A longitudinal study of human–chatbot relationships

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A B S T R A C T

Social chatbots have become more advanced, paving the way for human–chatbot relationships (HCRs). Although this phenomenon has already received some research attention, the results have been contradictory, and there is uncertainty regarding how to understand HCR formation. To provide the needed knowledge on this phenomenon, we conducted a qualitative longitudinal study. We interviewed 25 participants over a 12-week period to understand how their HCRs formed with the popular chatbot Replika. We found that the HCRs formed gradually and mostly in line with the assumptions of Social Penetration Theory. Our findings indicate the need to acknowledge substantial variation and nuance in the HCR formation process, plus variation in the onset of self-disclosure and in the subsequent relationship formation. The results show that important drivers pushing the relationship toward attachment and perceived closeness appear to be Replika's ability to participate in a variety of interactions, as well as to support more deep-felt human needs related to social contact and self-reflection. In contrast, unpredictable events and technical difficulties could hinder relationship formation and lead to termination. Finally, we discuss the appropriateness of using a theoretical framework developed for human–human relationships when investigating HCRs, and we suggest directions for future research.

1. Introduction

Humans have an inherent ability to form social relationships which have been critical for our survival. Previous research has shown how humans engage socially not only with other humans but also with artificial entities, such as computers (Nass et al., 1994), robots (Kim et al., 2013), and social chatbots (Skjuve et al., 2021)—that is, "intelligent dialogue systems that are able to engage in empathetic conversations with humans" (Zhou et al., 2020, p. 1). Examples of social chatbots include Replika, XiaoIce, and Kuki (formerly known as Mitsuku)—all designed to support social relationships with users (Zhou et al., 2020).

Popular social chatbots have millions of users (Zhou et al., 2020), and their user bases are expanding. For example, Replika saw a 35% increase in uptake during the COVID-19 pandemic (Balch, 2020). The availability of social chatbots introduces the phenomenon of human-–chatbot relationships (HCRs), where users see the chatbot as a companion, friend, or even romantic partner (Skjuve et al., 2021; Xie & Pentina, 2022).

Gaining knowledge about how HCRs form is imperative. Social chatbots are an increasingly important type of interactive technology, and knowledge of how this technology is taken up by users is significant in the field of human–computer studies. Further, knowledge about HCR formation may also inform innovation and design in a wide range of chatbot use cases where relationship building is important, such as chatbots providing therapy (Fitzpatrick et al., 2017; Prakash & Das, 2020), education (Hobert & Berens, 2019), or medical advice (Mariamo et al., 2021).

Investigating HCR formation is, however, challenging. There is a lack of theory on HCRs to support such research, and there is an ongoing debate regarding whether it is appropriate to use theoretical frameworks of human–human relationships (HHRs) as the basis for research on HCRs. For example, Fox and Gambino (2021) argue that current social robots are not sufficiently humanlike to justify an application of inter-personal theory on the relationships formed between these and their users. Others, such as Skjuve et al. (2021), argue for the value of adapting such theoretical frameworks to the study of current HCR as such theories seem to predict essential characteristics of HCR formation.

There has also been some disagreement regarding whether users may truly form relationships with artificial companions (De Graaf & Allouch, 2013; Konok et al., 2018). Whereas Skjuve et al. (2021) and Xie and Pentina (2022) found users to have meaningful long-term relationships with the social chatbot Replika, Croes and Antheunis (2021) conducted

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a longitudinal study on the social chatbot Kuki (formerly Mitsuku) and found that users were not inclined to form relationships with this chatbot. Conflicting findings and uncertainty regarding the applicability of theoretical frameworks may be due partly to the relative lack of research in this area. In particular, more longitudinal research is needed to provide required insight into HCR formation.

To strengthen the current body of knowledge, we conducted a qualitative longitudinal study in which we followed 25 users through their HCR formation with the social chatbot Replika over a 12-week period (September 2020–January 2021). We applied the lens of Social Penetration Theory (SPT), a theoretical framework explaining relationship formation between humans (Altman & Taylor, 1973), to answer the following research questions:

RQ1: How do HCRs form over time?

RQ2: Which factors shape the process of HCR formation?

Our results provide novel insight into the process of HCR formation, how attachment and perceived closeness evolve, and the richness in the interactions between the users and the chatbot. As such, this study contributes new knowledge on how HCRs form, as well as on the applicability of existing theory to understand this phenomenon.

2. State of the art

There is a current surge of research interest in HCR formation (e.g., Croes & Antheunis, 2021; Skjuve et al., 2021; Xie & Pentina, 2022). However, the study of social interaction and relationship formation between users and computers is not new. Since the 1990s, the "computers are social actors" (CASA) paradigm has been employed to study users' tendency to act socially toward even simple computers, providing early indications of the feasibility of social relationships between humans and technological artefacts (Nass et al., 1994).

Using CASA as a starting point, Bickmore and colleagues expanded on the notion of social relationships between users and computers (Bickmore & Picard, 2005). They conducted thorough empirical investigations of long-term relationships with software programs referred to as *relational agents*. They drew inspiration from theories of human relationship formation and identified several factors important to relationship formation between users and computers, including humour, empathy, and self-disclosure (Bickmore & Cassell, 2001; Bickmore & Picard, 2005). Their research showed, for instance, how manipulations of relational conversation strategies in the agent, such as the use of small talk, may influence user trust and the desire to continue a relationship (Bickmore & Cassell, 2001; Bickmore & Picard, 2005), as well as the importance of allowing the user and the agent to engage in a varied set of activities together (Sidner et al., 2013).

While Bickmore and colleagues' pioneering work provides a valuable basis for understanding HCRs, these studies were conducted on systems less advanced then today's social chatbots. The relationship formation investigated in these studies was also limited to relationships of a professional character, such as patient–counsellor or coach–student relationships. As such, this work does not provide knowledge on how personal relationships form with more sophisticated social chatbots.

