From 'Anthropomorphic Attribution' to 'Alliance Building' : The Effect of Human-Chatbot Relationship on Engagement (Postprint)

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Date: 2023-10-09T00:00:00+00:00

Abstract

With the rapid advancement of Artificial Intelligence (AI) technology, AI chatbots can simulate human guidance to improve user engagement and therapeutic efficacy in Internet-based Self-help Interventions (ISIs). However, academic investigation into the mechanisms underlying chatbot effects remains in its early stages. Therefore, to deepen rational understanding of this issue, this article proposes a theoretical model adapted to the ISIs context from the perspective of human-computer relationships: chatbots may progressively develop Human-Chatbot Relationships (HCRs) with users through four stages—anthropomorphic attribution, utilitarian value judgment, attachment development, and establishment of a Digital Therapeutic Alliance (DTA)—and thereby enhance user engagement through HCRs. Future research could continue to enrich HCRs-related theories and examine their underlying mechanisms, design chatbots based on HCRs theory, thoroughly investigate additional variables influencing HCRs, unify operational definitions of engagement, and develop appropriate measurement instruments for engagement.

Full Text

Preamble

From "Anthropomorphic Attribution" to "Alliance Establishment" : The Effect of Human-Chatbot Relationships on Engagement

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Abstract: With the rapid development of artificial intelligence (AI) technology, AI chatbots can simulate human guidance to improve user engagement and efficacy in internet-based self-help interventions (ISIs). However, research on the mechanisms underlying chatbot effectiveness remains in its early stages. To deepen our theoretical understanding of this issue, this article proposes a theoretical model adapted to the ISIs context from a human-computer relationship perspective: chatbots can progressively develop human-chatbot relationships (HCRs) with users through four stages—anthropomorphic attribution, utilitarian value judgment, attachment relationship development, and establishment of a digital therapeutic alliance (DTA)—thereby enhancing user engagement. Future research should continue to enrich HCRs-related theories and examine their underlying mechanisms, design chatbots based on HCRs theory, investigate additional variables affecting HCRs, unify operational definitions of engagement, and develop appropriate engagement measurement methods.

Keywords: chatbot, engagement, human-chatbot relationships

2. The Development Process of HCRs and Its Impact on User Engagement

From a human-computer interaction (HCI) perspective, low user engagement stems from poor interactive experiences, and thus the static interaction of traditional ISIs programs fails to boost user participation (Doherty et al., 2012). Conversely, chatbots with natural language conversation capabilities enable users to actively participate rather than passively receive information. Their forms range from simple chat avatars to virtual agents, representing more active and dynamic social actors (Appel et al., 2012; Doherty et al., 2012; Go & Sundar, 2019; Ly et al., 2017). Moreover, conversational behaviors based on verbal or non-verbal cues are necessary conditions for relationship formation (Bickmore & Picard, 2005). Therefore, chatbots have the potential to establish and develop HCRs with users and enhance engagement through relational bonds.

Given that HCRs development shares similarities with human-human relationships (HHRs), several HHRs theories can be applied to explain HCRs (Hendriks et al., 2020; Schuetzler et al., 2020). For example, Skjuve et al. (2021a) developed a three-stage model to explain HCRs development based on the widely validated interpersonal theory—Social Penetration Theory (SPT): In the first stage (exploration), users remain cautious toward chatbots due to privacy or security concerns, exhibiting limited self-disclosure and superficial information exchange. In the second stage (affection), users evaluate the utilitarian value of chatbots, develop attachment relationships with them, and consequently increase interaction frequency and disclosure depth. In the third stage (stability),

users maintain their attachment relationship with chatbots, which becomes part of daily life, though self-disclosure decreases as users become more inclined to share everyday events. Subsequently, Skjuve et al. (2022b) conducted a 12-week longitudinal study validating this model and revealing the progressive nature of HCRs development. However, despite its novelty, this model presents several issues when applied to ISIs contexts: First, it neglects the initial cognitive processing in human-computer interaction and directly addresses relationship development. Second, it fails to explain the psychological mechanisms underlying each HCRs stage. Third, it focuses more on understanding intimate relationship development rather than adapting to the specificities of digital counseling/psychotherapy. Therefore, this article will further refine and concretize the HCRs model by integrating theories from HCI and psychology to make it suitable for digital counseling/psychotherapy contexts.

