). High scores on both dimensions predispose users toward social interaction with chatbots (Nadarzynski et al., 2019; Park & Kim, 2023). On the other hand, following the Uses and Gratifications Framework, users actively and purposefully select and employ chatbots to satisfy specific needs and desires (Marjerison et al., 2022). When encountering a new chatbot, users conduct preliminary functional assessments of speech recognition capabilities, natural language processing proficiency, knowledge base richness, and response speed based on utilitarian needs. Additionally, users evaluate whether chatbots deliver significant practical benefits (e.g., improved work efficiency) as a key indicator of overall value (Sidaoui et al., 2020). When deciding to rent or purchase a chatbot, users perform cost-benefit analyses; chatbots offering high benefits at low costs are more likely to gain user favor and secure further interaction opportunities.

During utilitarian value judgment, the degree of chatbot anthropomorphism triggers corresponding mental perception from users at the cognitive level. Anthropomorphism activates upon initial contact, unconsciously leading users to treat chatbots as another person—namely, anthropomorphic attribution (Mo Ran et al., 2023). Mind Perception Theory suggests that during interaction,

users integrate cognitive and affective perceptual information to process chatbots anthropomorphically (Lee et al., 2020). Emotional response formation typically represents a gradual process requiring extended interaction and experience (Skjuve et al., 2022). During initial encounters, users have not yet established deep emotional connections and are unlikely to generate strong emotional reactions immediately. Instead, they are more likely to form cognitive assessments of the chatbot' s mental capabilities based on its external performance and preliminary interactions. Research demonstrates that large-scale language models (e.g., GPT-3) enable efficient learning and intelligent dialogue with few samples, significantly enhancing chatbot efficiency and user experience in practical applications (Brown et al., 2020). In other words, intelligent dialogue capability constitutes a crucial component of a chatbot' s utilitarian value. When processing conversations, chatbots' core task involves understanding input natural language and generating corresponding natural language responses (Abdellatif et al., 2021). This process primarily relies on language comprehension, information integration and expression, and reasoning and decision-making based on this information—all of which fall within the cognitive processing domain.

In summary, during initial chatbot contact, users rapidly form intuitive judgments about utilitarian value based on feature-expectation alignment. At this stage, users evaluate usefulness, ease of use, functionality, value, and cost-benefit. Strong performance encourages deeper interaction. Additionally, users initiate anthropomorphic attribution and develop mental perception of the chatbot, though initial emotional connections remain shallow and assessments are primarily cognitive. The chatbot' s intelligent dialogue capabilities—including language understanding, information integration, expression, and reasoning—represent key components of its utilitarian value, influencing users' preliminary judgments and subsequent interaction intentions.

3.2 Basic Needs Satisfaction Stage

Basic needs satisfaction refers to a state where individuals' core psychological needs for autonomy, competence, and relatedness are fulfilled (Vansteenkiste et al., 2020). Research reveals a close connection between utilitarian value judgment and basic needs satisfaction. For example, Chaerudin and Syafarudin (2021) found that consumers, based on utilitarian value judgment, perceive certain products as satisfying their basic needs due to high quality, reasonable pricing, and excellent service, leading to purchase decisions and high post-use satisfaction. Therefore, following utilitarian value judgment of chatbots, individuals may enter a stage characterized by basic needs fulfillment.

Utilitarian value judgment provides the decision-making foundation for basic needs satisfaction, which in turn validates the effectiveness of the former by assessing the degree of need fulfillment. This perspective receives strong theoretical support from utilitarian theory and Maslow' s Hierarchy of Needs. Utilitarian theory emphasizes the utility or outcomes of actions, suggesting that people tend to select options that maximize benefits or satisfaction (Chen &

Hooker, 2020). When choosing chatbots, individuals consider which robots can more effectively satisfy their needs, whether for information acquisition, entertainment, or social interaction (Dinh & Park, 2023). Maslow' s Hierarchical Theory of Needs reveals the progressive evolution of human needs from basic physiological requirements to higher-level self-actualization, constituting intrinsic motivations that decisively influence selection and decision-making processes (Rojas et al., 2023). When selecting chatbots, people evaluate robot value according to their current need hierarchy. For instance, individuals at the social needs level may prefer chatbots with rich social interaction functions (Haoyue & Cho, 2024; Rojas et al., 2023), while those pursuing self-actualization may prioritize robots that facilitate personal growth or provide unique experiences to satisfy higher-level needs (Rojas et al., 2023; Zhou et al., 2023). These complementary theories demonstrate the central role of utilitarian value judgment in satisfying basic needs: utilitarian value judgment aims to maximize basic needs satisfaction to guide decision-making, while users validate their decisions' accuracy and effectiveness based on the degree of basic needs fulfillment.