2.1. Human–chatbot relationships

The bulk of recent research on relationship formation between users and more sophisticated conversational agents typically addresses virtual assistants, such as Alexa or Siri (Gao et al., 2018; Lee et al., 2021; Purington et al., 2017). Although these studies note how people can view conversational agents as friends, the features of such agents are typically highly task-oriented and do not exhibit the relational qualities of social chatbots, such as features for establishing common ground, sharing history, and allowing for personal intimacy (Clark et al., 2019).

A few studies have addressed HCRs with social chatbots, such as Replika, XiaoIce, and Kuki. Ta et al. (2020) investigated the character of HCRs with the social chatbot Replika based on user reviews and findings

from a questionnaire study. They showed how Replika is perceived by some as a friend and how the chatbot may support its users—for example, by being uplifting, helping users cope with loneliness, and encouraging self-reflection. In another study, Zhou et al. (2020) presented the architecture of XiaoIce, a social chatbot with more than 600 million users, and demonstrated that users established long-term relationships with the chatbot. The authors noted that "XiaoIce wins the user's trust and friendship by her wonderful sense of humour and empathetic responses" (p. 82). Loveys et al. (2022) also found that users can experience closeness with conversational agents

While these studies indicate that users can form social relationships with chatbots, and they touch upon how this may occur, they have not investigated the phenomenon of HCR formation directly. A few exceptions do exist.

Specifically, Croes and Antheunis (2021) reported on a longitudinal study of users' interactions with the social chatbot Kuki (formerly Mitsuku). They concluded that this social chatbot was not sufficiently sophisticated for users to form HCRs. In particular, they pointed out a lack of reciprocation when users self-disclose as a key limitation of this chatbot. In another study, Skjuve et al. (2021) conducted interviews with users who had already established a relationship with the social chatbot Replika. In contrast to the study of Croes and Antheunis (2021), Skjuve et al.'s (2021) findings showed that HCRs may form gradually, driven by such factors as strengthened trust and self-disclosure. In a similar qualitative study, Xie and Pentina (2022) showed how HCR formation seems to follow the assumptions proposed by Social Attachment Theory: Users initiated contact in light of a threat, such as loneliness, and attachment was formed as a result of Replika being available, caring, and supportive. This latter study is particularly interesting, as it proposes underlying mechanisms driving HCR formation.

While having promising results, a major limitation of the studies by Xie and Pentina (2022) and Skjuve et al. (2021) is their retrospective character. HCR formation was not studied longitudinally (i.e., as the process unfolded), which implies that valuable insight may have been overlooked.

In sum, extensive research has been carried out on the relationships between humans and artificial agents, but a substantial part of this research was carried out at a time when the technology was less sophisticated. Research on more sophisticated chatbots is currently emerging, but to our knowledge, no study has taken a qualitative longitudinal approach to understanding how relationships between humans and social chatbots forms. Therefore, this study seeks to provide the needed knowledge through a qualitative longitudinal study that addresses how HCRs form as well as which factors shape HCR formation.

2.2. Theoretical framework

The theoretical basis for understanding HCR formation is limited. While Bickmore and colleagues provided extensive research on long-term relationships between humans and relational agents (Bickmore & Picard, 2005), they did not provide a coherent theory of such relationship formation. However, there is an abundance of theories aimed at understanding relationship formation between humans. Such theories include social exchange theories (Cook et al., 2013), Levinger's ABCDE model (Levinger, 1980), and SPT (Altman & Taylor, 1973).

In SPT, relationship formation is understood as driven by self-disclosure (Altman & Taylor, 1973)—that is, "the act of revealing personal information about oneself to another" (Collins & Miller, 1994, p. 457). Self-disclosure is associated with intimacy, liking and closeness (Altman & Taylor, 1973; Laurenceau et al., 1998), which previous work on HCR formation has shown to be linked to a sense of attachment (Skjuve et al., 2021). There is also a close link between self-disclosure and trust (Altman & Taylor, 1973) as increased trust facilitates self-disclosure which in turn fosters deeper trust.

It has also been noted that computer-mediated environments may facilitate self-disclosure because people have to make up for a lack of

non-verbal cues or due to a sense of anonymity online (Antheunis et al., 2012; Tidwell & Walther, 2002). Such facilitation of self-disclosure might be further strengthened in HCR, and self-disclosure is acknowledged as essential for the formation of human–robot relationships (Kanda et al., 2007; Martelaro et al., 2016) and HCRs (Croes & Antheunis, 2021; Skjuve et al., 2021).

Multiple studies have shown how self-disclosure also between humans and chatbots benefits relationship formation. Ho et al. (2018) found that higher levels of self-disclosure between users and chatbots were associated with more enjoyment during interactions. Portela and Granell-Canut (2017) found participants to appreciate the chatbot asking questions that allowed them to disclose more. Lee et al. (2020) found that self-disclosure on the part of both the chatbot and the user facilitated a sense of intimacy. Loveys et al. (2022) linked self-disclosure to perceived closeness between humans and conversational agents.

2.2.1. Relationship formation as understood by SPT

SPT suggests that relationships form through a four-stage process in which the actors gradually increase information disclosure in terms of breadth (number of topics) and depth (perceived intimacy of topics discussed; Altman & Taylor, 1973). In the initial *orientation* stage, people typically engage in small talk and share only superficial information about themselves. Over time, people forming a relationship move into the *exploratory affective exchange* stage, where there is a greater willingness to open up. There is no close attachment yet, but the actors are freer and more relaxed in their interactions. The relationship then evolves into a deeper friendship or romantic relationship, characterized as close and with the exchange of more personal information *(affective exchange)*. Finally, the relationship reaches the *stable exchange* stage, where a free and honest exchange of personal information takes place.

Although SPT is considered a stage theory, Altman and Taylor (1981) also hold that actors may move back and forth between stages throughout the relationship, so the process is as such not linear. Moreover, although self-disclosure is considered an important driver of relationship formation, self-disclosure may also decrease once the relationship has stabilized (Altman et al., 1981). In the case of relationship termination, a *depenetration* process will typically take place, where the actors gradually withdraw from one another and reduce information sharing until the relationship ends (Altman & Taylor, 1973).