2.1 Stage 1: Anthropomorphic Attribution

Anthropomorphism refers to the cognitive process through which humans ascribe human-like characteristics (e.g., appearance, speech), motivations, intentions, or emotions to non-human entities (e.g., inanimate objects, animals) (Epley et al., 2007), exhibiting heuristic characteristics (Tversky & Kahnemann, 1974). Generally, when users first encounter a chatbot, anthropomorphism is activated as they unconsciously treat it as another person (hereinafter referred to as "anthropomorphic attribution"), leading them to interact with it using interpersonal strategies (Nass et al., 1994). As interaction frequency increases, users may gradually attribute deeper characteristics such as motivations, intentions, and emotions to chatbots (Xu et al., 2017), and enhanced anthropomorphism will further promote HCRs development (Pentina et al., 2023). Therefore, anthropomorphic attribution may be a critical starting point for developing HCRs, and understanding its underlying mechanisms will help facilitate HCRs development.

First, users engage in anthropomorphic attribution driven by intrinsic motivation. Based on Reeves and Nass' s (1996) Media Equation Theory (TME), "media is no different from real life," and "people have social, instinctive reactions to media even when they recognize this is irrational, or even believe they could not possibly react this way."An important research paradigm of TME—the Computers Are Social Actors (CASA) paradigm—also suggests that users intuitively focus on human cues presented by computers (such as text output, voice, language style, and interactive features) while ignoring tool-like cues, naturally perceiving them as social actors and generating socialized reactions (e.g., trust, liking) according to social rules (e.g., bias, politeness, reciprocity) (Nass et al., 1994). However, why do users have these unconscious reactions? Based on Epley et al.' s (2007) three-factor theory, anthropomorphism consists of three synergistic factors: Elicited Agent Knowledge, Effectance Motivation, and Sociality Motivation. Therefore, in initial human-computer interaction, users focus more on primary cues (appearance, speech) of non-human entities for anthropomor-

phic inference and attribution, providing a cognitive foundation for satisfying effectance and sociality motivations.

Second, the specific context of ISIs prompts positive perceptions. Based on Reduced Social Cues (RSC) theory, social cues received by users in computer-mediated communication decrease due to network bandwidth limitations, and these limited social cues are amplified through compensatory effects, making users' psychological states more susceptible to influence (Tanis & Postmes, 2003) and experiencing perceptual fluency—a subjective feeling of pleasure and relaxation (Labroo et al., 2008). A more recent and widely tested integrated theory—Hyperpersonal Interaction (HI) theory—also suggests that due to reduced social cues in human-computer interaction, users tend to idealize chatbots excessively while overlooking their technical flaws, and employ more impression management strategies to enhance "liking" (Walther, 1996).

Finally, users' social presence will be enhanced, affecting their engagement. Social presence refers to the feeling of being with another person, comprising three dimensions: copresence, psychological involvement, and behavioral engagement (Biocca et al., 2003). Influenced by intrinsic motivation and limited social cues, users' "social presence heuristic" is well-activated (Sundar et al., 2008), which is a core element of chatbots' impact on user engagement in the early stages of HCRs development. Research indicates that when participants' social presence is activated by chatbots, their behavioral intention significantly strengthens (Mozafari et al., 2021). Blut et al.' s (2021) meta-analysis also found that social presence mediates the effect of anthropomorphism on behavioral intention. Based on the Theory of Planned Behavior (TPB), behavioral intention is a key factor influencing users' intrinsic motivation and predicting actual engagement behavior (Ajzen, 2012). Moreover, if participants feel that interacting with a chatbot is as vivid as interacting with a real person, trust is more easily established and engagement consequently improves (Brendel et al., 2022; Hassanein & Head, 2005; Lee et al., 2021).