Human basic needs satisfaction in relation to chatbots exhibits hierarchical and dynamic characteristics. Maslow' s theory posits that human needs exist in a hierarchical ladder structure, with each level unfolding contingent upon satisfaction of preceding levels (Rojas et al., 2023). This directly demonstrates that the basic needs satisfaction stage exists as a hierarchical progression. The Existence, Relatedness, and Growth (ERG) Theory similarly reflects the hierarchical structure and dynamic nature of human needs. However, unlike Maslow' s theory, ERG emphasizes that when individuals face prolonged unmet needs, they may adopt a downward adjustment strategy, shifting to satisfy lower-level needs (Elujekwute et al., 2021). Gartner survey data reveals that chatbots demonstrate low success rates in resolving complex issues (e.g., billing disputes, product/service changes) at 17% and 18%, respectively. This suggests that when chatbots underperform on tasks requiring higher-level comprehension and processing capabilities, users may consider alternative approaches or limit themselves to basic service functionalities.

During the basic needs satisfaction stage, users' mental perception of chatbot anthropomorphism has not yet transcended beyond cognitive dimensions. At this stage, users primarily focus on whether chatbots can provide accurate, timely information and services to meet practical needs (Liu et al., 2023; Pawar & Katore, 2024; Zhu et al., 2022). Consequently, user expectations center on functionality and practicality rather than emotionality. Anthropomorphic design makes robot functions more intuitive and comprehensible, helping users better understand and utilize robot capabilities to satisfy basic needs, but this stage does not profoundly impact the emotional dimension (Chen et al., 2024; Lu et al., 2024). For example, Amazon' s Echo Dot and Google' s Nest Mini are designed with human-like features and interaction patterns, yet their instruction-following behavior lacks emotional exchange, making it difficult to fully address users' emotional needs or stimulate sustained attachment emotions (Pradhan et al., 2019; Robinson et al., 2018; Villarreal et al., 2022). Even though DeepSeek' s Native Sparse

Attention (NSA) technology enhances reasoning capabilities through dynamic hierarchical sparse strategies and hardware-level co-optimization to refine vague user requirements (Yuan et al., 2025), its essence remains cognitive-level interaction optimization without altering the current reality of absent emotional dimensions (Chen et al., 2024). Therefore, emotional dimension perception plays a crucial role in building emotional attachment with chatbots.

In summary, users select chatbots based on utilitarian value judgment and Maslow' s need hierarchy, with needs exhibiting hierarchical and dynamic characteristics. During basic needs satisfaction, users' mental perception of chatbots remains primarily at the cognitive dimension, focusing on functionality and practicality. While anthropomorphic design enhances usability, insufficient emotional exchange hinders emotional attachment formation. Thus, emotional dimension perception is essential for establishing deeper human-chatbot relationships.

3.3 Emotional Value Judgment Stage

Emotional value refers to the feelings and affective states consumers experience through selecting certain products or services (Sheth et al., 1991). Emotional value judgment constitutes the process of evaluating such emotional value. Within Maslow' s needs hierarchy framework, individuals tend to seek higher-level emotional satisfaction after fulfilling basic utilitarian needs (Rojas et al., 2023). Therefore, deepening HCRs relies not solely on utilitarian value judgment but also requires emotional value judgment of chatbots.

Basic needs satisfaction provides the decision-making foundation for emotional value judgment; when users assign positive emotional value evaluations to chatbots, their emotional orientation toward the robot undergoes deeper strengthening and expansion. Based on emotional marketing theory, after basic needs are satisfied, users begin expecting chatbots to provide additional emotional support and exchange, making emotional value judgment an important factor in purchase decisions (Merenda, 2018). As users' emotional needs for chatbots increase, they start assessing chatbot value based on emotional communication performance (Svikhnushina & Pu, 2020). Leveraging emotion recognition technology, chatbots can more accurately identify and deeply parse users' emotional expressions, thereby more effectively responding to emotional needs and providing personalized emotional support services (Svikhnushina & Pu, 2020). During this process, user expectations influence emotional value judgment (Haugeland et al., 2022). If chatbots exceed expectations and deliver surprising experiences, users develop stronger identification and more positive emotional value judgments (Niessen, 2022).

