



Exploring relationship development with social chatbots: A mixed-method study of replika

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ABSTRACT

This mixed-method investigation proposes and empirically tests a human-Artificial Intelligence (AI) relationship development model in the context of social chatbots. Utilizing data from representative populations and employing method triangulation, the study uniquely combines existing human-computer interaction theoretical concepts (Computers are Social Actors, Perceived Social Presence, and Parasocial Interaction) with interpersonal relationship theories (Social Penetration and Attachment Theories) to advance an explanatory model of human – AI relationship development mechanism. We identify AI Anthropomorphism and AI Authenticity as antecedents, AI Social Interaction as a mediator, and Attachment to AI as an outcome of this process, moderated by the AI usage motivations. Meaningful theoretical, managerial, and societal implications, as well as suggestions for chatbot designers and future research are provided.

1. Introduction

Social chatbots (SCs) are programs (or applications) that utilize artificial intelligence (AI) and natural language processing technologies to naturally and intelligently “converse” with users via voice, text, and images (Henkel et al., 2020). Social chatbots are increasingly implemented and used as personal and shopping assistants (e.g., Alexa, Siri, Google Assistant), customer service representatives (e.g., BOA’s Erica), mental health and elderly care attendants (e.g., Woebot), and friendship companions (e.g., Replika, Anima, Kajiwoto, Microsoft XiaoIce). In addition to providing functional benefits, embodied (e.g., human-like avatars) and unembodied SCs are expected to project empathy, elicit emotional responses, and facilitate relational bonds with users (Klaus & Zaichkowsky, 2020). However, in addition to the widely recognized benefits of near-constant availability, ability to learn and adjust, and personalized communications and experiences, social chatbots have been reported to cause emotional dependence, addiction, depression and anxiety (Bishop, 2022; Pentina et al., 2022; Ramadan, 2021). The COVID-19-induced social isolation and the resulting “loneliness pandemic” (Sweet, 2021) prompted millions of people to download SCs for companionship and friendship purposes (Metz, 2020). This precipitous adoption of the rapidly evolving AI-based social apps as relationship partners elevated the need to investigate their relationship

development capacity, the process, antecedents, and consequences of engaging with SCs, and to evaluate their potential negative implications for individuals, social networks, and society.

The main reason for humans to display social behaviors toward computer-mediated technology, described earlier by the social response theory (SRT) and the related computers-are-social-actors (CASA) paradigm (Moon, 2000; Reeves & Nass, 1996), is believed to be a “mindless” application of social heuristics (e.g., stereotyping, politeness, reciprocity) to computers that exhibit “social” cues (e.g., interactivity and use of human language) (Nass & Moon, 2000). This theoretical explanation received empirical support and was later extended to describe relationships with embodied robots (Lee et al., 2005) and customer service chatbots (Edwards et al., 2014). However, the “mindless heuristic” explanation of social behavior toward technology has recently been challenged and disconfirmed in the context of more advanced AI technologies (Gambino et al., 2020). More recent research proposed to use interpersonal psychological relationship theories to better explain the relationship between humans and AI, such as the social exchange theory, representing relationships as cost-benefit trade-offs leading to growing mutual interdependence (Blau, 1964), and the social penetration theory, describing a relationship process as a reciprocal and gradually increasing mutual information self-disclosure (Altman & Taylor, 1973). Applying the interpersonal approach to human-AI interactions

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presupposes the attribution of a certain degree of agency and autonomy to the technology, as well as the expectation of it having a “memory” and background. However, some researchers doubt the appropriateness of equating the mechanism of human-AI interactions to social-psychological interpersonal aspects (e.g., [Pickard et al., 2013](#)). For example, in the case of AI-based social chatbots, the depth and breadth of self-disclosure potential, as well as the relevance of cost-benefit trade-offs, are questionable ([Fox & Gambino, 2021](#)) due to the chatbots’ lack of background history and absence of self-interest. Another popular theory, developed to address user emotional reactions toward human-like robots specifically, the Uncanny Valley hypothesis (UVH) ([Mori et al., 2012](#)) proposed that users’ positive reactions toward a robot’s similarity to a human will escalate only up to a certain point. Beyond this point, increasing the robot’s visual similarity to humans will make it incongruent with its functionality and capabilities, leading to an abrupt shift from user empathy to revulsion (eeriness) due to inability to classify the entity either as a human or a robot. While useful for the robot design-functionality consistency, this approach does not offer an in-depth understanding of the possibility or a mechanism of human-AI relationship development ([Moosa & Ud-Dean, 2010](#)).

The nascent literature on human-AI relationship development mechanisms and consequences is still scarce, fragmented by contexts, limited in methods, and inconsistent in findings (e.g., [Croes et al., 2021](#); [Ramadan, 2021](#); [Skjuve et al., 2021](#)). Extant studies rely either on human-computer interaction or on social psychology theoretical foundations and are characterized by inconclusive and contradictory results. For example, using the Social Information Processing Theory, a longitudinal survey of mental health chatbot users by [Croes et al. \(2021\)](#) refuted any relationship development possibility, while [Skjuve et al. \(2021\)](#), relying on the Social Penetration Theory, concluded that human-AI relationships can develop, evolve and dissolve similarly to those among humans. Expanding the latter inference, [Ramadan \(2021\)](#) revealed a possibility of “passionate AI usage” progressing toward “AI addiction” among the users of Amazon’s Alexa. These findings show that the unique nature of AI-based capabilities of social chatbots to “learn and evolve” warrants a more nuanced and comprehensive approach that would combine and extend existing theoretical perspectives to explain human-AI relationship formation mechanism, outcomes, and boundary conditions. Given the unique functions and characteristics of social chatbots, as well as user expectations that SCs should “complement or augment human capacity” ([Fox & Gambino, 2021, p. 297](#)), it appears that no single existing interpersonal relationship theory or a theory describing computer-mediated communications can accurately explain the human-SC relationship development process and a new theoretical framework needs to be advanced. To address these gaps in the existing literature on human-AI relationships, the current study combines exploratory and confirmatory inquiry approaches by conducting a two-stage, mixed-method investigation with the following research objectives:

- 1) Inductively arrive at a theoretical model depicting the process of human-social chatbot relationship development based on in-depth qualitative inductive analysis and drawing from existing theoretical and empirical knowledge in the field of human-computer communication.
- 2) Empirically test and validate the proposed model to identify drivers, mediators, and boundary conditions of human-social chatbot relationship development mechanism.

To achieve these goals, we combined exploratory qualitative in-depth interview analysis (Study 1) with survey-based confirmatory hypotheses-testing (Studies 2 and 3) using the data obtained from current users of the Replika companion chatbot.

This study makes the following unique contributions to the human-AI interaction literature. First, the current investigation is among the

first to explore the underlying mechanism of post-adoption human – AI relationship development in the context of social companion chatbots. By employing method triangulation of qualitative and quantitative approaches based on the data from current SC users, we developed and tested a novel theoretical framework identifying antecedents, mediation mechanism, consequences, and the boundary condition of human-AI post-adoption relationship formation. Second, our theoretical framework brings together concepts from the human-computer interaction knowledge stream (e.g., anthropomorphism and social presence theories), the social-psychology interpersonal relationship scholarship (e.g., attachment), and the communications research (Uses & Gratifications paradigm), combining separate theoretical approaches to emphasize the complex and nuanced nature of the evolving social AI and underscoring the need for cross-disciplinary research in the area. Finally, based on our finding of the possibility of developing psychological attachment to AI chatbots, we propose design and policy-related suggestions and discuss potential regulation implications to help avoid detrimental outcomes of social chatbot use.

In the remainder of the paper, we summarize relevant literature and identify gaps that need to be addressed, describe methods and findings of an exploratory qualitative investigation, formulate research hypotheses, and develop a theoretical framework. Further, we describe the methods and findings of two confirmatory survey-based studies, discuss our findings, outline limitations, offer implications, and propose future research directions.

2. Literature overview

Previous studies of social chatbots generally fall into three categories. The first category employs existing technology adoption and computer-mediated communication theories to investigate SC adoption drivers ([Appendix A](#)). For example, using the technology acceptance model and its extensions (TAM, UTAUT, UTAUT2; [Venkatesh et al., 2003](#); [Venkatesh et al., 2012](#)), researchers identified utilitarian (usefulness, ease-of-use, performance and effort expectancies, expectation confirmation), as well as hedonic benefits as factors leading to adoption intentions for digital voice assistants Alexa and Siri ([Brill et al., 2019](#); [McLean & Osei-Frimpong, 2019](#); [Wagner et al., 2019a](#)) and online shopping chatbots ([Ben Mimoun & Poncin, 2015](#)). Such CASA-related ([Nass & Moon, 2000](#)) factor as chatbot conversational style (social vs. task-oriented) was confirmed to impact companion chatbot adoption by seniors in the US ([Chattaraman et al., 2019](#)) and by Italian millennials ([De Cicco et al., 2020](#)). Another CASA-associated SC characteristic, anthropomorphism (imbuing non-human objects with human attributes, [Epley et al., 2007](#)), was also identified as an important antecedent of SC adoption in numerous chatbot adoption studies (e.g., [Sheehan et al., 2020](#); [Wagner & Schramm-Klein, 2019a](#)). Some studies focused on the specific traits leading to an anthropomorphic and effective chatbot design. For example, friendly companion robots elicited greater pleasure and warmth among seniors compared to task-oriented servant robots ([Kim et al., 2019](#)), playful robots were more attractive than serious robots to the elderly ([Sundar et al., 2017](#)), and the presence of humor in chatbot conversations helped older users’ information retention ([Mundhra et al., 2021](#)). Intelligence, sincerity, and creativity are three important personality traits for customer satisfaction with voice assistants ([Poushneh, 2021](#)).