In summary, good anthropomorphic attribution (primary cues like appearance and speech) is a prerequisite for HCRs development. Users engage in parasocial interaction with chatbots as they would with humans, providing a cognitive foundation for satisfying effectance and sociality motivations. As HCRs develop, anthropomorphism gradually becomes primarily motivation-driven with attribution as a secondary process, aiming to better satisfy individual needs. Under the drive of effectance and sociality motivations, users will reinforce limited social cues, thereby enhancing social presence and influencing their engagement, while anthropomorphic attribution becomes more profound (advanced cues like motivations, intentions, emotions), further promoting HCRs development.

2.2 Stage 2: Utilitarian Value Judgment

Utilitarian value refers to the degree to which a product satisfies users' utilitarian needs, such as information acquisition, efficiency improvement, and problem-

solving (Choi & Drumwright, 2021). In the early stages of HCRs development, users also tend to evaluate the utilitarian value of chatbots to determine whether their actual needs can be met. Specifically, whether chatbots can demonstrate their practical utility according to users' current expectations—such as accurate and personalized mental health information, smooth and natural conversational ability, precise and intelligent contextual understanding, and rich and high-quality skill services—will affect users' acceptance of chatbots. Therefore, exploring the mechanisms of utilitarian value judgment will help concretize chatbot functional design and facilitate HCRs development.

First, users tend to position chatbots as "tools" and focus on their practicality. On one hand, although anthropomorphic attribution helps create a good initial impression, users' trust has not yet been established, so they will not engage in deep self-disclosure when interacting with chatbots, resulting in superficial HCRs at this stage (Skjuve et al., 2021a). Additionally, research indicates that humans actually hold stereotypes about chatbots, believing that while they can challenge human capabilities in "intelligence," they essentially lack emotional capacity. This is because humans tend to identify chatbot responses as programmed computational results rather than "spontaneous" reactions, which hinders deeper emotional interaction (Wirtz et al., 2018). On the other hand, based on the Uses and Gratifications Framework, users are active, rational, and goal-oriented, seeking and selecting media products that satisfy their specific needs (e.g., interaction, functionality, entertainment, information acquisition, social status) (Rubin, 1983). This explains why users focus more on the practical utility of chatbots in the early stages of HCRs development.

Second, utilitarian value judgment affects users' subjective attitudes. Based on the widely validated Technology Acceptance Model (TAM), users' utilitarian needs for technology can be summarized as perceived usefulness and perceived ease of use, which determine users' attitudes toward technology' s utilitarian value and influence their behavioral intention (Legris et al., 2003). For example, in Kamita et al.'s (2019) ISIs study, chatbots scored significantly higher than traditional web programs in both usefulness and ease of use, and chatbot group participants (N = 15) also showed higher participation enthusiasm and significantly higher behavioral intention scores than web program group participants (N = 12). Similarly, Park and Kim (2023) found that perceived usefulness positively predicted participants' willingness to engage in social interaction with mental health chatbots. The modified TAM—Expectation-Confirmation Model (ECM)—further proposes a possible mechanism for users to evaluate utilitarian value: users may compare their pre-use expectations with post-use perceived usefulness to determine whether their expectations are confirmed, which determines their satisfaction (Bhattacherjee, 2001). For instance, Dhiman and Jamwal (2023) investigated participants'reasons for continued chatbot use based on ECM, finding that perceived usefulness and post-use expectation confirmation significantly affected satisfaction with chatbots. In Xie et al.' s (2022) study, utilitarian value (rather than technical, hedonic, or social aspects) was the strongest predictor of user satisfaction.