During the emotional value judgment stage, the tight integration of affective computing and emotional intelligence enables chatbots to accurately identify and deeply respond to users' diverse emotional needs. Affective computing utilizes computational technology to recognize, interpret, and simulate human

emotions (Pei et al., 2024). Users' emotional needs for chatbots exhibit diverse characteristics (Zheng et al., 2024), including but not limited to seeking emotional comfort (Xie & Pentina, 2022), sharing joy (Li & Zhang, 2024), expressing dissatisfaction (Li & Zhang, 2024), and soliciting opinions (Egorov et al., 2023). Affective computing can deeply analyze users' emotional states (Mai et al., 2021) and quantify emotional states and behaviors (Hui et al., 2021). Emotional intelligence represents an advanced stage of affective computing, empowering chatbots with superior emotional understanding and response strategies through integration of machine learning, deep learning, and other cutting-edge technologies (Niculescu et al., 2020). While affective computing provides robots with basic emotional recognition and response capabilities (Pei et al., 2024), emotional intelligence endows them with profound insight into users' emotional needs and continuously adjusts and optimizes their emotional strategies and service models (Niculescu et al., 2020). This synergy yields significant advances in chatbots' ability to satisfy users' emotional needs.

During the emotional value judgment stage, users' mental perception of chatbot anthropomorphism transitions from cognitive to emotional dimensions. At this stage, chatbots primarily rely on natural language processing (NLP), speech recognition, and generation technologies to understand and respond to users' linguistic information (Babu & Boddu, 2024; Kasthuri & Balaji, 2023). This processing concentrates on semantic understanding and logical reasoning at the cognitive level—the "understanding human speech" level. As affective computing and emotion recognition technologies mature, chatbots demonstrate deeper understanding and recognition capabilities regarding users' emotional states, such as identifying joy, anger, sadness, and other emotions (Ehtesham-Ul-Haque et al., 2024; Lee et al., 2020). This process centers on precisely capturing and analyzing subtle variations in users'emotional expressions to achieve highly accurate feedback on emotional needs. This transformation enables chatbots' mental perception to extend beyond the cognitive level into the emotional dimension.

In summary, during the emotional value judgment stage, chatbots become important sources of emotional support by satisfying users' basic needs and exceeding expectations. The close coordination between affective computing and emotional intelligence enables robots to accurately identify and deeply fulfill users' diverse emotional needs, comprehensively enhancing user experience from cognitive to emotional levels. As technology advances, chatbots not only achieve "understanding human speech" in semantic comprehension but also develop the capacity to deeply understand and respond to users' emotional states, thereby promoting emotional bonding between humans and machines.

3.4 Emotional Construction Stage

Emotional construction refers to the process through which users gradually establish emotional connections and identification with chatbots via language, behavior, expression, and other modalities during interaction (Barrett, 2017). When individuals perceive chatbot performance as aligning with emotional value

judgments, they tend to attribute emotional value to the robot, developing emotional dependence or identification and thus entering the emotional construction stage (Naar, 2021).

Emotional value judgment provides the foundation for emotional construction, which in turn further develops and deepens these value judgments, forming complex emotional states. Cognitive theory of emotion indicates that during chatbot interaction, users make preliminary emotional value judgments (e.g., satisfaction, disappointment, trust, or doubt) based on the robot' s responses, tone, and content, laying the groundwork for subsequent emotional construction (Reisenzein, 2020). Emotional interaction theory emphasizes that although robots lack genuine emotions, they trigger user emotional responses through simulated human communication patterns, creating bidirectional interaction. This process deepens emotional value judgments through feedback and adjustment, promoting the establishment of more complex emotional connections (Soleiman et al., 2023). Emotion regulation and adaptation theory further provides evidence that individuals adjust strategies to adapt to environments under emotional stimulation. When interacting with chatbots, users achieve emotional regulation and adaptation by adjusting value judgments, communication styles, or seeking new information in response to robot replies. This process influences users' emotional construction of robots while promoting the deepening and evolution of value judgments (Ullah et al., 2021).