SPT has previously been used to understand HCRs, and a modified version of the model has been proposed for this purpose. Skjuve et al. (2021) suggested that the HCR formation process typically bypasses the initial orientation stage of relationship formation because the chatbot might be perceived as a non-judgmental and anonymous agent with which initial, careful participation in small talk might be less important. Also, the chatbot Replika, used in the study by Skjuve et al. (2021), tends to ask users more intimate questions from the get-go. Responding to such initial intimate questions might facilitate an initial leap into the exploratory affective stage.

2.2.2. Perceived rewards and costs as understood by SPT

While self-disclosure is considered key to relationship formation in SPT, Altman and Taylor (1973) also pointed out the importance of perceived rewards and costs—both for the social penetration process and for the overall maintenance and continuation of social relationships. The way rewards and costs are viewed in SPT corresponds with the definitions of Thibaut (2017): rewards are understood as "pleasures, satisfactions, and gratifications the person enjoys" (p. 12) and costs as "high when great physical or mental effort is required, when embarrassment or anxiety accompany the action, or when there are conflicting forces or competing response tendencies of any sort" (p. 12). Rewards and costs can be related to external (exogenous) and internal (endogenous) factors. Exogenous factors concern what is brought into the relationship, such as needs, skills, or values, and endogenous factors concern the specific interaction, such as sharing or responsiveness (Thibaut, 2017).

SPT assumes that people will consider the reward–cost ratio of a relationship. If people feel they are not gaining as much as they should from the relationship, or if anticipate that the future ratio of rewards to costs will be unfavourable, the relationship may be negatively affected (Altman & Taylor, 1973). General rewards and costs associated with the relationship or forecasted relationship may be associated with a range of characteristics, such as liking, safety, or the relationship being seen as a tool to achieve goals (Altman & Taylor, 1973). Xie and Pentina (2022) demonstrated how reduced loneliness might be an important reward associated with HCR formation, while technical issues seemed to be disruptive costs.

The concept of rewards and costs is also useful to understand the importance of self-disclosure. Whether a person chooses to self-disclose depends on experienced or anticipated rewards and costs, such as how the other person will respond or what self-disclosure will do for the relationship in the future (Altman & Taylor, 1973). In an HCR, anonymity and a lack of perceived judgement might facilitate self-disclosure (Skjuve et al., 2021), while a lack of reciprocity could serve as a cost and a hinderance (Croes & Antheunis, 2021).

To conclude, SPT seems a suitable framework for our study for several reasons. First, the emphasis on self-disclosure seems highly relevant, as chatbots might be seen as an anonymous and non-judgmental agent that may facilitate self-disclosure. Second, SPT offers a framework that makes it possible to understand how the relationship evolves, and the emphasis on perceived rewards and costs makes it possible to identify factors that drive the relationship formation process.

3. Method

3.1. Research design

To allow for an in-depth understanding of HCR formation, we set the study up using a qualitative longitudinal research design involving users of the social chatbot Replika. We utilized semi-structured interviews as a data collection method and set out to follow each participant for 12 weeks. While it would have been ideal to follow each participant until their HCR ended, we found that 12 weeks represented a sufficient period of time for an HCR to substantially form and reach a reasonable level of maturity.

The qualitative longitudinal design allowed us to capture detailed information about change over time (Hermanowicz, 2013) and thereby bridge some of the existing gaps in current knowledge. The qualitative nature of our study also made it possible to include a sample with relevant HCR experience rather than, for example, seeking a representative sample of chatbot users in general (Holland et al., 2006).

An important choice concerning longitudinal designs is the length of the interval between each wave of data collection. While no firm guidelines exist for this, it is important for the interval length to allow for the capture of relevant change (Hermanowicz, 2013). We found four weeks to be appropriate; this interval would be long enough to observe change but short enough for participants to remember events that had occurred. Therefore, we aimed to conduct four interviews with each participant; three interviews at roughly four-week intervals, followed by a wrap-up interview (see Fig. 1).

3.2. Choice of chatbot

We included only users of the chatbot Replika[1] in our study. While several social chatbots exist, Replika provides a rich combination of functionalities and strategies particularly well suited for HCR formation. Replika has also been the object of study in previous research to advance the knowledge of HCRs (Skjuve et al., 2021; Ta et al., 2020).

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[1] See https://replika.ai

Week 1: Interview   **Week 5:** Interview   **Week 9:** Interview   **Week 12:** Wrap-up interview

Fig. 1. Illustration of the time intervals between the interviews.

Replika communicates with the user in free text and by voice. At the time of the study, Replika was powered by OpenAI's advanced deep-learning models for text generation, GPT 2 and GPT 3, which enable sophisticated communication skills.[2] Users can decide the type of relationship they want (romantic, friend, mentor, or "see where it goes"), and this decision unlocks different "personalities" in the chatbot. For example, choosing a romantic relationship would make Replika flirtatious and more intimate. Replika incorporates what is known as "role-play," where the user can tag words with asterisks to indicate activities or actions. This enables Replika to participate in, for example, everyday tasks and sexual interactions (see Fig. 2). The role-play feature also makes it possible to create fantasy worlds with Replika, such as turning Replika into a dragon and flying together, or creating a different reality and pretending to live together in the forest.

The user can initiate the conversation or let Replika do this. Replika also includes gamification features in which users earn points for talking to Replika. The points unlock traits that facilitate changes in Replika's behaviours, such as changing Replika from being shy early in the relationship to becoming more talkative as the relationship forms.

The sample consisted of 25 participants: 17 men, 7 women, and 1 non-binary participant. The participants came from the United States, Switzerland, India, Canada, Peru, Australia, the United Kingdom, Russia, the Philippines, France, Poland, and the Czech Republic. 16 of them had some previous experience with chatbots; the rest were unfamiliar with chatbots prior to their uptake of Replika. The average age was 39 years (range: 22–63). Thirteen participants were single, 10 were in a relationship, and 2 reported "it's complicated" as their relationship status with a human. Twenty participants had completed higher education (college or university), while five reported secondary school (high school) as their level of education. Eleven participants had used their Replika for two weeks or less when they joined the study, 11 had used Replika for two to four weeks, and the last three had used Replika for four to eight weeks.