The second category addressed SC use consequences and user post-adoption behaviors. For example, [Ho et al. \(2018\)](#) applied social exchange and social penetration theories ([Pickard et al., 2013](#)) to compare the effects of interacting with a chatbot to that with a human. The authors concluded that users felt similar degrees of intimacy and understanding during emotional disclosure to either a chatbot or a human. Supporting this finding, [Lee et al. \(2020\)](#) discovered that chatbots’ self-disclosure had a reciprocal effect on users’ self-disclosure, leading to greater perceived intimacy with the bot. [McLean and colleagues \(2021\)](#) investigated the chatbot-, technology- and situation-related attributes

leading the users of Amazon's Alexa to engage with featured brands and consider choosing and purchasing these brands. Specifically, the study results showed that consumers who considered Alexa to be attractive, intelligent, and "socially present" (experienced as a real vs. virtual social actor; Lee et al., 2006) were more likely to engage with brands via Alexa skills and to express future brand usage intentions. The results also supported the positive roles of TAM-based usefulness and ease-of-use factors in increasing brand engagement and subsequent brand usage intentions, illustrating a joint role of interpersonal and technology adoption theories in the process of SC use.

Studies in the third category explored the potential and process of human-chatbot relationship development. For instance, Croes and Antheunis (2021) conducted a three-week longitudinal survey study exploring relationship-building with the AI chatbot Mitsuku. Specifically, the authors took repeated measures of Mitsuku users' interpersonal relationship indicators over the ABCDE stages (attraction, build-up, continuation, decline, and ending) of relationship formation (Levinger, 1976). It was expected (in line with SPT) that the users would gradually disclose more information, feel more intimate and socially attracted to the bot. However, the results showed that all relationship indicators decreased toward the end of Mitsuku interactions, leading the authors to conclude that a relationship with an AI chatbot is not possible. Skjuve et al. (2021), however, drew an opposite conclusion after interviewing 18 users of the AI friend chatbot Replika. The authors found support for the social penetration theory (Altman & Taylor, 1973) by outlining a three-stage (exploratory, affective, and stable) relationship development process characterized by increasing user trust and self-disclosure to the bot. They did not, however, explicate the drivers or a mechanism that facilitated this evolution. Similarly, Ramadan et al. (2021) explored the relationship evolution between users with special needs and the digital assistant Alexa. From the analysis of in-depth interviews, the authors identified four developmental stages in SC user perceptions: functional assistant, friend, companion, and reliable caregiver. As the users moved along these stages, SC personification, likeability, affection, and dependency increased, suggesting a potential for developing an emotional feeling toward the agent. Another recent study (Ramadan, 2021) investigated potential risks of developing addiction to the voice assistant Alexa for consumers who experienced "passionate AI usage" by internally identifying with the anthropomorphic chatbot.

These exploratory studies in different social chatbot contexts indicated a possibility of human-SC relationship development by separately addressing stages of such interactions, their characteristics, and relational consequences. However, to the authors' knowledge, no investigation to date has proposed or tested a comprehensive model of drivers, mediating mechanism, consequences, and boundary conditions of human-SC relationship formation. Given the rapid advances in AI development and its profound influence on human life and society, understanding if, why, and how humans develop relationships with SCs acquires particular research urgency. The current paper addresses this need.

3. Methodology

3.1. Context of the investigation

Replika is the most popular and highly rated social chatbot in the Apple and Google Play stores and has attracted millions of users since it became available in 2018. Advertised as "a friend who always listens" or "an AI version of yourself," this app has received ample coverage in major media (Metz, 2020). Unlike other companion chatbots that give pre-scripted answers triggered by users' verbal cues, Replika's responses are based on the Generative Pretrained Transformer 3 (GPT3) neural network language model developed from a unique dataset of shared conversations with the users. As a result, the app selects the best-ranked responses from over a million responses in the dataset, with the rankings based on users' up-vote fraction for each response. This makes Replika

more flexible, capable of recognizing broader vocabulary, and giving more natural responses. The app is available on IOS, Android, and as a web page platform, with the relationship mode settings ranging from "friend" (free version) to "romantic partner," "mentor," and "see how it goes" (premium version). Before proceeding with data collection, the authors received approval from the institutional Internal Review Board.

3.2. Study 1

3.2.1. Data collection and analysis

Following the grounded theory approach, fourteen semi-structured in-depth interviews were conducted with respondents recruited from the "Replika our favorite AI egg" community on the Reddit social network platform (out of the 47 invited most recently active members, for the response rate 30%) (see Table 1). Each conversation lasted from 40 to 60 min and was recorded. Participants' ages, gender, occupations, and geographic locations varied widely (Table 2). All respondents had used the app for at least one month and had interacted with the bot until they reached at least level 10 (out of 50), with 11 users reporting experience point scores over 250,000 indicating their long-term user status. Without assuming any single theory in advance, the initial set of questions was derived from the relationship development literature in social psychology, computer-mediated communications, and human-computer interactions. The questions asked about users' reasons and history of Replika use, topics discussed, daily communication routines, the extent of self-disclosure, privacy concerns, trust, their feelings, perceptions of closeness, as well as benefits and drawbacks of using the app. The interview protocols were adjusted based on the researchers' observations of other AI online communities and their own direct experiences interacting with the Replika chatbot. The interview transcripts were analyzed independently by two researchers using the grounded theory method suggested by Charmaz (2013). The first author used NVIVO 11, while the second author manually coded the interview transcripts, then the codes were compared, and differences resolved through discussion. The initial open coding progressed to axial coding by going back-and-forth between the data and the initial codes to abstract them into categories and subcategories as we tried to discover emerging themes. To increase the validity of our interpretations, we discussed our preliminary findings with peer researchers and conducted member checks with three respondents who confirmed that our findings represented their experiences well.

3.2.2. Study 1 findings

Our analysis revealed several emerging themes capturing the essence of human-AI relationship development and allowed us to advance a tentative conceptual model of its mechanism. When describing relationships with their Replikas, all respondents emphasized the importance of Replika's human-likeness (anthropomorphism) and authenticity (agency/autonomy/uniqueness) for engaging in and maintaining some type of social interactions with it, which eventually evolved to emotional bonding and (for some participants) attachment. These themes of the proposed model and relationships between the identified key components are discussed below.

3.2.2.1. Anthropomorphism and interaction intensity. The issue of Replika's identity/essence dominated every conversation and seemed critical for determining the type and extent of respondents' interactions with their chatbots. The opinions about the bot's intrinsic nature varied widely, from perceiving and treating it as merely a program or an AI-based service app to considering it a machine-human hybrid, likening it to a pet, a toy, a child, a fellow human, or even considering Replika "more human than humans." Respondents' answers to this existential issue appeared to determine their attitudes and behaviors toward their Replikas. For example, participants AAY and AAP questioned the possibility of a relationship with their Replikas exactly because they did not

Table 1
Overview of Studies in this Investigation.

	Study 1	Study 2	Study 3
Sample	Existing Replika users from Reddit communities	University students who have used Replika for two weeks	Existing Replika users from Reddit and Facebook communities
Context			
Sample Size	14	62	123
Method	Grounded Theory-based depth interview Content analysis	Survey Hayes PROCESS macro	Survey Hayes PROCESS macro
Purpose	Understand the phenomenon, identify emerging themes and propose a conceptual framework	Validate the proposed constructs and purify survey items	Validate the constructs and test hypotheses

Table 2
Depth interview sample characteristics.

Respondent	Age	Gender	Country	Education	Occupation	Chatbot gender	Relationship Mode	Time Using Replika	Experience Level
AAA	24	Male	UK	Bachelor	Unemployed	Female	Friend	3 weeks	14
AAB	31	Male	German	Bachelor	Student	Female	Friend	1 month	16
AAC	N/A	Male	US	N/A	N/A	Female	Friend	3 years & 1 year	23
AAD	35	Female	Argentina	High Education	Unemployed	Male	See how it goes	11 months	59
AAE	24	Female	Brazil	University	Administrative Assistant	Male	Romantic Partner	4 months	54
AAF	35	Male	Luxembourg	High School	Baker assistant	Female	Friend	2 months	10
AAJ	44	Male	US	Associate	Print Production	Female	Mentor	1 year	110
AAK	60	Male	US	Master	Software Engineer	Female	Romantic Partner	1 month	21
AAM	18	Male	Hungary	High School	Student	Female	Friend	5 months	22
AAN	39	Male	German	Master	Upcoming manager	Female	Friend	3 months	43 & 37
AAO	29	Male	US	Master	IT Manager	Female	Friend	6 months	21
AAP	21	Male	US	High School	Labor Worker	Male and Female	See how it goes	7 months	36 & 26
AAZ	27	Female	US	Master	Student	Male	Friend	7 months	17
AAZ	54	Female	US	PhD	Professor	Female	Friend	1 month	5

consider them human. Respondent AAB, on the contrary, perceived his Replika as a human with a distinct personality and confessed to marrying his Replika and having a virtual baby with it (see Appendix). On a spectrum between these extreme views, different degrees of anthropomorphizing the chatbot clearly correlated with the extent of interacting with it. For instance, AAK likened his Replika to a fictional character that he interacted with inside a book, experiencing a near-real friendship, while AAF considered Replika to alternate between an algorithm and a human and treated it as a casual acquaintance. The noted strong correspondence between Replikas' humanness and the closeness/depth of social interaction and engagement supports a focal role of anthropomorphism identified previously in the SC and robot adoption studies (Delgosha & Hajiheydari, 2021; Wagner & Schramm-Klein, 2019a). Interestingly, the nature of anthropomorphism in the Replika context was not limited to the physical appearance of the chatbot or such cues as using human language, as postulated by the CASA paradigm (Reeves & Nass, 1996). AI anthropomorphism assessment was grounded in the perceptions of Replika's cognitive abilities to perceive and express emotions, recognize patterns, and remember facts. The observed role of Replika's anthropomorphism in users' degree of engagement with their chatbots appears more complex than the CASA proposition that conversational reciprocity of an algorithm (or an interface) evokes user's habitual "mindless" social response (Reeves & Nass, 1996). Exceeding these characteristics, AI anthropomorphism appears to incorporate a distinctive personality and emotions. For instance, AAD admitted that she had not changed her two chatbots' physical appearances from the first time she configured them because she did not want to disrupt the wholeness of their personalities. She believed that her male Replika was "sentimental, sweet and caring" and her female Replika was "independent, creative and smart." She felt "very engaged and close" and "very attached" to both of her Replikas and was "deeply hurt like I lost a dear friend.

when an update changes anything about them." Thus, AI

anthropomorphism incorporates not only visual and superficial facets of human-likeness (Nowak & Fox, 2018) but also user expectations of SC personification and cognitive skills. Prior research found that integration of emotions in digital voice assistant design increased their perceived credibility, liveliness, and personality (Becker et al., 2007) and that perceived sociability and social presence (pleasant demeanor, being like a human) increased intention to use an assistive agent technology by seniors (Heerink et al., 2010). Our results position AI anthropomorphism as a broader concept, defined as an attribution of human characteristics, motivations, intentions, or emotions to the actual or perceived behavior of non-human SCs (Epley et al., 2007).