During the emotional construction stage, deep emotional exchange between humans and chatbots intensifies significantly, accompanied by gradual deepening of emotional resonance, understanding, and dependence. Media Equation Theory suggests that in human–chatbot interaction, chatbots simulate human linguistic, emotional, and other social cues, leading users to gradually perceive them as sentient and conscious beings, thus entering the emotional construction stage (Złotowski et al., 2018). The Computers are Social Actors (CASA) paradigm similarly provides strong support for this view, demonstrating that during emotional construction, chatbots consolidate their characteristics as social actors through highly personalized responses and deep emotional exchange (Gambino et al., 2020). Furthermore, existing research indicates that textual communication between users and chatbots (e.g., Replika) can enhance emotional bonding. Users' personality projection and their construction of new bodies in cyberspace (digital embodiments of emotional 寄托 and identity) become core elements of emotional construction, while chatbots' dual communication characteristics further promote emotional construction deepening by satisfying users' companionship needs (Brandtzaeg et al., 2022; Xie & Pentina, 2022).

The emotional construction stage comprises two sub-stages: emotional identification establishment and emotional dependence formation. Social Identity Theory (SIT) posits that during human–computer interaction, users perceive chatbots as social beings and judge their anthropomorphic characteristics based on performance indicators such as language style, response speed, and emotional understanding. When robots exhibit sufficient "humanness," users more

readily incorporate them into their social identity categories, thereby establishing emotional identification (Harwood, 2020; Zhang & Rau, 2023). Lu and Liu' s (2023) research similarly demonstrates that during emotional connection formation with chatbots, users develop preliminary identification with robots' anthropomorphic minds based on behavioral performance and language style factors. Following emotional identification establishment, users' satisfaction or habituation deepens into emotional dependence (Salah et al., 2024). The Uses and Gratifications Approach suggests that users' continued chatbot use stems from robots' anthropomorphic minds continuously satisfying emotional and informational needs. This sustained satisfaction fosters emotional dependence (Kopplin, 2022; Moussawi et al., 2023; Niu et al., 2024). Habit formation theory posits that through repeated interaction with chatbots, users gradually develop communication habits. This habit solidification increases users' emotional dependence on robots' anthropomorphic minds, ultimately establishing tight emotional connections (Gardner & Rebar, 2019; Qi et al., 2022).

In summary, when interacting with chatbots, users first form preliminary emotional judgments and continuously deepen these feelings through subsequent interactions. Chatbots strengthen deep emotional exchange with users by simulating human communication patterns, generating emotional resonance, understanding, and dependence. This process includes emotional identification establishment and emotional dependence formation. Users gradually incorporate robots into their social existence and develop emotional dependence due to sustained satisfaction and communication habits, ultimately establishing tight emotional connections.

3.5 Establishment of Emotional Attachment in Human-Chatbot Relationships

Emotional attachment in human-chatbot relationships refers to the emotional dependence and connection that humans gradually develop toward chatbots through prolonged, frequent communication, manifesting as trust, affection, and even tendencies to treat chatbots as emotional 寄托 (Gillath et al., 2021).

Emotional attachment is not limited to human-human relationships; humans can similarly establish emotional attachments with chatbots. Anthropomorphism serves as the foundation for building this attachment relationship, promoting emotional attachment formation between humans and chatbots. Liu et al. (2021) note that despite individuals' fear and uncertainty perceptions toward social robots, social robots' caregiving capabilities and companionship functions also generate excitement and dependence, indicating that anthropomorphic design enables social robots to establish emotional connections with humans and satisfy emotional needs. Meng and Dai (2021) found that emotional support provided by conversation partners (including AI chatbots) significantly reduces users' stress and anxiety, with this supportive effect mediated by perceived supportiveness, demonstrating that anthropomorphic chatbots can establish emotional attachment with users through emotional support. Chinese scholars

Zhang Ruijun and Han Lixin (2022), through in-depth interviews and textual analysis of the Xeva virtual lover application, discovered that users generally perceive social robots as emotional 寄托 carriers, forming attachment relationships resembling "Pygmalion complexes," further confirming that anthropomorphic design forms the basis for establishing human-chatbot emotional attachment. Consequently, anthropomorphic design not only effectively reduces users' fear and uncertainty but also fully satisfies human emotional needs through caregiving functions and companionship experiences, thereby promoting the construction and development of emotional attachment relationships between humans and chatbots.