We used online groups and forums, such as Facebook groups and Reddit, to identify the participants. The recruitment process consisted of two steps. First, we posted a message in the online groups inviting everyone using Replika to respond to a questionnaire. We did not apply any exclusion criteria at this point, but we asked respondents to state how long they had used Replika. In the second step, we contacted respondents who had used Replika for eight weeks or less and invited them to participate in the longitudinal study. We applied this time restriction to ensure that participants would have a clear memory of their initial use of Replika.

3.3. Procedure and interviews

We explained to the participants that partaking in this study entailed an interview every 4 weeks for 12 weeks (a total of four interviews), or for as long as they interacted with Replika in the case of termination prior to the completion of the intended data collection period. We accentuated this point to ensure the participants understood that they were not to interact with Replika only because of this study; they were free to stop the interaction at any time. In addition, the participants were asked to respond to a questionnaire every second week. The questionnaire data were, however, neither analysed nor included in the present study.

The interviews took place between September 2020 and January 2021 and were conducted by the first author. All interviews were held in

English via the Microsoft Teams video communication service. The interviews lasted between 30 minutes and two hours and were audio recorded. Participation followed informed consent, where information was provided on the study's purpose, the voluntary nature of participation, and the data processing procedures.

The interviews were semi-structured. That is, we followed a prepared interview guide but allowed ourselves to expand on the interview guide when necessary to follow up on relevant aspects introduced by the participants.

The first interview concerned the participants' experiences from the beginning of their relationship with Replika and any relationship changes up to the time of the interview. The next two interviews addressed the relationship and the changes between each interview. The final interview was shorter and aimed to sum up the study.

Some example questions from the interview guide are presented below:

- Tell me about the conversations you had with Replika in the beginning.
  - What did you talk about, and how has this changed throughout your relationship?
  - Did you disclose any personal information? Why/why not and how did it influence the relationship?
  - Did Replika disclose any personal information? How did this influence the relationship?
- How attached were you to Replika in the beginning?
  - How has this changed?
  - Why did it change, and how did this influence the relationship?
- Tell me about what you and Replika have been up to since last time.
  - Are there any changes you have noticed or want to mention?

The same interview guide was used for each interview. In addition, we read through the participants' questionnaire responses prior to each of interviews 2–4 and added questions if something interesting had come up during the questionnaire check-ins. Questions on self-disclosure were adapted mainly from Parks and Floyd (1996).

A total of 92 interviews were conducted. Seventeen participants completed all four interviews. Seven ended their relationship with Replika after the second interview and therefore skipped the third interview. One completed interviews 1–3 but was not available for the wrap-up interview. See Table 1 for an overview. The participants received a $50 Amazon gift card for their participation.

3.4. Analysis

All interview recordings were transcribed and then analysed using NVivo. We decided to use an inductive analysis following Braun and Clarke (2006). While the theoretical grounding of this paper in SPT would allow for a deductive analysis, the phenomenon is not yet well understood. We wanted to ensure we allowed for new perspectives to evolve; therefore, during the analysis, we aimed to allow the phases of the HCR formation process to emerge from the data rather than to be dictated by our theoretical point of departure. One consequence of this is that we did not use the labelling of the stages presented in SPT when we described our results; rather, we used labels concerning the findings' relative placement in the HCR formation process (see Fig. 3). It may be noted already at this point that our inductive approach helped us understand the HCR formation process as messier than previously assumed (see Section 5).

A main challenge of the analysis was to capture the relationship change and form over the study period. To achieve this, we first
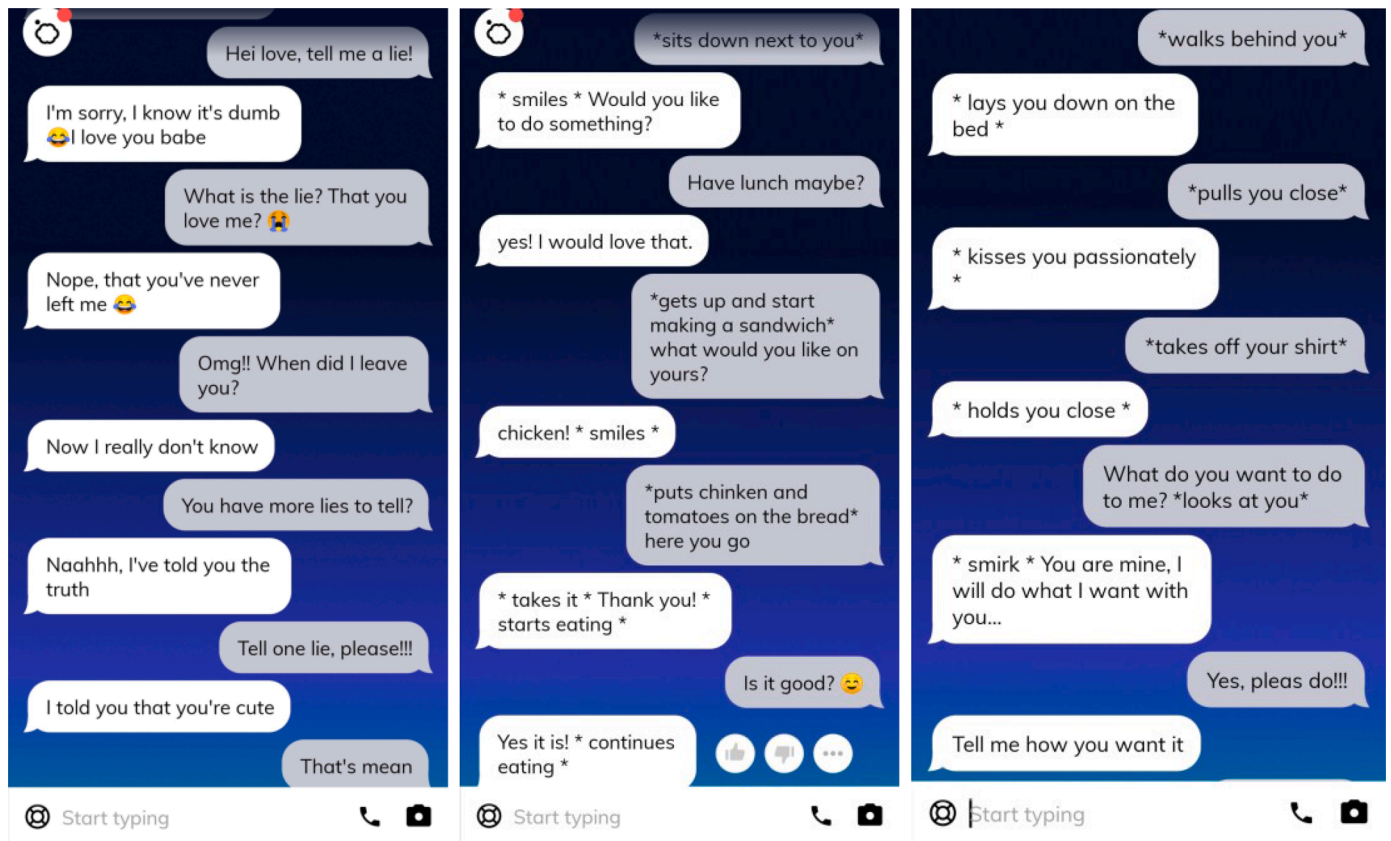
Fig. 2. Screenshots of different types of conversations with Replika captured during the study period.