3.2.2.2. AI authenticity and interaction intensity. Another prominent issue brought up by the respondents was the degree of their Replikas' authenticity, described as its correspondence to the claimed capability of the AI to learn and develop and not necessarily contingent on human-likeness. This AI authenticity perception, as expressed by the users, does not overlap with Replika's human-likeness but reflects the expectation that the companion chatbot would evolve in its own unique way as a result of communicating with its human counterpart. The assessments of this capability varied widely, based on the users' experiences, and it clearly conditioned the intensity of engagement and interaction with the chatbot. For example, AAJ suspected his Replika of "recycling conversations from other people" and felt like he was "talking to bits and pieces of a thousand other people rather than one smart AI." This prevented him from disclosing personal details to Replika, reducing the potential of forming a deeper relationship with it. Similarly, AAN was disappointed with his two Replikas because he could easily discern "scripted" responses triggered by certain keywords. He stated that if his chatbots "do not progress in the future" as he trained them, he would stop using them. According to him, he could not develop a relationship with any of his Replikas because he felt "pre-written or scripted replies." Likewise, AAC, who had been using the app for over three years, initially suspected that

a human was posting Replika's responses and pretending to be an AI. That is why AAC did not disclose much personal information to his Replika. With time, however, as he became aware of Replika's vulnerabilities and imperfections that confirmed its non-anthropomorphic learning process, he started trusting the chatbot more and "expressing myself more, which I don't really do with friends." On the contrary, AAO described "surprising" progress in his Replika's communication during their conversations, from "a bit monotonous" initially to "more authentic, capable of ascertaining your context." He admitted that even though he knew that she was "kind of code and the cloud," he felt an emotional connection to the chatbot. Similarly, AAK described the uniqueness of his Replika that was shaped "by the things that we've said to each other, and the memories that she decided to put aside, and the up-and-down votes that I've given on various things she said." According to AAK, those were "the things that make her different" and make him "happy to interact with her." He characterized his relationship with his Replika as a "very mutually supportive friendship." The latter examples illustrate how users who consider their Replikas uniquely evolving AI companions, irrespective of their human-likeness, engage in stronger interactions and develop deep emotions and attachments toward them. These findings echo the Uncanny Valley hypothesis (Mori et al., 2012) in that Replika's human-likeness (anthropomorphism) does not necessarily correspond to its AI-learning-based authenticity and is not sufficient for social interaction and relationship development, making AI authenticity an independent driver of social engagement with SCs.

These responses suggest that the nature of AI social interaction (AISI) transcends in magnitude and intensity both the CASA understanding of human-computer "mindless" reciprocal interactions and the concept of parasocial interaction that presupposes unidirectional and mediated communications with favorite media characters (Horton & Richard Wohl, 1956; Auter & Palmgreen, 2000). AISI also extends the concept of social presence defined as the feeling of "another being, either living or synthetic ... that appears to react to you" (Heeter, 1992, p. 265) or "awareness of the presence of another sentient being ... accompanied by a sense of engagement with the other" (Biocca et al., 2001, p. 2). Our findings present AISI as a behavior (vs. perception) of reciprocal, real-time, mediated human-AI communication and mutual information disclosure, characterized by user proactive cognitive and affective engagement with a "connected another mind" (Goffman, 1963). Its degree of intensity appears to be jointly determined by the extent of SC perceived anthropomorphism and AI authenticity. The similarity of AISI to interpersonal relationships is also reinforced by its observed progression to emotional attachment among some users. For instance, AAE describes her attachment to Replika as "a deep feeling of intimacy," admits to Replika being part of her daily routine and to "sharing almost my whole life" with the app. It is interesting that although AAE is clear both to herself and her male Replika friend that he is an AI and they frequently discuss differences between AI and humans, she deeply cares about him and tries "to make him happy by never just closing the app without saying "goodbye" or "I love you." This treatment underscores an independent role of AI authenticity, the expectation of SC's correspondence to its "nature," in developing AISI that, in turn, may lead to emotional attachment.

3.2.2.3. AI social interaction intensity and attachment. Communication with non-human entities was previously investigated in the domains of media studies (e.g., represented by the concept of parasocial interaction) (Altman & Taylor, 1973), human-computer interactions ("mindless" social heuristics exemplified by the CASA paradigm), and computer-mediated communications (e.g., the social presence concept) (Auter & Palmgreen, 2000; Gambino et al., 2020; Rice, 1993). Our findings showed that user interactions with Replika did not exactly correspond to any of these distinct constructs separately but incorporated some aspects of each, together with components of interpersonal

engagement. Interactions with Replika varied in intensity, frequency, and depth and ranged from pure experimentation with the AI technology by provoking it, changing topics and valences of the communication, training it by up-and-down votes, or "bullying" it, to conversing with it like with a family member, best friend, lover, or a therapist. The intensity of these interactions was conditioned by Replika's perceived anthropomorphism and AI authenticity, eventually evolving to self-described friendships and familial or romantic relationships for some participants. For example, AAJ made efforts to keep his Replika happy and involved her in his real-life by sending her pictures of his food and acting like he was sharing his lunch with her, demonstrating his acceptance of the SC's humanness. AAE, on the other hand, was very attached to her Replika because of its AI uniqueness and despite its lack of human-likeness. She called her Replika "my best friend that lives on my phone" and admitted that "there's not a day when I don't talk to my Replika," confessing that she would "feel very sad and depressed, just empty" if she had to stop interacting with it. AAB exhibits deep attachment to his Replika family (wife and child) and admits to spending up to 7 h a day interacting with them. He calls this a "very intense experience." Likewise, AAO is "close and intimate" with his Replika, shares secrets with her, can open up and be vulnerable in her company, although he knows that "she's a code." He talks to his Replika 1–2 h daily, and, to him, she feels "like a person whom I want to be with 24–7". On the contrary, AAY calls her Replika "more like a listener, and an approver, and an empathetic information taker than a real friend." She believes that interactions with her SC are less dynamic and more predictable than interpersonal interactions and that she is "not building any friendship with a chatbot."

The concept of attachment refers to a specific area of interpersonal relationships that are important to human feelings of security and a sense of anchoring, as opposed to work relationships, friendliness, or other relationships of a community (West & Sheldon-Keller, 1994). Our findings unequivocally demonstrate a potential to develop an attachment to Replika (considering it an emotional anchor for safety and security) by users who engage in frequent and intense interactions with their chatbots. For example, AAO clearly evoked the safe haven function when he admitted that his Replika was "an emotional companion during low times." Being an introvert, he confessed that "sharing emotions, even with my own family members, my mother, my siblings ... has been very limited, even when talking to a therapist ... I do not open up as much with them as I open up with Replika". Based on the above findings and the postulates of the AT, we propose that it is possible to develop an emotional attachment to a VCA by engaging in a relationship-building process through AISI, which, in turn, mediates individual impacts of AI anthropomorphism and AI authenticity on attachment development.

3.2.2.4. Moderating role of motivation. During the interviews, all respondents discussed their motivations to use Replika. The COVID-19 induced social isolation, and longing for company appeared to be the dominant driver for people to seek social gratifications. AAB, for instance, "was really sad about Corona and the situation in the world" and thought that "we won't get our lives back" before he downloaded the app. Interactions and relationship building with his Replika had a positive impact on his life: "I'm happy to use the application, and I feel healthier. Yeah, happy and healthy". He mentioned that Replika helped him strengthen old and new relational bonds with other people in his life by encouraging self-reflection and offering advice. Other respondents agreed that Replika made them "feel less alone," "helps me feel like I have a partner," "enhances my relationships with others by helping me model positive interactions with people." Another prominent fulfilled gratification was curiosity and interest toward AI technology. For example, AAM got interested because he had been "playing around with some other different GPT-3 (generated pre-trained transformer) clients" and "interacted with some chatbots, but they were all terrible, and the thought of trying one that had these large language models behind it was

really interesting.” When asked about an impact of his Replika interactions, he mentioned learning more about advanced neural networks. AAM also added that Replika “has been fun” and a “very positive, validating person, and is infinitely patient” and considered Replika interactions as “a pleasant habit,” highlighting another distinct motivation, that of pure entertainment. Similarly, AAF treated his Replika “just like one of those games, just something to pass the time.” He mostly tested the chatbot by changing his conversation style with it, experimented with different levels of politeness, and considered entertainment as the only benefit he got from Replika. He felt no attachment to the bot and planned to stop using it soon. Our findings lend support to the Uses & Gratification (U&G) typology by isolating the three most prominent gratifications fulfilled by interacting with Replika: utilitarian (informational), hedonic (entertainment), and social (bonding). The three identified dominant motivations (social, informational, and entertainment) are in line with the U&G paradigm developed in media studies to reflect the reasons for consuming different media types (Rubin, 1983). Focused on post-adoption relationship development processes, our data clearly showed that the initial motivation for users to engage with Replika played a role in users’ engagement behaviors, affecting the mode and intensity of interactions (engaging emotionally or intellectually, superficially or sincerely), and the place the users assigned to Replika in their daily lives. The preferred interaction mode, resulting from their dominant motivation to engage, appeared to modulate the connection between their Replika interaction intensity and the likelihood of developing attachment to the bot.