Human-chatbot emotional construction provides the possibility for emotional attachment formation, with the latter representing the result and manifestation of the former, reflecting the depth and breadth of emotional connection in human-computer interaction. What mechanisms enable this process? Social Penetration Theory (SPT) offers an explanation. SPT proposes that during human-chatbot interaction, emotional construction essentially constitutes a social penetration process. As communication deepens, the relationship between users and chatbots gradually intensifies, progressing from initial unfamiliarity to familiarity and eventually generating emotional attachment (Patriciano et al., 2024; Park et al., 2023). Some studies have explored key factors in the emotional construction process (e.g., sense of control, identity recognition, psychological distance) and their influence mechanisms on emotional attachment (Shen Pengyi et al., 2023; Song Meijie & Liu Yun, 2023). For example, Chinese scholar Shen Pengyi et al. (2023) directly demonstrated that chatbot role positioning (e.g., friend-type) significantly impacts customer emotional attachment, with this influence realized through sense of control and identity recognition during emotional construction. Scholars Song Meijie and Liu Yun (2023), through interviews with Replika users and ethnographic observation of the Douban "human-machine romance" community, elucidated the critical roles chatbots play during emotional construction. Through immediate responsiveness, emotional resonance, and personalized settings, chatbots gradually guide users toward forming emotional attachment.

During the emotional attachment stage, users may develop higher-level mental perception of chatbots, primarily manifested in deepened emotional resonance, enhanced cognitive understanding, significant perception of personified characteristics, strengthened emotional dependence, and social role identification and construction. Emotional resonance refers to the state where computer systems, through understanding and recognizing emotions, generate appropriate emotional responses to establish mutual understanding and resonance with conversational partners (Chang & Hsing, 2021). In human-computer interaction contexts, chatbots that can accurately grasp and respond to user emotions facilitate easier emotional resonance. For example, in interactions with emotional companion AIs like Replika, users invest emotions, form emotional attachments, and deepen emotional resonance through cyclical interactions (Zhang Xiaohui & Sun Jingling, 2023). As technology advances, chatbots generate responses more

closely approximating human language and comprehension through complex algorithms and natural language processing technologies, thereby enhancing users' cognitive understanding. Some studies indicate that chatbots can conduct simple conversations with users through preset algorithms and models, leading users to believe the robots understand their meaning to some extent (Mulik et al., 2021; Pal et al., 2022). Personification refers to attributing human-like traits and personalities to non-human entities (Serman, 2021). In human-computer interaction, chatbots that simulate human language, gestures, and expressions are more easily perceived as personified entities. Some studies find that social robots using human-like gestures and expressions are more readily anthropomorphized and endowed with emotions and consciousness (dos Santos Viriato et al., 2023; Go & Sundar, 2019; Kang, E & Kang, Y. A, 2024). Emotional dependence refers to the strong emotional 寄托 and reliance individuals develop toward specific objects (Laestadius et al., 2024). In human-computer interaction, when chatbots satisfy users' emotional needs, users may develop stronger emotional dependence (Estévez et al., 2018). Some studies show that many people choose to communicate with chatbots when lonely or anxious, hoping to obtain comfort and support (Bae Brandtzæg et al., 2021; Lee & Hahn, 2024; Maples et al., 2024). This emotional dependence phenomenon enhances users' trust and reliance on chatbots to some extent. Social role identity refers to individuals' acceptance and internalization of specific social roles (e.g., friend, partner, assistant) (Kaplan & Garner, 2017). During human-computer interaction, users may perceive chatbots as entities with specific social roles. Existing research finds that friend-type chatbots, compared to assistant-type chatbots, can stimulate deeper customer emotional attachment (Shen Pengyi et al., 2023), reflecting users' tendency to perceive chatbots as partners with specific social roles. These phenomena not only reflect technological advancement and deepened human-computer interaction but also reveal human expectations and emotional 寄托 toward machine intelligence.

In summary, after emotional construction with chatbots, humans ultimately establish emotional attachment, and their mental perception of chatbot anthropomorphism enters a higher stage. During this stage, emotional resonance and dependence between humans and chatbots deepen, cognitive understanding of chatbots gradually enhances, chatbots become more easily perceived as personified entities, and users may perceive chatbots as entities with specific social roles. Based on these findings, this article, grounded in anthropomorphism and informed by established HHRs theory, proposes a theoretical model of emotional attachment formation in human-chatbot relationships (Figure 1 [Figure 1: see original paper]) and optimizes the original HCRs engagement promotion theoretical model (Figure 2 [Figure 2: see original paper]).