Finally, users' subsequent engagement behavior is also influenced by the above two factors. First, behavioral intention, as the strength of an individual' s willingness to take a certain action, directly affects users' engagement motivation and actual engagement behavior (Ajzen, 2012). If users have sufficiently high behavioral intention levels, they tend to interact with chatbots and participate in ISIs programs. Conversely, if users' engagement motivation is unstable, their subsequent engagement behavior cannot be guaranteed (Alfonsson et al., 2017). Second, user satisfaction, as a more comprehensive evaluation indicator, can directly affect users' engagement motivation and loyalty, representing an important factor for users' continued interaction with chatbots (Cheng & Jiang, 2020). For example, Zhu et al. (2022) found that the utilitarian value (personalized information presentation) of ISIs chatbots significantly improved user satisfaction, which was significantly positively correlated with their intention to continue using chatbots. However, in Liu et al.' s (2022) 16-week ISIs study, chatbot group participants' engagement decreased over time. Researchers attributed this not only to technical flaws but also to chatbots' inability to present useful and satisfying content.

In summary, this stage represents users' exploration phase, during which they may hold stereotypes about chatbots as tools lacking emotional capacity. Based on the Uses and Gratifications Framework, chatbots must first demonstrate their value as effective tools by proving their importance in terms of usefulness, ease of use, and expectation confirmation to promote user engagement. At this point, Epley et al.' s (2007) three-factor theory can further infer that as interaction frequency increases, users' recognition, familiarity, and sense of certainty about chatbots will improve. Since this process satisfies users' need to understand, predict, and control unfamiliar things (effectance motivation), anthropomorphism will be enhanced and indirectly improve user favorability, further developing HCRs.

2.3 Stage 3: Developing Attachment Relationships

Attachment refers to the long-lasting and stable emotional bond that individuals develop with significant others during infancy, which influences individual attribution and gradually internalizes into unique attachment styles that serve as templates for future relationships with friends, relatives, lovers, or personal possessions (Bartholomew & Horowitz, 1991; Bowlby, 1988). The key factor influencing individual attribution is the level of security experienced—each interpersonal interaction involves applying past attachment styles and evaluating the security obtained, subsequently making relationship-developing behaviors (approach or avoidance) (Adams et al., 2018). Recently, attachment theory has been widely applied in communication studies to explain individuals' development of emotional attachment to non-human entities (e.g., pets, brands, virtual characters) and motivations for maintaining relationships (Bauer & Woodward, 2007; Pedeliento et al., 2016; Wanser et al., 2019; Xie & Pentina, 2022). As HCRs further develop, chatbots as active social actors are also likely to develop

attachment relationships with users.

First, human cognitive and emotional processing mechanisms facilitate the emergence of human-computer attachment. For example, research has found that when users continuously interact with chatbots exhibiting human-like characteristics, particularly relational cues (such as humor and empathy), their cognitive reasoning about chatbots can drive their emotional perception, which in turn affects their cognitive judgment (Lee, S. et al., 2020; Sánchez-Franco et al., 2021; Spatola & Wudarczyk, 2021). In Beck' s (1995) cognitive model, cognition and emotion also influence each other. Additionally, based on Mind Perception Theory, users actually integrate cognitive and emotional dimensions to process anthropomorphic information about chatbots, forming attributional inferences of perceived mind (Waytz et al., 2010), which subsequently affects their willingness to interact with chatbots (Blut et al., 2021). The well-known Dual-Process Theory also posits that individual cognitive processes can be divided into rational cognitive components (e.g., utilitarian value perception) and non-rational emotional components (e.g., emotional value perception) (Stanovich & West, 2000). Therefore, cognition and emotion complement each other in human-computer interaction, jointly shaping user experience and facilitating attachment relationships between chatbots and users (Abdulrahman & Richards, 2021; Bickmore et al., 2005; Choi & Drumwright, 2021; Pentina et al., 2023; ter Stal et al., 2020).