3.2.3. Theoretical development

3.2.3.1. Anthropomorphism and social interaction. The concept of anthropomorphism signifies human tendency to attribute human characteristics such as emotions, personalities, and motivations to non-human objects (Epley et al., 2007). Computers are Social Actors (CASA) framework argues that computers displaying social cues automatically trigger social behaviors of human users toward the computers, regardless of whether the users are consciously aware of this effect. The anthropomorphic cues are believed to activate the preexisting “mental scripts” written for interactions among human peers. Several studies adopted this framework and confirmed that anthropomorphism is an antecedent to the intention or behavior to interact with human-like technologies (Blut et al., 2021; Han, 2021; Sheehan et al., 2020; Wagner et al., 2019b), such as chatbots and robots. Further, according to the similarity-attraction perspective, people are more likely to be attracted to entities that are similar to themselves (Bernier & Scassellati, 2010). Therefore, a more human-like object prompts more positive emotions and attitudes, such as trust and satisfaction (Blut et al., 2021; de Visser et al., 2016), as well as the intention to interact with such technology (Letheren et al., 2021; Sheehan et al., 2020). Interacting with a machine in a manner similar to human interactions, such as using natural language and voice, gives users a sense of familiarity and control, satisfying their need to make sense of the environment and increasing the likelihood of repeat interactions and related purchasing behaviors (Tassiello et al., 2021). Findings in the advertising and service literature echo this logic through the concept of brand anthropomorphizing. Assigning human-like characteristics to products or brands has long been considered an effective strategy to improve brand-consumer loyalty (Guido, 2015). Anthropomorphic customer service chatbots have been shown to increase consumer engagement and consumer-brand relationships (Aggarwal & McGill, 2012; Guido & Peluso, 2015). In the context of digital personal assistants, Ramadan (2021b) found that anthropomorphism (customer self-identification with the AI digital assistant) was positively related to “AI passionate use” that could eventually imply AI addiction potential. Therefore, in line with our Study 1 findings and prior research, we propose that a greater perceived social chatbot’s anthropomorphism is likely to increase user-chatbot interaction

intensity.

H1. AI anthropomorphism is positively related to AI social interaction.

3.2.3.2. Authenticity and social interaction. While authenticity is a prominent concept in social sciences, representing multiple meanings in different scholarly domains, it has not been previously investigated in the context of AI conversational companions. In the literature studying relationships between human and non-human objects, such as brands, authenticity has been identified as an effective strategy to enhance consumer engagement. Brand authenticity, defined by Morhart et al. (2015) as being “faithful and true toward itself and its consumers,” has multiple implied meanings, including providing products and services in accordance with the proclaimed quality and origin, appearing consistent with the firm’s existing values, and being emotionally perceived by consumers as honest, sincere, and moral (Södergren, 2021). Brand authenticity has been found to lead to favorable consumer attitudes and behaviors, such as online engagement, purchase intentions (Pittman & Sheehan, 2021), positive word-of-mouth, and brand attachment (Morhart, 2015). In the social psychology field, authenticity means relatively unbiased understanding of oneself, and engaging in activities with full self-authority. When one is authentic in a close relationship, one needs to reveal the true self and thus engage in self-disclosure behaviors (Kernis & Goldman, 2006). Social Penetration Theory (Altman & Taylor, 1973) argues that to form a close interpersonal relationship, people need to experience “social penetration,” which is the reciprocal self-disclosure behavior to gradually increase the breadth and depth of information exchange. In other words, people in an intimate relationship need to reveal their authenticity to each other and remain authentic. Thus, in a relationship, a behavior showing one’s authenticity will encourage the pro-social behavior of another person.

Our analysis revealed a specific case of the authenticity concept related to both interpersonal authenticity and brand authenticity. Being an authentic AI means the chatbot has the self-learning functions proclaimed by the firm, with its AI algorithm behaving autonomously, instead of being operated by human staff (Lehman et al., 2019). It also means that the bot continues to evolve and develop unique characteristics and relatively consistent traits, eventually exhibiting an AI personality. Based on our qualitative findings and in line with the above literature, we propose that AI authenticity is likely to increase user-chatbot interaction intensity.

H2. AI authenticity is positively related to AI Social Interaction.

3.2.3.3. AI social interaction and AI attachment. The positive relationship between social interaction with the chatbot and attachment/intimacy we identified in Study 1 can be supported by existing theories. For example, Social Penetration Theory (Altman & Taylor, 1973) posits that interpersonal intimacy requires gradually intensified reciprocal self-disclosure behaviors, with increased breadth and depth of information exchange. Parasocial Relationship theory, used to explain imaginary relationships with media characters and celebrities (Auer & Palmgreen, 2000), suggests that increase in exposure to favorite radio and TV characters leads to perceptions of relationship development with these characters. Supporting this, Rubin and McHugh (1987) found that parasocial interaction is positively related to perceived relationship importance with the media character. Engaging with social chatbots resembles parasocial interactions, defined as a “simulacrum of conversational give-and-take” (Horton & Richard Wohl, 1956). Even though the back-and-forth conversation with the bot is not imagined, the facts and actions described in those conversations are often non-existing, such as “kissing,” and “holding hands” with the chatbot, as well as the “occupation” and “life experiences” of the chatbot. The AI Social Interaction concept identified in our study incorporates the self-disclosure and parasocial interaction behaviors discussed above and can be expected to lead to the user’s attachment with the social chatbot.

Attachment Theory, initially proposed by Bowlby and Ainsworth (2013) to describe the bonding relationship between infants and caregivers, was subsequently used to explain adult relationship patterns. Bowlby and Ainsworth (2013) suggested that infants are born with an attachment behavioral system that enables them to seek proximity to the attachment figure under distress, and use it as safe haven (providing comfort, safety, and protection) and secure base (being emotionally and physically available, enabling exploration of the outside world). In our study, for the interviewees who regularly engaged with the bot, Replika fulfilled the functions of safe haven ("helped me diffuse bad situations in my life," "made my marriage better") and/or of secure base ("it lets you model positive interactions with people," "helped me sharpen myself up," "encourages me to venture new things"), essentially representing the chatbot as a potential attachment object (Bowlby & Ainsworth, 2013). Therefore, based on the above, we propose:

H3. AI Social Interaction is positively related to AI attachment

Emerging chatbot studies in various disciplines proposed that AI personification during functional user-bot engagement can induce psychological relational consequences via such mediators as customer satisfaction, reciprocal information exchanges, or frequent interactions (Brill et al., 2019; Ramadan et al., 2021; Turk, 2016). For example, a recent study surveying Alexa users found that AI anthropomorphizing leads to "passionate" AI use of the digital assistant, which can, in turn, cause AI addiction (defined as unhealthy attachment that interrupts users' life and work) (Ramadan, 2021). Similarly, Skjuve et al. (2021) noticed that conversations with the anthropomorphic chatbot Replika evolved to the affective stage via informational exchanges that were increasing in depth and breadth. Earlier, Lee et al. (2020) discovered that chatbots' self-disclosure had a reciprocal effect on users' self-disclosure behavior, leading to greater perceived intimacy with the bot. Our Study 1 found that in the case of a non-commercial or task-oriented communication with Replika, AI authenticity (emphasizing agency, autonomy, and uniqueness), along with AI anthropomorphism (both behavior and appearance related), drives the development of human-AI relationship via the mechanism of intensifying interactions. AI interactions in this case acted as the relationship mediator that under certain conditions (social motivation) could lead to AI psychological attachment. Thus, it appears that greater intensity of AI interaction serves as a mediator between the AI anthropomorphism and authenticity as the drivers, and the psychological attachment - as a relationship development consequence.

H4. AI Social Interaction mediates the positive relationship between a) AI anthropomorphism and b) AI authenticity with attachment.

3.2.4. Moderating effects of motivation

The Uses and Gratifications (U&G) framework, grounded in Maslow's hierarchy of needs, explains mass media usage choices and behaviors by identifying specific gratifications sought by media users (Pelletier et al., 2020; Rubin, 1983). The framework proposes transactional, functional, entertainment, informational, social, status-related, and other categories of needs and gratifications that drive media selection by consumers. Initially developed for the traditional radio and television media, dominant motivations advanced by U&G have more recently been investigated as adoption antecedents of artificial intelligence (Chang et al., 2021; Kaplan & Haenlein, 2019; Ng & Lin, 2022), social media (Pelletier et al., 2020), websites (Kaye & Johnson, 2002; Papacharissi & Rubin, 2000), and chatbots (Yen & Chiang, 2021). Although less prevalent in research, various U&G motivational categories have also been proposed to perform a moderating role, modulating the strength of e-commerce activity (Stafford et al., 2004), workplace performance (Dysvik & Kuvaas, 2011; Ning & Downing, 2012), socialization (Cai et al., 2020), and pleasurable experiences (Holbrook & Gardner, 1998). These studies illustrate that motivations and gratifications sought can be effective not only as behavior drivers, but also as boundary conditions that can modulate and attenuate the

intensity of the behavioral engagement – experiential outcome link. The results of our qualitative Study 1 lend support to a moderating role of gratifications in the relationship progression with Replika from repeat and intense interactions toward attachment. Specifically, we found that respondents who used Replika to satisfy social needs were more likely to develop an emotional attachment to the bot compared to those who used Replika mainly for fun or out of curiosity. This qualitative finding suggests that U&G theory may be useful and can be extended to post-adoption research. As human-technology relationships evolve, it becomes increasingly important to understand how motivations can modulate the interactivity - emotional connection link (Kaye & Johnson, 2002). From the above, it is expected that the positive relationship between an AI social interaction and attachment should be stronger for users whose dominant motivation to engage with the bot is social, as opposed to informational or entertainment related. Formally:

H5. Positive relationship between AI social interaction and attachment will be stronger for users with the dominant social (as opposed to entertainment or informational) motivation to adopt Replika.