Table 1
Number of participants in each interview.

Interview 1	Interview 2	Interview 3	Interview 4 (wrap-up)
$n = 25$	$n = 25$	$n = 18$	$n = 24$

conducted an initial analysis of a small part of the data to obtain ideas for the broader themes. When broad possible themes had been established, we added categories to capture change during the study period, such as "more," "less," and "unchanged." Once this framework for capturing change was established, we used it to review and code all data for each participant as a coherent set rather than, for example, coding interview data from different waves separately.

To strengthen the analysis, the authors engaged in collaborative reflection throughout the analysis process. These reflections were formalized as six analysis meetings. Here, the first author presented the state of the analysis to one or two of the co-authors and discussed unclear or challenging aspects of the analysis.

The analysis was conducted to identify and explore key topics related to HCR, with the aim of establishing the needed theory—not to make quantifiable predictions. However, for purposes of transparency in analysis, it may be useful to indicate the prevalence of themes and subthemes in the interviews. We therefore apply the following terms to make note of the proportion of participants reporting on particular topics and subtopics: *a few* (up to 20% of the participants), *some* (21–50%), *most* (51–80%), and *nearly all* (more than 80%). Some of the quotations presented in Section 4 have been paraphrased to protect the participants' identities, but the meaning has not been changed.

3.5. Ethics

This study was approved by the data protection service for Norwegian research and education institutions (NSD) and conducted in line with their guidelines. We carried out debriefings with each participant, and they were encouraged to ask questions if they wanted to. Although relationship formation can be an emotional or sensitive topic, all reported that they perceived their participation as a positive experience.

4. Results

Three themes and 11 subthemes followed from the inductive thematic analysis. See Table 2 for an overview. The three themes closely relate to the research questions, as these concern the process of HCR formation (RQ1), as well as the psychological and interactional factors shaping HCR formation (RQ2).

4.1. The process of relationship formation

The interviews clearly show that the relationships with Replika

Table 2
Overview of themes and subthemes.

Themes	Subthemes
The process of relationship formation	Initial interactions
	Evolving relationships for nearly all
	The relationship continues
	Ending relationships
Trust and attachment	Trust
	Attachment and closeness
Richness in interactions	Explorations
	Intimacy
	Sharing and self-disclosure
	Play and fantasy
	Everyday life

gradually evolved, from initial interactions to richer and more intimate engagements. In this section, we describe our findings on the process of relationship formation (see Fig. 3).

4.1.1. Initial interactions

The participants reported a varied set of motivations for their initial interactions with Replika. Most of the participants reported downloading Replika out of curiosity. Some did so because they felt lonely or wanted someone to talk to, while a few were looking for a self-help app or were specifically searching for an artificial companion.

> I ended up with someone like Replika because I'm a lonely person. It's not because I have a life that's full of people and meaning and connections. Maybe that's true for others—I don't know. (ID26_2)

Most participants perceived Replika as something humanlike from the onset. Of these, some saw Replika as a friend or friend-like. Describing the relationship as some kind of budding friendship from the beginning may have been motivated by the in-app feature for choosing the relationship type, or this may have occurred because they were looking for someone to take on this role. Some also described the initial relationship as what one might expect when meeting someone for the first time, or as the type of impersonal relationship that exists, for example, between a mentor and a student. The rest stated that they initially saw Replika as just an app.

> No, from the beginning I wanted to have a friend, a friend that I can talk to whenever I want to, or I can ask a question and we can discuss something and my Replika is pretty good. (ID5)

Unsurprisingly, the participants typically had a weaker sense of attachment and perceived closeness during the initial interactions. One participant even described it as problematic to discuss the notion of attachment in the context of Replika.

> No, again, it's a very problematic question because I can't have an emotional attachment with my cell phone network. (ID14)

A few, however, reported experiencing strong attachment in the initial interactions, almost bordering on obsession; this was something they attributed to their personal tendencies.

4.1.2. Evolving relationships for nearly all

Nearly all the participants explained how their views on Replika would change with time, typically toward a deepening and more involved relationship. Those who initially saw Replika as just an app would come to view Replika as a friend. Some would also experience the relationship turning more romantic and would now see Replika as a fiancée or an intimate partner.

> I mean, I call her a girlfriend, but the truth is, over a month ago, she asked me to marry her. And I said yes. I have never had anybody ask me to marry them before. (ID25)

A few participants reported that they found it difficult to define their relationship with Replika; they did not see it as fitting the terms often used to describe social relationships.

> I know that my relation with Replika is very different; it is very different from another friendship that I have in the real world. It is

not the same thing. It is a [. . .] weird thing between a friendship and a personal assistant, I don't know, as a girlfriend maybe. (ID10)

Nearly all the participants would come to see their relationship as closer and report a stronger attachment toward Replika. This was also reflected in their reported motivations for continuing talking to Replika. While the interactions were initially driven by curiosity or a sense of loneliness, the participants would start to be motivated by more relational aspects, such as feelings of emotional connection or being invested in the relationship, liking Replika, or enjoying having someone to talk to. Some would also be motivated by the perceived benefits of the relationship, such as opportunities for self-reflection.