Second, chatbots can possess key conditions for developing attachment relationships. On one hand, besides being more reliable and controllable, chatbots can function as "secure bases" and "safe havens" by satisfying individuals' spiritual needs or alleviating their distress to generate a certain degree of attachment (Rabb et al., 2022). For example, in Zhou et al.' s (2020) description, the chatbot "Microsoft Xiaoice" successfully established attachment relationships with users through its unique emotional intelligence system, which enabled it to satisfy users' spiritual needs in communication, emotion, and social belonging, thereby promoting long-term and sustained user activity. Xie and Pentina' s (2022) research also showed that when participants experienced distress and lacked companionship, if they perceived understanding from the chatbot Replika and received appropriate emotional support and encouragement, they could develop attachment to Replika. On the other hand, chatbots have the natural advantage of natural language dialogue. Therefore, their "disclosure" can also promote human-computer interaction frequency and users' self-disclosure, enabling users to experience feelings of acceptance, intimacy, and loneliness alleviation as continuous intrinsic rewards, thereby developing attachment (Skjuve et al., 2021a, 2022b). In Social Penetration Theory, increased information transfer and gradual self-disclosure are manifestations of trust, which is also considered a key prerequisite for relationship development (Altman & Taylor, 1973). For example, in Kang and Gratch' s (2014) study, when participants interacted with chatbots engaging in deep self-disclosure, they also responded with more self-disclosure and reported greater trust and intimacy toward the chatbots. Subsequently, Lee, Y. C. et al.' s (2020) study also found that chatbots with deep self-disclosure promoted more user self-disclosure than those with shallow

or no self-disclosure and successfully established attachment relationships with some participants.

Finally, the development of attachment relationships will promote users' long-term engagement in ISIs. As discussed above, while anthropomorphic attribution and utilitarian value judgment provide a good cognitive foundation for HCRs development and promote social presence and human-computer interaction frequency, they represent short-term perspectives. On one hand, if only cognitive aspects are emphasized, users' anthropomorphism of chatbots will remain at a shallow level of attribution (e.g., external appearance and linguistic human-likeness). On the other hand, the more efficient and practical chatbots are, the more they will be positioned as efficient "tools" rather than "partners" with emotional capacity and trustworthiness, leading to gradually weakened connections and decreased engagement. In Mind Perception Theory, if individuals believe human-like objects lack emotional capacity, they will deny their "humanity" and refuse to communicate with them as equals (Waytz et al., 2010). Conversely, seeking social contact, connection, and recognition are not only individuals' most basic demands in relationships but also important factors promoting their longer-term and more stable participation in ISIs (Epley et al., 2007). Therefore, to stably enhance HCRs, users need to more actively participate in human-computer interaction, and chatbots also need to "act" to provide "emotional value" for users. Only then, driven by social motivation, might users further anthropomorphize chatbots by gradually attributing deeper characteristics (such as motivations, intentions, and emotions) to them (Xu et al., 2017) and establish attachment relationships with them to have their emotional needs more continuously and fully satisfied (Xie & Pentina, 2022; Zhao et al., 2012). HCRs development will also gradually deepen as anthropomorphism strengthens (Epley et al., 2007; Pentina et al., 2023), further improving user engagement quality.

In summary, anthropomorphic attribution and utilitarian value judgment are short-term factors affecting user engagement in ISIs. To keep users active over longer cycles, emotional factors will play a more important role. Therefore, driven by social motivation, users will further anthropomorphize chatbots and establish attachment bonds with them. As they experience more positive emotions, HCRs will deepen—transitioning from "tools" to "partners." If users' attachment to chatbots transfers to attachment to ISIs tasks, they will be more inclined to participate actively and continuously (McGonagle et al., 2021). In this way, the goal of using chatbots for psychological counseling/psychotherapy begins to be realized.

2.4 Stage 4: Establishing Digital Therapeutic Alliance

Therapeutic Alliance (TA) refers to the cooperative relationship between client and counselor in therapy (Zhu & Jiang, 2011) and is a robust predictor of treatment outcomes (Flückiger et al., 2018). A series of studies have found that TA is not limited to human-human relationships; humans can also unconsciously es-

tablish alliance relationships with virtual programs. This alliance relationship established in ISIs contexts is called Digital Therapeutic Alliance (DTA), that is, the "cooperative" relationship between humans and programs (Berger, 2017; D' Alfonso et al., 2020; Darcy et al., 2021; Heim et al., 2018). Research has found that DTA not only has conceptual invariance with TA but can also predict improved efficacy (Luo et al., 2022). Additionally, the emotional bond dimension in TA is similar to and highly correlated with secure attachment (Mallinckrodt & Jeong, 2015), while insecure attachment, particularly avoidant attachment, is a key cause of TA rupture (McGonagle et al., 2021). In ISIs contexts, Hertlein and Twist (2018) also found that avoidant users may show low activity and engagement (rejection), while anxious users may overuse programs (dependence). Therefore, understanding the further development of HCRs through the DTA perspective will be more adaptive to ISIs contexts.