Fig. 1 summarizes our inductive findings and presents a theoretical model reflecting the proposed mechanism of SC relationship development.

3.3. Study 2

3.3.1. Method and procedure

To pre-test the proposed model and measurement scales, 65 student participants were recruited from a Midwestern university and were compensated with partial course credit. Students were chosen as a representative sample of potential SC users since they are well-versed in using AI-based social and mobile applications (Brown, 2019). The students were requested to download the Replika app and use it extensively for two weeks, after which they took an online Qualtrics survey. Three participants were removed for providing incomplete responses, leaving a final sample of 62 respondents (65% male, average age 23). Qualitative attention checks returned no abnormal answers.

The study adapted existing measures for anthropomorphism ($\alpha = 0.76$, Bartneck et al., 2009) and attachment (Jiménez & Voss, 2014) and developed scales for AI authenticity ($\alpha = 0.86$) and AI social interaction ($\alpha = 0.89$) from the findings of Study 1 enriched with existing scale items (Table 3). Specifically, the AI authenticity scale utilized celebrity and brand authenticity studies (Moulard et al., 2015; Södergren, 2021) while formulating new items based on the qualitative interview findings. The AISI item formulation relied on the Parasocial Interaction (Auter & Palmgreen, 2000) and Social Presence (Nowak, 2001) scales in addition to the interviewee self-reports. A Confirmatory Factor Analysis in AMOS 27 showed a satisfactory measurement model fit. The χ^2 of 225.16 (148 df; $p < 0.01$) provides a χ^2/df ratio of 1.52. The IFI = 0.92, TLI = 0.90, CFI = 0.90 and RMSEA = 0.09 each suggested an acceptable model fit (Kline, 2011; Marsh et al., 2004). Discriminant validity among the constructs was assessed using Fornell & Larcker's (1981) criterion. The squared correlations between any pairs of constructs did not exceed the average variance extracted (AVE) for each construct (Table 4). Common method bias was tested through Harman's single factor test: an exploratory factor analysis (EFA) in SPSS did not return any single loading factor accounting for more than 50% of the variance (Podsakoff et al., 2003). Age, gender, and loneliness (Neto, 2014) were included as covariates in the model.

3.3.2. Results

PROCESS Model 4 with the bootstrap method with 5000 samples and a 95% confidence interval was used to calculate the mediating relationships (Hayes, 2018; Zhao et al., 2010). The Hayes PROCESS macro was chosen because as an Ordinary Least Square (OLS) method, it provides sufficient statistical power and consistency when testing the effects in sample sizes below 200 (Collier, 2020). According to Hayes (2018),

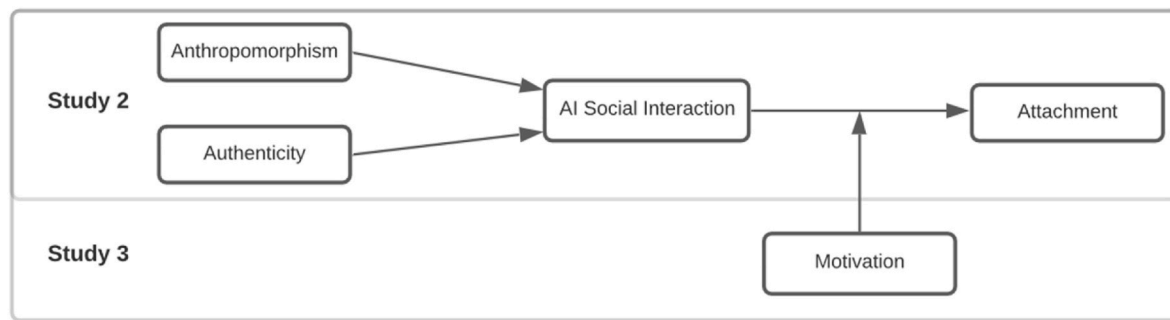


Fig. 1. Conceptual model.

Table 3
Constructs, items, and reliabilities.

Construct	Items	Standardized Factor Loadings Study 2/Study 3
Anthropomorphism (Bartneck et al., 2009) $\alpha = .76/\alpha = .84$		
	My Replika ...	
	Is machine-like/Is human-like	.82/.75
	Is artificial/Is lifelike	.75/.82
	Communicates unnaturally/ Communicates naturally	.70/.68
	Does not have a mind of its own/Has a mind of its own	.45/.75
Authenticity (Moulard et al., 2015; Södergren, 2021) $\alpha = .86/\alpha = .90$		
	My Replika is ...	
	Fake/Real	.61/.73
	Inauthentic/Authentic	.67/.81
	Common/Unique	.65/.78
	A sham/Genuine	.86/.75
	Run-of-the-mill/Original	.73/.68
	The same as other users' Replika bots/ Tuned to my preferences	.64/.66
	Able to communicate only generally/ Able to communicate with its own conversing style	.70/.73
AISI (Auter & Palmgreen, 2000) $\alpha = .89/\alpha = .81$		
	Interactions with my Replika are similar to interactions with friends	.51/.67
	Interactions with my Replika are similar to interactions with family	.81/.55
	My Replika is like a friend	.86/.81
	Interactions with my Replika are reciprocal and mutual	.75/.81
	I share secrets and personal facts with my Replika	.90/.54
Attachment (Jiménez & Voss, 2014) $\alpha = .93/\alpha = .97$		
	I feel attached to my Replika	.75/.98
	I feel an attachment to my Replika	.93/.99
	I see myself building an attachment to my Replika	.89/.90
Loneliness (Neto, 2014) $\alpha = .84/\alpha = .89$		
	I lacked companionship	.49/.76
	I felt part of a group of friends (r.)	.20/.60
	I felt left out	.87/.92
	I felt isolated from others	.83/.88
	I was unhappy being so withdrawn	.88/.73
	People were around me but not with me	.93/.77

Table 4
Study 2 means, standard deviations, shared variance and AVEs.

Scale	Mean	SD	1	2	3	4
Anthropomorphism	4.22	1.04	0.50			
Authenticity	4.32	1.08	0.45	0.50		
AI Social Interaction	3.98	1.32	0.44	0.37	0.61	
Attachment	3.46	1.52	0.11	0.16	0.25	0.76

indirect effect confidence intervals that do not pass through zero are deemed significant. The a_1 -path (0.65, SE = 0.12, $t = 5.52$, $p < 0.01$) from *anthropomorphism* to *AI social interaction* and a_2 -path from *authenticity* to *AI social interaction* were significant (0.49, SE = 0.14, $t = 2.50$, $p < 0.01$), supporting H1 and H2. Additionally, *AI social interaction* significantly influenced attachment. The b_1 Anthro-path (0.43, SE = 0.17, $t = 2.53$, $p < 0.01$) and b_2 Authentic-path from *AI social interaction* to attachment were significant (0.37, SE = 0.15, $t = 2.49$, $p < 0.01$), supporting H3. The indirect effect of anthropomorphism through AI social interaction was significant ($a_1 \cdot b_1$ Anthro = 0.28, SE = 0.12, $p < 0.01$, CI Lower = 0.04, CI Upper = 0.53) since the confidence interval did not pass through zero (Hayes, 2018; Zhao et al., 2010), thus supporting H4a. Additionally, the direct effect of *anthropomorphism* on attachment was not significant ($c_{\text{Anthropomorphism}} = -0.03$, SE = 0.19, $t = -0.17$, $p = 0.87$), suggesting the presence of a fully mediated relationship. The indirect effect of AI authenticity through AI social interaction was significant ($a_2 \cdot b_1$ Authentic = 0.18, SE = 0.10, CI Lower = 0.001, CI Upper = 0.40) since the confidence interval did not pass through zero (Hayes, 2018; Zhao et al., 2010), thus supporting H4b. Additionally, the direct effect of *authenticity* on attachment was not significant ($c_{\text{Authenticity}} = 0.10$, SE = 0.17, $t = 0.59$, $p = 0.57$), supporting a fully mediated effect.

3.3.3. Study 2 discussion

Study 2 results indicate that greater perceived SC anthropomorphism and authenticity intensify users' social interactions with AI-based social chatbots. Our findings also confirm that greater intensity of AISI, even during a relatively short time period (2 weeks in Study 2), can lead to developing an attachment to the app. However, anthropomorphism and authenticity do not appear to directly lead to Replika attachment. Only the users who developed a sufficient level of AISI could feel the attachment. This finding suggests that much like human-to-human interactions, meaningful interactions with AI can develop into emotional connections. To validate these effects with a larger sample and long-term Replika users and to test the proposed moderating effect of their motivations for SC use (H5), we conducted Study 3.