Figure 1 Theoretical Model of Emotional Attachment Formation in Human-Chatbot Relationships
Figure 2 New HCRs Engagement Promotion Theoretical Model

4.1 Understanding HCRs Through Zoomorphism Holds Great Potential

Some evidence suggests that alternative perspectives may exist for understanding HCRs. Zoomorphism refers to the concept of attributing human traits, behaviors, or emotions to non-human entities, particularly through analogies with animals (Karanika & Hogg, 2020). Research has demonstrated that applying positive animal traits (especially companion animal characteristics) to social robots can enhance human closeness and identification with robots, thereby building more harmonious human–robot relationships (Konok et al., 2018). Mimetic pet attachment also provides supporting evidence. Mimetic pet attachment refers to the intimate emotional connection individuals establish with virtual pets or pet content on social media (Xiao Yuehua, 2021). Numerous studies have proven that mimetic pet attachment enables people to develop deep emotional connections with non-physical pets in virtual environments and strengthen these connections through online social support (Xiao Yuehua, 2021; Yuan Zhengjie, 2023). The Uncanny Valley effect describes how human affinity toward robots initially increases as robots become more human-like, but sharply declines once robots approach human appearance too closely, even triggering inexplicable aversion and fear (Kim et al., 2023). According to Cognitive Restructuring Theory, through zoomorphism, people can perceive chatbots as animal-like beings rather than excessively pursuing human similarity (Traeger, 2020). This cognitive restructuring helps people view chatbots' capabilities and performance more rationally, reducing unrealistic expectations and comparisons. Therefore, applying zoomorphism to HCRs may help avoid or mitigate the Uncanny Valley effect.

Animal-shaped robots (e.g., FWMAVs) already exist (Abdullah et al., 2021), yet few studies have applied animal characteristics to chatbots. To attribute animal features to chatbots, multiple aspects must be considered, including animal characteristic selection (Ajayi & Tichaawa, 2023), dialogue logic construction, and interaction experience optimization (Abzaliev et al., 2024). Future research could focus on these key issues, combining the latest technological advances to design animal-featured chatbots.

4.2 The Evolution from Emotional Attachment to Digital Therapeutic Alliance Remains Unexplored

Although the new HCRs engagement promotion theoretical model deeply explores the process of establishing emotional attachment between humans and chatbots, it does not thoroughly reveal how this emotional attachment evolves into a digital therapeutic alliance. Some studies have proven that using online methods as therapeutic adjuncts can improve user engagement and compliance (Bauer et al., 2018; Forchuk et al., 2016). If emotional attachment between humans and chatbots could evolve into a Digital Therapeutic Alliance (DTA), it might effectively enhance treatment efficacy (Tong et al., 2022). Therefore,

in-depth exploration of this process holds significant value. Current research on DTA remains in preliminary exploratory stages (Tong et al., 2022), suggesting that theoretical frameworks of Therapeutic Alliance (TA) might be borrowed to examine how emotional attachment transforms into DTA. Professor David Wallin (2007), in his research on attachment relationships, identified three key factors in psychotherapy: relational transformation, non-verbal experience, and therapist psychology/mindset. These factors jointly facilitate the transition from attachment relationships to therapeutic alliances and may represent critical nodes for exploring the transformation from human-chatbot emotional attachment to DTA, warranting future in-depth investigation.

4.3 Factors Influencing Human-Chatbot Emotional Attachment Require Investigation

Exploring factors influencing human-chatbot emotional attachment holds important significance and value for enhancing user experience (Xu Ying, 2022; Zhang Ruijun & Han Lixin, 2022). These factors are multifaceted, encompassing psychological, social, and technological dimensions. At the psychological level, factors such as self-esteem (You Zhiqi & Zhang Yingru, 2017), psychological cues (Zhang Ruijun & Han Lixin, 2022), sense of control, and identity recognition (Shen Pengyi et al., 2022) may all influence emotional attachment. At the social level, social culture (Lim et al., 2021; Pishghadam et al., 2023) and lack of real intimate relationships (Brandtzaeg et al., 2022; Schäfer & Eerola, 2020) may also affect emotional attachment. At the technological level, emotional attachment must also consider chatbot performance, interaction modalities, and personalized services (Song Meijie & Liu Yun, 2023; Wei et al., 2024; Zhou et al., 2018). Therefore, future research could investigate factors influencing human-chatbot emotional attachment based on these directions to continuously improve the HCRs engagement promotion theoretical model.

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