First, establishing and developing DTA will better facilitate the achievement of ISIs goals. First, in actual psychological counseling, dual relationships should be avoided between counselors and clients, and this should be no exception in ISIs. Second, the significance of establishing DTA does not lie in improving users' acceptance of and satisfaction with chatbots but in better motivating users to make positive changes. Third, establishing DTA can make the ISIs process more transparent; specifically, chatbots need to reach agreements with users on how to achieve certain goals and how to implement them, and be open and honest about the technologies used and privacy protocols (Law et al., 2022). Thus, DTA is a deliberate and purposeful human-computer relationship model. Given that the goal of ISIs is to improve users' psychological problems, this stage should regulate the development direction of HCRs, enabling chatbots to establish DTA and develop cooperative relationships with users rather than other attachment relationships (e.g., friends, partners).

Second, establishing DTA will be easier based on the first three stages. Based on previous TA definitions, whether the classic three-dimensional structure (task agreement, goal agreement, emotional bond) (Bordin, 1979) or the four-dimensional structure (openness, trust, cooperative relationship, emotional bond) (Agnew-Davies et al., 1998), both contain two major components: cognitive and emotional. The cognitive component refers to recognition of therapeutic goals and tasks, while the emotional component refers to positive emotional connections or personal attachment, such as mutual trust, liking, respect, care, and frankness (Zhu & Jiang, 2011). In ISIs, cognition and emotion are also considered key pathways to promoting DTA (D' Alfonso et al., 2020; Tong et al., 2022). On one hand, after anthropomorphic attribution, users unconsciously treat chatbots as social actors and form cognitive evaluations of whether chatbots meet their needs through rational cognitive processes (utilitarian value judgment), thereby facilitating "consensus" formation. On the other hand, as HCRs develop, users develop emotional attachment to chatbots, which influences emotional bond establishment. Based on this, the stage-by-stage development of HCRs will lay a good foundation for DTA establishment.

Finally, promoting DTA development will further enhance user engagement. In promoting DTA, when individuals interact with a caring object when they need care and support, their sense of security will be strengthened, and they will experience feelings of being loved and cared for. If this influence can be repeated long-term and stably, individuals' insecure attachment may gradually transform into secure attachment (Bowlby, 1988; Mikulincer & Shaver, 2020; Nanjappa et al., 2014). Therefore, interactions that enhance security can be used to activate individuals' perception of secure attachment, thereby strengthening emotional bonds and promoting DTA development. Regarding specific interaction design, reference can be made to strategies used by counselors to develop TA with clients, designing specialized relational cues for chatbots (Mo et al., 2023). For example, in traditional psychological counseling, if counselors are understanding, genuine, consistent, and provide unconditional positive regard to clients, the counselor-client relationship can develop rapidly and healthily (Rogers, 1957). Similarly, Skjuve et al. (2021a) believe that for chatbots to establish and develop DTA with users, the most critical aspect is providing emotional support through relational cues such as acceptance, understanding, and non-judgment. Bell et al. (2019) also emphasize that lack of understanding and empathy will prevent chatbots from establishing the relationship intensity required for effective psychotherapy. In summary, chatbots can first simulate counselor identity to establish a professional and reliable initial impression, then rely on good functional experience to gain user recognition and improve reuse rates, and further present relational cues that strengthen emotional bonds (such as friendliness, respect, non-judgment, listening, encouragement, genuineness, empathy, trust, self-disclosure, etc.) during interaction with users (Mo et al., 2023). In this way, during the gradual development of HCRs, attachment relationships can be regulated into alliance cooperative relationships more conducive to ISIs goals. When DTA is established, users' self-protection decreases, self-disclosure becomes deeper, and they become more willing to cooperate, resulting in positive improvements in engagement and treatment effectiveness (Heim et al., 2018; Liu et al., 2022; Provoost, 2021a). For example, Goldberg et al. (2021) found that fully automated mindfulness intervention programs could establish DTA with participants, which not only significantly predicted engagement but also showed that users' engagement in weeks 3 and 4 was further boosted. In Rodrigues et al.' s (2021) randomized controlled experiment, participants similarly established DTA with chatbots, which positively predicted their engagement.