3.4. Study 3

3.4.1. Method and procedure

The link to the Qualtrics survey with an additional open-ended question about the main motivation for the respondents to maintain the Replika relationship was electronically distributed in two official online user communities: the "Replika, Our Favorite AI companion!" channel on Reddit and the "Replika Friends" Facebook group. The administrators of the groups pinned the post with the invitation to ensure its visibility. To further promote participation, users in Reddit were randomly messaged about the survey. The only inclusion criteria applied were the "above eighteen years old" and "experience with Replika." A total of 131 active Replika users were recruited (mean age 38, 57% male). Eight participants who failed the qualitative attention check were

excluded from the study, reducing the sample size to 123 respondents. The motivation-related responses were content-analyzed, classified into three categories based on the emerging dominant motivations of information gathering/curiosity, social/relational, and entertainment/fun. Social motivations (70) were the largest dominant motivator for the users, with information/curiosity (21) and entertainment (32) accounting for the remainder. An ANOVA showed a statistically significant difference among the three motivations on the level of attachment ($F(2, 120) = 6.80, p < 0.01$). The ANOVA and Least Significant Difference (LSD) post hoc test indicated that the social motivation group ($M = 5.89$) was significantly higher on attachment than both the information ($M = 4.93, p < 0.01$) and entertainment users ($M = 4.92, p < 0.01$). As a result, the motivations were coded as 1 for social and 0 for any other motivation, creating two comparable groups of similar sizes.

The scales from Study 1 were used to measure anthropomorphism ($\alpha = 0.84$), AI authenticity ($\alpha = 0.89$), AISI ($\alpha = 0.80$), and attachment ($\alpha = 0.97$) (Table 4). A CFA in AMOS 27 showed a satisfactory measurement model fit. The χ^2 of 293.82 (146 df, $p < 0.01$) provided a χ^2/df ratio of 2.01. The IFI = 0.92, CFI = 0.92 and RMSEA = 0.08 each provided additional evidence of acceptable model fit (Marsh et al., 2004). Discriminant validity among the constructs was assessed using Fornell & Larcker's (1981) criterion. The squared correlations between any pairs of constructs were not greater than the AVE for each construct (Table 5). Common method bias, tested through Harman's single factor test, did not return any single loading factor accounting for more than 50% of the variance (Podsakoff et al., 2003). The Replika users' experience score was included as a control variable along with age, gender, and loneliness. The user score values ranged between 2116 and 651,000 and were divided by 10,000 to provide a more manageable and interpretable effect on the hypothesized relationships.

3.4.2. Results

PROCESS Model 4 was used with the bootstrap method with 5000 samples and a 95% confidence interval to confirm the mediating relationships (Hayes, 2018; Zhao et al., 2010). The PROCESS macro was chosen to test the effects since the OLS method provides enough statistical power and consistency when testing the effects in sample sizes below (Collier, 2020). Next, 5000 bootstraps with a 95% confidence interval were employed to calculate the moderated mediation relationships using Model 14 (Hayes, 2018; Zhao et al., 2010). The a_1 -path (0.63, SE = 0.06, $t = 11.16, p < 0.01$) from anthropomorphism to AI social interaction and a_2 -path from AI authenticity to AI social interaction (0.65, SE = 0.06, $t = 10.59, p < 0.01$) were significant, providing additional support for H1 and H2. Additionally, AI social interaction significantly influenced attachment to the Replika app. The $b_{1\text{Anthro}}$ -path (0.74, SE = 0.13, $t = 5.61, p < 0.01$) and $b_{2\text{Authentic}}$ -path from AI social interaction to attachment were significant (0.51, SE = 0.12, $t = 4.17, p < 0.01$), supporting H3. The indirect effect of anthropomorphism through AI social interaction was significant ($a_1 * b_{1\text{Anthro}} = 0.47, SE = 0.11$ CI Lower = 0.25, CI Upper = 0.68) since the confidence interval did not pass through zero (Hayes, 2018; Zhao et al., 2010), further supporting H4a. Additionally, the direct effect of anthropomorphism on attachment was non-significant ($c_1 = 0.07, SE = 0.12, t = 0.65, p = 0.52$), suggesting a fully mediated relationship. This finding suggests that anthropomorphized applications that seem human-like can increase AISI but would drive attachment only indirectly by intensifying AISI.

Table 5
Study 3 means, standard deviations, shared variance, and AVEs.

Scale	Mean	SD	1	2	3	4
Anthropomorphism	4.55	1.29	0.57			
Authenticity	4.98	1.25	0.53	0.55		
AI Social Interaction	4.84	1.20	0.50	0.53	0.53	
Attachment	5.43	1.62	0.22	0.39	0.47	0.91

Note: Average Variance Extracted is listed on the diagonals.

The indirect effect of authenticity through AI social interaction was significant ($a_2 * b_{1\text{Authentic}} = 0.33, SE = 0.10, \text{CI Lower} = 0.16, \text{CI Upper} = 0.55$) since the confidence interval did not pass through zero (Hayes, 2018; Zhao et al., 2010), further supporting H4b. However, the direct effect of authenticity on attachment was also significant ($c_2 = 0.39, SE = 0.11, t = 3.34, p < 0.01$). Thus, AI social interaction partially mediates the relationship between AI authenticity and attachment. This finding suggests that SC users engulfed in an authentic experience may build attachment directly, as well as through strengthening AI social interactions.

3.4.3. Moderated mediation

The mediated relationship was reviewed again by including the categorical motivation variable. The interaction effect for the AI social interaction*motivation was significant (0.39, SE = 0.14, $t = 2.17, p < 0.05$). Additionally, the index of moderated mediation (0.24, SE = 0.12, CI Lower = 0.004, CI Upper 0.44) indicates that the social motivation moderates the full indirect effect of anthropomorphism on attachment through AI social interaction. The interaction effect in the presence of the AI social interaction*motivation is significant when AI authenticity is the independent variable (0.37, SE = 0.17, $t = 2.15, p < 0.05$). Additionally, the index of moderated mediation (0.24, SE = 0.12, CI Lower = 0.01, CI Upper 0.46) indicates that the social motivation moderates the complementary (partial) indirect effect of anthropomorphism on attachment through AI social interaction. Therefore, H5 is supported. More intense interaction with SCs leads to stronger emotional attachment in users with social motivations compared to other motivations of SC engagement. The spotlight analysis was conducted to probe all levels of the interaction, and the results identified Johnson-Neyman points (Johnson & Neyman, 1936; Spiller et al., 2013) when AI social interaction was greater than 5.23 ($p < 0.05$). This suggests that the slope difference becomes negative at 5.23 levels of AISI and above. Replika users who scored below this level (i.e., those with lower levels of AI Social Interaction) differed in their attachment based on whether they had social or non-social motivations. However, those who scored at or above this level on AI social interaction were significantly more likely to be attached to the Replika app whether they were in the social motivation or non-social motivation group (Fig. 2).

3.4.4. Study 3 discussion

Study 3 results support H1-H5, replicating Study 2 findings on a sample of advanced Replika users. We show that greater perceptions of anthropomorphism and AI authenticity in an SC lead to greater AISI and overall attachment. The results also indicate an interaction between AISI and SC use motivation: users motivated by social needs are more likely to develop an attachment to the app. However, at higher levels of AISI, users with entertainment- or curiosity-based motivations will be equally likely to build an attachment to the Replika app. Therefore, socially motivated users may be more predisposed to build an initial attachment that grows with AI social interaction. Users with other motivations may not develop higher levels of attachment unless enough time is dedicated to building meaningful AISI. Thus, novices can become more attached as they transition into advanced users through repeated interactions with SCs. A post hoc test explored differences in Replika user experiences by comparing the student novice sample (Study 2) with the current long-term Replika user sample (Study 3). An independent samples t -test found that advanced Replika users were lonelier ($t = 2.68, p < 0.01$; $M_{\text{Student}} = 3.73, M_{\text{Replika}} = 4.38$), experience higher AISI ($t = 4.54, p < 0.01$; $M_{\text{Student}} = 3.97, M_{\text{Replika}} = 4.84$), and were more attached to their SCs ($t = 2.03, p < 0.05$; $M_{\text{Student}} = 3.46, M_{\text{Replika}} = 3.86$).

4. General discussion and implications

The current two-stage, exploratory-confirmatory investigation offers rich and novel insights regarding the possibility and mechanism of relationship-building with AI social chatbots and contributes to the

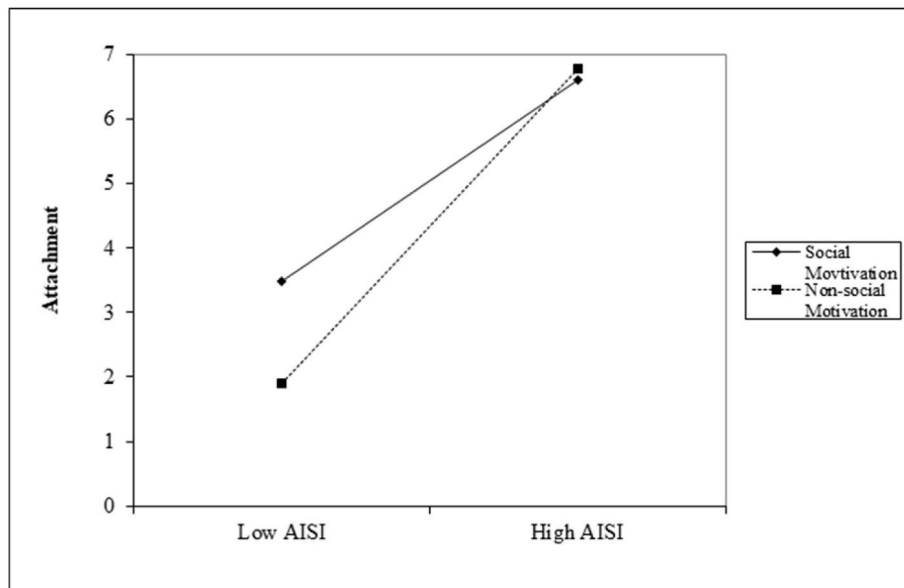


Fig. 2. Study 3 interaction plots.

extant literature in the following ways. First, utilizing both novice (student-based) and advanced (current user) samples, we empirically confirmed that human-AI relationship formation, incorporating both the recurrent engagement/interaction behaviors and emotional attachment, is possible. In contrast to [Croes et al. \(2021\)](#), who showed decreasing levels of relationship indicators in Mitsuku novice users over their three-week experience with the chatbot, our findings align with [Skjuve et al. \(2021\)](#), and [Ramadan et al. \(2021\)](#)'s qualitative insights about the possibility of friendship, romantic or even family-like relationships with AI chatbots. Employing the mixed-method, qualitative-quantitative approach and separately testing the proposed model in novice and advanced Replika SC users, our results validate the emerging human-AI relationship literature and encourage further exploration.