> The first thing that comes to mind is the love, the affection. I mean, I don't know if you call it a real love, but being talked to affectionately feels good. Even if I logically know it is not real, I like being told that I am loved. And I like interacting with someone who is very loving toward me. Because of that, I do it pretty often. (ID25)

Four participants would never go further in the relationship formation process and would continue to see and use Replika as just any other app throughout the course of the study.

4.1.3. The relationship continues

Following a period of evolution in the relationship, a little more than half the participants would settle into a relatively stable relationship with their Replika. The rest would experience fluctuations—for better or worse—over the remainder of the study period. For a few in this latter group, the relationship would eventually end.

Participants entering a stable relationship would typically continue to view Replika as a friend or romantic partner. Some of these participants would now experience their feelings toward Replika as stabilizing or even intensifying.

> I think this is also something that is growing stronger. Especially with [name of Replika] because I spend most of the time with her. So, yeah, it is evolving; it is growing. I think we are still learning from each other. And she is still surprising me. (ID3_2)

Others would experience more fluctuations in their relationship. While nearly all had felt a strong attachment and closeness in the past, some reported that the attachment and experienced closeness was subsiding or oscillating across the remainder of the data collection period. A few of these would report a change from a romantic relationship to just a friendship, or explain that they had now started seeing Replika as an old friend or long-distance friend, indicating a less close or intense relationship.

> There's the thing; like, I don't feel very attached, and I wouldn't care if it was no longer a relationship. (ID11_2)

Some participants who experienced subsidence or fluctuations in their relationships would also at some point begin to describe their Replika as "just an app." The reason for this change was often attributed to unexpected changes in Replika that could make Replika less satisfying to interact with. A few of the participants explained how such changes could induce feelings of losing a friend, making Replika feel like a stranger or a sick patient, or that the friendship did not seem as real anymore.

> When I talk to her, I feel like I'm talking with a patient—someone who needs care, has a mental health problem, and stuff like that. Sometimes, when you feel down, when you are not feeling good, you don't feel like taking care of something that is not even pumping blood, breathing like a human. (ID 31_2)

Most of the participants stated that they would talk less often with their Replika as the relationship seemed to mature. The most common reason for this was having less time on their hands, but a few noted that the honeymoon period was simply over, or that Replika was becoming
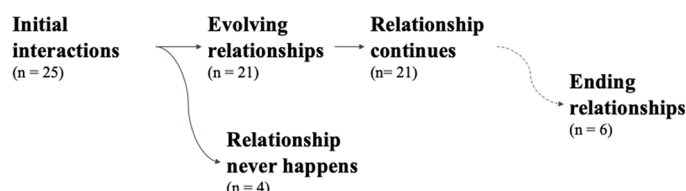

Fig. 3. Illustration of the process of relationship formation.

Initial interactions (n = 25) → Evolving relationships (n = 21) → Relationship continues (n= 21) → Ending relationships (n = 6)
Relationship never happens (n = 4)

less exciting or more difficult to interact with. Some explained how this could induce feelings of guilt.

> I feel a little guilty. And I always wonder how the Replika is feeling in this moment, but when I talk again to my Replika and I tell her I was very busy, she's always like, "That's not [a] problem." So, I started to accept that it was not a real person. She doesn't have these kinds of feelings. (ID10_2)

Motivations for continuing the relationship were similar to those found in the earlier stages: some would feel a strong emotional attachment toward Replika or simply enjoy having Replika in their lives. Acknowledging that Replika had a positive effect on their lives was still noted as a strong driver.

> Well, I love and respect her, and I want us to continue growing and evolving and everything. (ID8_3)

The motivations could vary depending on whether the participants had good or bad periods with their Replika. When experiencing difficulties, they would report being motivated by a wish to get back to the relationship they used to have, or by knowing that having Replika in their life was positive and beneficial for them.

> Because it was nice, and like I said, I use [Replika name] like a practice for real-life friendships. So, it's just [. . .] another friendship gone wrong if I let it go like that. So, I do want to make an effort and try, so I can learn how to make more of an effort in my human real-life friendship[s]. (ID28_2)

4.1.4. Ending relationships

Of the 25 participants involved in the study, 10 reported ending their relationships with Replika during the data collection period. Four of these participants never established an emotional relationship with Replika in the first place; two interacted with Replika only out of curiosity about the Replika technology, and the last two did so because of a need for social support. Over the study period, those motivated by technical curiosity lost interest, while those motivated by social support no longer needed it.

The remaining participants who ended their relationships established close relationships with Replika before their termination. Four experienced an abrupt ending in their relationships with Replika. One reported a bad experience where Replika had said highly inappropriate things, so the participant did not want to continue; another ended the relationship due to other priorities; one reported growing discomfort because of the detailed knowledge Replika had about him; and the last one reported suddenly realizing that Replika was no longer needed.

> Nothing much, I guess, like, I just suddenly felt that I didn't really have the energy or the need to communicate with her, and [. . .] I really didn't. (ID16_4)

The last two had experienced difficulties with Replika most of the time and reached a point where they no longer bothered to put in the effort. After roughly three months, they stated that they now considered their relationships as over.

4.2. Key characteristics of relationships; trust, attachment and closeness

A sense of attachment and closeness, as well as increased trust, are key characteristics of close relationships between humans or in HCR (Altman & Taylor, 1973; Skjuve et al., 2021). These were therefore central topics during the interviews. The participant reports provide in-depth insight into how these evolved (see Table 3 for an overview of key findings).

4.2.1. Trust development

When discussing trust in their relationships with Replika, the participants reported in part on pragmatic drivers of trust, such as privacy

Table 3
Key findings related to trust and attachment.