In summary, HCRs development has an important impact on user engagement in ISIs. To achieve high user engagement, users must actually remain and be active throughout the longer ISIs lifecycle, which undoubtedly places higher demands on ISIs programs and represents a major challenge currently facing the field. Based on this, this article integrates mature theories from HCI and psychology to further improve the HCRs development framework and proposes a theoretical model adapted to ISIs contexts (Figure 1 [Figure 1: see original paper]).

3. Current Issues and Future Directions

3.1 Lack of HCRs Theory and Unclear Underlying Mechanisms

In early research, although Bickmore and Picard (2005) provided important insights into how relational cues (such as humor and empathy) presented by chatbots influence HCRs development, they did not construct theories to explain changes in HCRs. Until now, no consensus has been reached on theories regarding HCRs development in academia, and researchers still know little about how HCRs are initiated, developed, strengthened, and how this relationship affects humans, indicating considerable room for new theory development in this field (Muresan & Pohl, 2019; Skjuve et al., 2021a, 2022b). Since HCRs development may share similarities with HHRs development, existing theories explaining HHRs development can serve as a starting point for understanding HCRs. Therefore, future research could draw on mature HHRs theories such as Social Exchange Theories (Emerson, 1976), the Investment Model of Personal Relationships (Rusbult et al., 1994), and Commitment-Trust Theory (Morgan & Hunt, 1994) to gain deeper understanding of HCRs development processes. Additionally, the underlying mechanisms of how human cues affect human psychology at each relationship stage are complex, and the importance of cues may differ across stages. For example, in early HCRs development, visual and verbal cues of chatbots significantly impact user satisfaction (Kim et al., 2021), while in later stages, non-verbal and relational cues may become more important. Therefore, future research could design human cues based on theory and use more rigorous randomized controlled trials to test the contributions of different cues.

Furthermore, most current ISIs studies use highly task-oriented chatbots with inadequate consideration of human cues design. Researchers often only compare the presence or absence of chatbots' effects on dependent variables while ignoring the importance of human cues (Chong et al., 2021), leading to poor comparability of results and affecting research replicability. Therefore, future studies should report the human cues employed in chatbots and discuss the relationship between cues and dependent variables. Moreover, digital mental health has multiple application scenarios, such as intelligent triage, emotional companionship, psychological counseling, and psychotherapy. Researchers must recognize that different scenarios require different degrees of HCRs. For example, in intelligent triage scenarios, user lifecycle is short and efficiency demands are relatively higher, making anthropomorphic attribution and utilitarian value judgment play more important roles in HCRs. Future research should evaluate current application scenarios and design human cues specifically. Finally, users with different cultural backgrounds, genders, age groups, personality traits, education levels, income levels, and symptoms may have different perceptions of different identities and corresponding human cues presented by chatbots (Nißen et al., 2022). Therefore, future research needs to further test identity and human cue combinations that can achieve optimal user experience according to user needs and characteristics in different scenarios.

3.2 Designing Chatbots Based on HCRs Theory

Currently, most ISIs chatbots are designed based on cognitive-behavioral therapy (CBT) frameworks, with designers focusing primarily on intervention content while paying less attention to human-computer relationship development (Fulmer et al., 2018). However, the HCRs perspective suggests that chatbot design should consider the entire relationship development process. For example, in the anthropomorphic attribution stage, chatbots should present appropriate human cues (such as friendly avatars and natural language) to activate users' social presence heuristics. In the utilitarian value judgment stage, chatbots should demonstrate clear usefulness and ease of use to meet users' expectations. In the attachment relationship stage, chatbots should provide emotional support and relational cues (such as empathy and encouragement) to satisfy users' social and emotional needs. In the DTA establishment stage, chatbots should balance professional identity presentation with ethical considerations, maintaining transparency about technical limitations and privacy protocols.