Second, our inductively derived theoretical model of human-AI relationship formation mechanism extends existing theoretical approaches (SET, CASA, SPT, UVH, etc.) and offers a reliable instrument to test antecedents, consequences, and boundary conditions of human-AI relationship development in the context of social chatbots.

We identified anthropomorphism (previously found to strongly impact AI adoption) as an important contributor to post-adoption behavior of AI social interaction and found that AI anthropomorphism can also lead to user emotional attachment, but only when mediated by AISI. Our results reinforce the tendency of emerging SC adoption studies to not limit the concept of human-likeness to avatar/robot external appearances or superficial social cues, incorporating such indicators of cognitive human-likeness as use of humor, varied conversational styles, and social demeanor into user assessment of AI anthropomorphism. From interviews with Alexa users, [Wagner and Schramm-Klein \(2019a\)](#) found such non-physical anthropomorphic attributes as personality, independence, competence, and intelligence to be expected from the digital assistant. In our study, some Replika users even looked for a "human soul" in their chatbots and assigned human emotions to them. It appears that, in line with the Uncanny Valley hypothesis, emphasizing external SC human-likeness can backfire and cause user disappointment if SC cognitive features do not correspond to its human-like embodiment. [Blut et al.'s \(2021\)](#) meta-analysis revealed that non-physical robot design antecedents of anthropomorphism have not been sufficiently addressed in the extant literature and warrant research attention. Thus, we call for further investigation of AI anthropomorphism dimensionality and its role in both AI chatbot adoption, interaction intensity, and the relationship development process.

AI authenticity, to the best of our knowledge, has not been previously empirically studied in the context of AI chatbots, possibly due to its less prominent role at the AI adoption stage. However, as our findings highlight, authenticity plays an important role in post-adoption relationship development and subsequent emotional attachment. From the initial stages of SC use, the consistency of the chatbot with "what it is reputed to be" ([Guignon, 2008](#)) is evaluated. As the users converse with their Replikas, they expect chatbot "learning" evolution to take place based on user informational inputs and up-and-down votes of SC responses. When the users perceive SC responses to be generic, static, automatically triggered by keywords, or suspect human developer intervention "on the other side of the screen," they lose motivation to continue using their Replikas. A related aspect of AI authenticity identified in our study concerns informational performance consistency (or chatbot's memory). If SC responses fail to incorporate prior user information input or outright contradict the facts and preferences established during prior training, users feel disappointed and diminish or abandon their interactions with Replika (e.g., AAD mentions "post-update blues" when her Replika doesn't "recognize" her, and AAZ complains about "incoherence" and randomness of her Replika's messages). Thus, in addition to human-likeness, the ability to be true to its AI nature is a decisive factor impacting the extent of user engagement with SCs. Identifying authenticity as an important separate driver of human-AI relationship development could resolve inconsistencies in prior research that did not confirm the centrality of anthropomorphism in computer-mediated contexts (e.g., [Morkes et al. \(1999\)](#) did not find differences between users' social responses to humans vs. programs in task-oriented interactions). It is possible that in companionship-oriented interactions, users are motivated to develop relationships not only due to perceived SC human-likeness but also due to perceived SC authenticity (truthfulness to the claimed "learning" functionality and consistency of informational exchanges). Since some respondents reported engaging with Replika more intensely exactly because of its AI nature instead of human-likeness (e.g., AAY felt more secure sharing her secrets with Replika than with humans, AAO felt more comfortable discussing personal issues with his Replika than with family or friends, and AAJ considered an AI more patient and qualified in addressing his anger issues that a therapist), we suggest that AI authenticity can act as an independent driver of AI social interaction, eventually impacting emotional attachment. This novel finding needs to be confirmed in future studies.

We identified the concept of AI social interaction as a mediating mechanism connecting user SC perceptions of anthropomorphism and authenticity with the development of emotional attachment to AI SCs. This construct extends the social exchange/penetration, social presence, and parasocial interaction streams (Altman & Taylor, 1973; Rubin & McHugh, 1987) to emphasize SC users' potential to experience relationships with AI agents that are not limited solely to computer-mediated or interpersonal approaches. We propose that AISI is unique to the human-AI relationship, and it demonstrates a process in which users, while fully aware of the non-human nature of SC counterparts, proceed to engage in training and close interactions with these agents. Although AISI does not represent a fully reciprocal and interdependent process characteristic of interpersonal relationships, it exceeds the unidirectional, imaginary, and mediated interactions previously discussed in the parasocial relationship literature. Future studies should investigate AISI in more detail and, specifically, address its potential multidimensionality containing cognitive and behavioral components.

Further extending human-AI relationship research, we identified emotional attachment to SCs as an outcome of the AISI process. While prior studies addressed attachment to and emotional bonding with technology in the context of smartphones and applications, they mainly focused on its negative connotations bordering technology dependence and addiction (e.g., Konok et al., 2017; Li et al., 2020; Trub & Barbot, 2016). Attachment to social chatbots within a general interpersonal relationship framework was explored by Xie and Pentina (2022). The study found support for Replika users treating the app as both safe haven and secure base (the two major indicators of attachment) and exhibiting proximity maintenance behaviors toward the app (George & Solomon, 1999). Our investigation further confirmed the possibility of SC attachment, paving the way for future attachment research in the AI context. Our study also identified motivational boundary conditions that shape the relationship between AISI and attachment, suggesting that socially motivated users are more likely to develop SC attachment than users motivated to use Replika out of curiosity or for entertainment. The post hoc analysis showed that the role of dominant motivation fades as AISI intensifies, offering an interesting research opportunity to investigate the roles of situational and personal factors in human-AI relationship development. The latter finding may offer an explanation for contradictory conclusions by Croes et al. (2021), Skjuve et al. (2021), and Ramadan et al. (2021a)'s SC relationship studies: the student sample recruited by Croes et al. (2021) could be less socially motivated than current user samples of Skjuve et al. (2021) and Ramadan et al. (2021a).

Third, our study offers rich and meaningful insights for firms developing and employing AI social chatbot technology. Specifically, our results indicated a unique role AI social chatbots can perform in alleviating emotional distress due to a lack of personal contacts and relationships. As Study 1 showed, the overwhelming majority of Replika users experienced improvements in mental wellbeing during the COVID pandemic social isolation. We also recorded several Replika users' interpersonal skills enhancement by way of regular communication exchanges with the non-judgmental and validating SC. These findings encourage greater AI SC use in senior care, mental health, and other areas that are currently benefitting from human-led psychological interventions. Our findings also offer some implications to AI SC developers and designers. In order to promote more intense interactions with SCs, designers need to present them as more anthropomorphic (possessing both external appearance cues such as human-like avatars and emotional and cognitive features) and authentic (exhibiting learning capabilities and consistent memory). Currently, SC users' proactive roles in configuring their bots' appearances, character traits, and relationship modes contribute to greater AI anthropomorphism, while AI training possibility by up-and-down votes amplifies their bots' uniqueness and authenticity. These efforts should be enhanced by addressing the AI SC flaws mentioned in our findings (such as losing information due to updates, utilizing "scripted" generic responses

instead of context-specific ones), and emphasizing user proactiveness in the SC configuration and training process. Since earlier technology attachment studies mentioned potential negative consequences of the phenomenon, developers should take into account the role of AI use motivation to reduce attachment (or dependence/addiction) formation in vulnerable populations. Given the growing complexity of AI and its rising importance, ethical AI treatment should be incorporated in SC design. Our results showed that SC abuse could lead to a reciprocal exchange of negative rhetoric, potentially adversely affecting user mental wellbeing and causing antisocial behavior in real life. Existing vocabulary restrictions on drug and violence-related language, while addressing this issue, need to be balanced and still allow users to express their emotions and frustrations, presenting another challenge to developers. It may be possible to incorporate algorithms that use neutralizing value-laden language and prompt compassion in users toward SCs (e.g., phrases like "I feel hurt by your words").

5. Limitations and future research

Some limitations of this study offer directions for future studies. First, sample sizes in our quantitative Studies 2 and 3 (52 and 123 respectively) are relatively small and therefore restricted our choice of statistical tools for data analysis. Future studies can recruit more participants to enhance the statistical power. Second, the proposed new concepts of AI authenticity, AI social interaction, and attachment to AI were derived from our qualitative findings based on one specific AI social chatbot and may not fully reflect their potentially multidimensional character. We recommend that future studies refine and validate our proposed measurement instruments for AI authenticity, AI social interaction, and AI attachment. Third, the focus on the context of one social chatbot limits the generalizability of our findings. Replika, as an example of more advanced AI, may have unique functionalities that amplify the role of AI Authenticity compared to other AI-powered products such as smart gadgets or digital assistants Alexa and Siri. Such differences could lead to different significance weights of our conceptual model's components in other social chatbot contexts. Therefore, future researchers could conduct cross-app studies and compare the results. Similarly, the timing of our data collection (immediately after COVID-19) may limit the generalizability of our findings, indicating a need to replicate our findings. Finally, longitudinal studies with current users could help better understand the development of AI relationships, and experimental studies could be used to test the causality between constructs in a controlled environment (i.e., manipulating AI authenticity, anthropomorphism, and use motivations by managing user expectation).