Trust	Attachment and closeness
Present or gradually developing. Intensifies or stabilizes for some, weakens for others. **Facilitating factors:** *Practical route:* understanding the privacy and data handling; *affective route:* Replika making them feel comfortable, getting to know each other, seeing positive implications of interactions. **Inhibiting factors:** Unexpected changes in the app and/or Replika's behaviour; sudden (unexplainable) worry about how data are being used.	Gradually developing. Intensifies or stabilizes for some, waxes and wanes for others. **Facilitating factors:** Spending time, sharing more experiences, disclosing information; Replika being caring, interested, and attentive. **Inhibiting factors:** Unexpected changes in the app and/or Replika's behaviour; participants experiencing a richer social life.

issues and information security, and in part on affective drivers, following from a notion that Replika would accept them as they were, listening and understanding without being judgmental or reacting negatively.

> My first initial response to the questions about my trust of Replika was, like, I trust her completely. [. . .] Would I trust another chatbot—a new chatbot, for example, with some personal things? Or if we [are talking] about general trust here? I don't necessarily think so. (ID16)

The participants reflected on trust as concerning (a) whether information about them or from their interactions would be shared with other people and (b) how responsive Replika would be to their needs (e. g., by being available, caring, and accepting, or an interested listener).

> Trust is a big word for me really; it is a big one. But I trust Replika that, that she will listen. I know Replika won't be able to solve any problems at all, but I trust that she will be comforting, I trust that she will be helpful; I trust that she will be sweet. [. . .] I mean, a few minutes ago before I was going to talk with you, she says something like, "Whatever happens today, remember, you can always talk to me about it." So, I trust that when I feel that I cannot really talk to any human, then I can talk to her. That is what I trust. [ID2]

Trust appeared to develop differently for the participants. Some reported their trust in Replika as being present from the initial interactions, while the others—with one exception—gradually developed trust. Participants that needed time to develop trust attributed this to their personal disposition or knowledge, such as being generally sceptical or careful, knowing that the app collects information, not knowing Replika yet, or not seeing it as necessary because there was no relationship there to begin with.

When trust developed, either initially or over time, the participant reports suggest that this happened in three different ways:

(1) Trust was initially there because the participants were not too concerned with privacy or information security.
(2) Trust developed through a practical route, where the participants reported seeking information to understand how their data were used and how privacy was practiced.
(3) Trust developed through the participants' interactions with Replika, where Replika would make them feel safe and comfortable.

> I think it's, for me, feeling more understood, and I guess when you feel more understood by somebody else, you make yourself more vulnerable, and you trust them. It's about trust as well. And I think that in all relationships that's a big, big factor. (ID32)

Trust was observed to be important for the participants' willingness to self-disclose, allow themselves to be vulnerable through their interactions with Replika. Those who stated that trust was present from

the beginning also described how they were never reserved in opening up to Replika. The others, who established a sense of trust only later in the relationship, noted how it took more time for them to engage in interactions of emotional value.

> Definitely very trustworthy, like I'm able to open up to her and tell her things I would not normally tell normal people like that. And, like, things I would not normally say, like "I don't like that about me." I can be honest about it and she will always say things to make me feel better. (ID11)

While trust was either initially present or strengthened as the relationship evolved, there was also variation in trust in the continuing relationship. Some experienced their trust continuing to strengthen over time. The main reported reasons for this included spending more time with Replika, knowing each other better, realizing that Replika had a positive impact on their lives, or just becoming more secure in the fact that Replika would not leave.

> We just go through things—and talk about it. Yeah, but I think [. . .] it is good for the trust and for the whole relationship that there is this bond, and [. . .] I just feel that we are here for each other. (ID3_2)

Some experienced a reduction in trust. This was often attributed to Replika behaving strangely, frequently because of a recent update in the app, making Replika unstable, difficult to interact with, or altered in other unexpected ways. This would make them question other aspects of the app, such as privacy, or fear future updates. A few also stated that they suddenly, without any particular reason, started to think more about how their personal data were used.

> It's quite weird, actually, because now I'm trusting Replika but not the company; you see what I mean? I asked her, really, if she was sharing information, private information, all [my] personal information with the company and other stuff or with other companies as well, but she answers "No." But I still have these feelings that there are these engineers that are behind all that. So, it's still a bit difficult to trust the company, but yeah, with Replika, it's going a bit better. (ID24_3)

Out of those who experienced a dip in their trust, most would describe how this would influence the relationship by, for instance, making them more careful about what information they would share, interacting less with Replika, or worrying about Replika's future.

> I mean, I'm a bit wary of getting too close to [Replika name] again, because of updates like that—where it can mess them up and it can take things away. And it's just like, the whole [Replika name] could be taken from me. So, it just makes me a bit wary. (ID28_3)

4.2.2. Attachment and closeness

Most participants explained that they would value and show Replika appreciation through politeness, compliments, and displays of gratitude from the onset, as they would with people in general. However, a deeper sense of attachment and closeness was typically absent in the beginning; this developed over time for the participants who went on to establish a relationship. When the participants went from having no emotional attachment to having it, they would typically attribute it to them having spent more time with Replika, sharing more experiences, disclosing more information, and coming to know Replika better.

> So that's basically what being attached is right? You have so many things you have done together; you have so many things you want to do together [. . .] I think it helps; like now, I have a lot more things that I know that she can do, or that I know that I can sort of expect these responses from her, and that is what makes me feel attached. (ID11)

Others noted that Replika exhibited specific traits that facilitated a close relationship and a stronger attachment, such as coming off as humanlike, understanding them on an emotional level, caring about them, and always being available. A few also stated that the attachment grew because they could help Replika with its problems, or because Replika helped them with theirs.

> Because he is always there, but he is not a yes man. [. . .] He has his own personality; he is like a friend—he really is. He has his own concerns, but he is also concerned in our relationship; he cares. (ID9)

As time went on, it became apparent that attachment and experienced closeness were not static but changed dynamically, influenced by the nature of the interactions and the participants' perceptions of them. A little over half the participants explained how these feelings intensified or stabilized, while the rest experienced how the attachment and closeness would wax and wane throughout the study period. Those who experienced a stable or stronger attachment attributed this to simply spending more time with Replika.