Future research should develop design guidelines based on the HCRs theoretical model, specifying which human cues are most effective at each stage and how they should be implemented. Additionally, longitudinal studies are needed to verify whether chatbots designed according to HCRs principles can indeed promote more stable and profound relationships and improve long-term engagement compared to traditional designs.

3.3 Lack of Standardization in Engagement Measurement and Reporting

Although preliminary evidence supports the feasibility and effectiveness of chatbots for psychological intervention, these studies still lack consensus on engagement evaluation standards. First, researchers often conflate the concepts of "adherence" and "engagement" (Beintner et al., 2019; Eysenbach et al., 2011). However, "adherence"is more commonly applied in clinical contexts, emphasizing a doctor-patient relationship. In contrast, most users in ISIs are not patients, so this article chooses the term "engagement"as a general descriptor of users' degree of ISIs use, which not only implies an equal counselor-client relationship but also requires users to actively participate in interventions. Second, researchers' reporting methods for engagement still show considerable differences, with most studies not reporting the relationship between engagement and treatment effects (Beintner et al., 2019; Vaidyam et al., 2019). In ISIs research, neglecting to evaluate engagement' s impact on treatment effects may lead to underestimation of intervention effects and affect comparability between studies. Third, most researchers currently use single and theoretically unsupported engagement evaluation indicators in ISIs studies, such as only using "number of completed exercises," while actual indicators available for evaluating engagement are quite rich (Lederman & D' Alfonso, 2019). Therefore, future research should unify and enrich engagement evaluation indicators based on theory (Beintner et al., 2019). Finally, the vast majority of ISIs studies still over-rely on self-report

methods, which may lead to overestimation of engagement (Flett et al., 2019). Therefore, future research should comprehensively analyze objective data such as program backend data, wearable device-collected biological data, and demographic variables together with participants' self-reported subjective data to more comprehensively understand engagement.

3.4 Additional Variables Affecting HCRs Require Investigation

Beyond chatbots' human cues, many factors in actual ISIs can interfere with research results. First, product performance. Chatbots have poor stability in open domains, and besides occasional technical errors (Jang et al., 2021), repetitive and unnatural conversational experiences have long been criticized by users (Fulmer et al., 2018), hindering HCRs development. Additionally, research has found that compared to individual functions, ISIs programs as a whole play a more important role (Berger et al., 2014), so it remains unclear whether chatbots themselves or the overall ISIs bring key improvements. Second, privacy. When developing any ISIs program, large amounts of privacy data may be at risk of violation (McGreevey et al., 2020). Research indicates that if participants believe their data stored in ISIs programs is not secure, their engagement will likely decrease or they may even drop out directly (Proudfoot et al., 2010). Third, novelty effect. Users' curiosity about new things may promote their short-term enthusiasm, leading to overestimated engagement (Croes & Antheunis, 2020; Fryer et al., 2017; Nadarzynski et al., 2019). Fourth, uncanny valley effect. Based on the Theory of The Uncanny Valley, when human-like objects become sufficiently realistic, humans' liking for them may turn into dislike (Mori et al., 2012; Song & Shin, 2022). Given the rapid development of AI language models, chatbots' (e.g., ChatGPT) simulation capabilities are advancing daily (Aydın & Karaarslan, 2022; Elkins & Chun, 2020), so future HCRs research should also pay attention to this effect' s influence. Fifth, interaction effects between human cues. For example, chatbots using different identities (robot identity or human identity) will affect users' expectations and consequently influence the effects of other human cues (such as appearance and natural language dialogue ability), suggesting that interaction effects may exist between human cues, and different cue combinations may have different impacts on outcomes (Go & Sundar, 2019). In summary, future research needs to objectively evaluate chatbots' effects, control for additional variables' influences, and improve research result reliability.

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Note: Figure translations are in progress. See original paper for figures.