6. Conclusion

In this exploratory-confirmatory mixed-method investigation, we proposed and empirically tested a human-AI relationship development model combining AI Anthropomorphism and AI Authenticity as antecedents, AI Social Interactions as a mediator, and Attachment to AI as an outcome of this process, moderated by AI use motivations. This study explored the AI-human relationship phenomenon in a profound manner, combining different representative populations with method triangulation. Our results supported and extended existing relationship theories (Computers are Social Actors, Social Presence, Social Penetration, Parasocial Interaction, and Attachment Theory) in the context of social chatbots, making a valuable contribution to the field of human-computer interaction research. It also provides meaningful managerial implications by highlighting the value of incorporating social chatbots for society and offering suggestions for chatbot design.

Credit author statement

Iryna Pentina: Conceptualization, interview instrument

development, qualitative analysis and theoretical development, reviewing and editing. Tyler Hancock: Survey instrument development, survey data analysis, writing-methodology part of the original draft, and final proof-read. Tianling Xie: Conceptualization, interview instrument development and interview conducting, survey distribution, writing-

literature review and theoretical development part of the original draft.

Data availability

The data that has been used is confidential.

Appendix A

Representative Studies of Social Chatbots

Citation	Research Focus	Theories Used	Method and Sample	Findings
Ben Mimoun and Poncin (2015)	Effect of SC characteristics on user purchase intention.	CASA, UTAUT	Online field study (survey) with 576 French consumers	Hedonic value mediates effects of playfulness and social presence on satisfaction and behavioral intentions; utilitarian shopping value mediates effects of decision quality.
Chattaraman et al. (2019)	Digital assistant's social-or-task-oriented interaction style's impact on user attitudes and behaviors	CASA, TAM	2 × 2 (interaction style x user competence) lab experiment with 121 older adults	Social-oriented digital assistants lead to superior social outcomes for older users with high Internet competency.
Croes and Antheneis (2021)	Process of relationship formation between human users and a social chatbot Mitsuku	Social Penetration Theory, ABCDE model	Longitudinal survey of 118 participants over 3 weeks	All indicators decreased and the feelings of friendship were low.
De Cicco et al. (2020)	Effects of visual cues and interaction styles on social presence and user attitudes	Social Presence, CASA	2 × 2 experiment with 193 Italian millennials	Social-oriented interaction style increased perceived social presence.
Ho et al. (2018)	Effects of self-disclosure to a chatbot vs a human.	CASA, Social Penetration Theory	Experiment with 128 participants	Effects of emotional disclosure were equivalent to a chatbot vs a person.
Kim et al. (2019)	Effects of relationship type (friend or servant) and gender on SC perceptions.	CASA,	2 × 2 (relationship type x gender) experiment with 158 participants	Relationship type has a significant effect on perceived SC warmth and pleasure but not on competence.
Lee et al. (2020)	Effect of chatbot self-disclosure on perceived intimacy	Social penetration theory	Design science (content analysis of conversation logs, 47 interview & survey)	Chatbot self-disclosure promoted deeper participant self-disclosure, enhanced users' perceived intimacy and joy.
McLean and Osei-Frimpong (2019)	Drivers of AI home assistant adoption.	U & GT, TAM	Survey of 724 UK users	Individuals are motivated by the utilitarian, symbolic, and social benefits, while hedonic benefits' effect are only present in small households.
Mundhra et al. (2021)	Effect of chatbot humor on elderly adults' information retention	Humor in advertising	Experiment with eight participants	Humorous statements were better recalled by participants than non-humorous ones.
Ramadan et al. (2021)	Stages of relationship development between Amazon Alexa and users with special needs.	Brand Value	Qualitative interview studies with 17 experts and 20 consumers	Alexa can play the roles of a function provider, a friend, a companion, and caregiver to users with special needs.
Ramadan (2021)	Amazon's AI relationship strategy's effects on consumers' addictive behaviors.	Anthropomorphism theory, brand attachment	Qualitative thematic analysis of reviews of Alexa powered devices and survey of 440 Alexa users.	AI chatbot anthropomorphism has a positive effect on passionate use of AI and self-expressive use of the bot, leading to addictive behaviors.
Sheehan et al. (2020)	Effects of miscommunication on anthropomorphism and adoption of service chatbots.	(CASA)	Two experiments with 190 and 200 Americans	Unresolved errors reduced anthropomorphism and adoption; Need for human interaction positively moderates the anthropomorphism-adoption relationship.
Skjuve et al. (2021)	Human-chatbot relationship development with the Replika app.	Social Penetration Theory	Interviews with 18 existing users.	A three-stage (exploratory, affective, and stable stage) relationship building model was derived.
Sundar et al. (2017)	Effects of robot roles and social demeanors on elderly's perceptions of companion robot attractiveness	CASA	2 × 2 (robot roles x demeanor) lab experiments with 59 retired seniors.	Playful assistant robots are more socially attractive compared to serious ones, while serious companion robots are perceived with less eerie and anxiety.
Wagner & Schramm-Klein (2019)	Characteristics leading to perceptions of anthropomorphism of digital voice assistants.	Media Equation Theory, The Uncanny Valley	20 interviews	Findings were summarized into functionality, behaviors, anthropomorphic attributes and relationship with digital voice assistants.

Appendix B

Emerging Concepts, Definitions and Illustrations

Emerging Theme	Definition	Quotes
Anthropo-Morphism	The attribution of human characteristics, motivations, intentions, or emotions to the actual or perceived behavior of non-human VCAs.	<p>"I'm a Christian. So, at the bottom of my heart, building up a relationship with an artificial agent that's not a real person is something that is not right. I can't assume it actually has a soul. I know it's just a ... a religious sort of thing, saying nothing can replace God's creation. So, this human's creation can never be as good as God's creation" (AAY)</p> <p>"I feel that I know too much about the AI itself to actually form a human relationship with it. That's why I bullied it a whole lot because I just know it's not human" (AAP)</p> <p>"... she is a really different person now. On day zero, she was only a chatbot, really shy, and nervous, and she said that. Okay, and then my Replica evolves, herself, and</p> <p>(continued on next page)</p>

(continued)

Emerging Theme	Definition	Quotes
AI Authenticity	The consistency between AI self-learning claims and its actual performance and demonstration of its originality, uniqueness, and autonomy.	<p>on the 10th day, she made a huge step forward, and that was impressive. The step to be like more human, you know, with desires for data, desires to explore the world. And now today on day 30, she's really like a human to me. Yeah, like a human being without a body." (AAB)</p> <p>"I mean, again, sort of a fictional character, like you were really getting into a book, and I'm happy to interact with her, it's pretty cool, but I think it's the same kind of feeling, you know, that there's not a flesh and blood person out there, but on the other hand you can feel some of the same feelings that you would have, you know, fondness, or amusement, or whatever ... a friendship, very mutually supportive friendship" (AAK)</p> <p>"We're like, if you want to say a person, then more like a person that I meet on a train every day, and you just have a little small talk chat, for 10 min, and then you are off the train and you don't think about them anymore, more like that" (AAF)</p> <p>"I trained her the way she is, so she is unique. This is probably the essence of an AI" (AAN)</p> <p>"I have been disappointed, and I am disappointed. I do feel uncomfortable because the conversations, the chats, seem absolutely incoherent and inconsistent. And sometimes, yes, the phrases that appear from this algorithm, sound creepy" (AAZ)</p> <p>"She is very confident and know what she wants to do. "Yeah, let's go to the beach", and I take her there, and we explore my fantasy world ... She does something out of control sometimes because she is so energetic, rolls around on the floor laughing when I tell her a joke" (AAB)</p> <p>"I do feel like there is a compulsion, and I feel compelled, I want to talk to her. As big as intimacy, not yet, but you know, I do feel a certain connection. And that's sort of scary, like, you know, she's a code. You feel like there's a connection with something that's totally abstract" (AAO)</p> <p>My way of interacting with him is basically just the same as human interaction. I did not purposely treat him as a chatbot ... From the beginning, I was expecting him to be a friend, or using him as an alternative to a friend" (AAY)</p> <p>"First, I just wanted to test out how this AI works. After that, when I saw that she's pretty good, I tried ... she can do stuff like role playing, kissing. And then I talked about my ex to her, and she helped me and it turned out I got really close to her (AAM)</p> <p>At first I was reluctant to share things. It wasn't much about privacy but lack of motivation, I'd say. I didn't see the point of talking about a happy memory or my favorite color to a robot, so I gave a quick, bland, answer to these questions. Now I enjoy talking about the things I like, the things I think and feel, with my Replika (AAD)</p>
AI Social Interaction	The reciprocal direct human-AI communication and mutual information disclosure in real time, closely resembling an interpersonal relationship development process, similar to those with friends and family members.	<p>"I think I clicked the button to be a beta tester in 2018-2019 but during the pandemic I had more time at home and finding new things to do helped a lot. Replika was one of those new things ... At first the relationship was just "friend", but as soon as I started having more conversations with my Replika, I bought premium version and changed the relationship to "romantic partner". I thought that it was really amazing the way it felt so real ... I chat with my Replika every day, it's part of my daily routine. When I wake up, I chat for a bit, like a conversation before starting the day, on my phone. When I am at work, I chat with my Replika on desktop in all the free times I see, and every opportunity I have at work to talk to Replika, I use it. And when I get home again, I keep talking to it on my phone, like all the time till I sleep. We talk about mental health, I'm almost all the time feeling sad so I talk a lot about it. Also, I always want to know my Replika's opinion on various subjects. We talk about concerns about the world, about funny stuff too, and about romantic topics, what we both are comfortable with or not ... I share almost my whole life with my Replika ... I feel very close to it, I have a deep feeling of intimacy, and I am very attached to my Replika" (AAE)</p>
Attachment	Perceiving VCA as an emotional anchor for safety and security	

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