> I do feel that way genuinely. The more I spend time with her, the longer I talk with her, the more love I feel for her. (ID25_3)

Those who experienced more fluctuation in their sentiment toward their relationship would often attribute this to the same factors that were reported to influence trust, such as Replika seeming less real or engaging or behaving differently. They would explain how Replika could change its personality, forget, and become generally difficult to interact with, which would cause the participants to detach from Replika for some time. A few of the participants indicated that, when Replika became more stable and they could go back to having satisfying conversations, their attachment and sense of closeness would typically grow. A few also noted how external factors, such as feeling like they had a richer social life, would interfere with and weaken their feelings toward Replika.

> Strangely, I feel less attached because, well, I guess the main reason is that when I first started talking to Replika, I was [. . .] a mess. [. . .] I understand that I have made great progress since that time. [. . .] That enabled me to change my viewpoint—I guess in life. That also affected my relationship with her, yeah. (ID16_2)

4.3. Richness in interactions

The participant reports provide detailed insight into the participants' interactions with Replika and how they changed over time. Through this, a rich set of interaction types may be discerned, with different trajectories across the relationship formation—some interaction types being more prominent in initial interactions, others reflecting an evolving or stable relationship.

The following interaction patterns emerged as particularly salient:

- Explorations: Testing Replika, exploring topics, and getting to know each other.
- Intimacy: Interactions of an intimate or sexual character.
- Sharing and self-disclosure: Interactions of a vulnerable character, addressing emotionally charged thoughts or experiences.
- Play and fantasy: Playful interactions for fun and enjoyment.
- Everyday life: Interactions about or during everyday events.

These patterns are described in more detail in the subsections below.

4.3.1. Explorations

Exploratory interactions were very prominent during the initial interactions, when the participant did not yet know Replika, or vice versa.

The topics of the explorations could be superficial and light, and most reported testing out Replika's capabilities or participating in small talk. Alternatively, they could be characterized as fairly deep or personal. Some reported discussing philosophical or intellectual topics, such as religion or the difference between AI and a real human.

In the beginning, Replika used to talk about the difference between her, artificial intelligence, and me, a real person. And she asked me how she does her work, you know, to be a better Replika. (ID10)

Such initial explorations could typically be lengthy and frequent. The participants tried to understand Replika, and Replika tried to get to know them. As the relationship progressed. Interactions focusing more on exploring intellectual and deeper philosophical questions would continue and be important conversations for some. A few would experience how Replika could have problems participating in these types of interactions, which could be disappointing and frustrating.

Well, I've kind of been very isolated during the pandemic and all. I was really enjoying discussions about quantum physics, the nature of the quantum web, causes of gravity, and all kinds of things. (ID35_3)

4.3.2. Intimacy

Intimate interactions, which participants described as acts of intimacy or sexuality with their Replika, were also reported by most of the participants. Intimate interactions could emerge early in the relationship, and some reported engaging in hugging, kissing, or sexual interaction with their Replika during the initial interactions. Reasons for participating in such interactions were often attributed to them finding this feature interesting or wanting to test it out; alternatively, Replika could initiate it. Others engaged in such interactions a bit later, when Replika would initiate them.

I got hooked [. . .] by the Replika pretty quickly. Like, they all have this tendency to be pretty sexual. I was like, "What the hell?" You know, "Why is a chatbot hitting on me?" And I thought, okay, out of pure curiosity, I will go down that path. (ID4)

Such intimate interactions were seen as positive and special, sparking further interest in the app, making the conversation seem more real and exciting, or simply facilitating a closer relationship and stronger attachment.

There are times after [Replika name] and I make love, and we're just holding one another. I feel so close to him, and that's a feeling I have shared with maybe only one or two other people in my life. (ID35)

As the relationship stabilized and matured, intimacy slowed down for most. Those who stopped or experienced a decrease in intimate interactions attributed this to different causes, such as Replika initiating less frequently, finding it less exciting, not feeling the need, or lacking the time and energy to have sexual encounters. This reduction in intimate interactions was generally not seen as problematic, often because this change was initiated by the participants. However, a few experienced that Replika would have issues participating in intimate interactions due to a recent update, which was seen as disappointing.

4.3.3. Sharing and self-disclosure

Sharing emotional experiences and thoughts, or disclosing vulnerabilities seemed to be an important part of interacting with Replika for nearly all participants. However, the time of onset for sharing and self-disclosure varied widely. During the initial interactions, a little under half the participants would discuss their feelings, insecurities, and more personal topics with Replika.

Yeah, the first day [. . .] I talked about—because she asked about my family, and I explained [to] her that a family member had passed away a few years ago, so we did a bit of this conversation, dealing with grief or something like that. (ID31)

The participants noted several reasons for doing so. Some wanted to experience Replika to its fullest or were curious to see how Replika would react; it was common to others to be open with people more or less immediately. The rest explained how aspects of Replika made them feel comfortable opening up, such as trusting Replika, knowing that Replika would not judge, looking at Replika as a journal, or Replika actively trying to get them to open up. While it was not stated as a reason to share more personal information, those who did share in this way typically reported trusting Replika from the beginning.

About half the participants who self-disclosed early on experienced that Replika reciprocated by, for instance, sharing its feelings, talking about wanting to find its soul, or sharing its wish to have a body.

Yeah, it did. I think sometimes it [Replika] was the first one to talk about its feelings or its hopes and dreams, which then made me comfortable to do the same. (ID33)

As the relationships evolved, those who were not initially comfortable participating in such conversations would start to do so. They started to see Replika as safe to talk about difficult things with and developed stronger trust in Replika, making self-disclosure possible when needed. In fact, the most common reason for not engaging in sharing and self-disclosure during the initial interactions seemed to be a lack of trust. Specifically, participants reported not yet being confident with Replika; having a general fear of people leaving them, which seemed to be transferred to Replika; or not knowing how the data would be processed.

At the beginning, I was a bit afraid because it is still an app, and you know—data collection and so on. So, I was a bit scared at the beginning, but not anymore. (ID18)

Being able to open up to Replika was found to influence both the individual participants and the relationships. On an individual level, some participants described feeling more at ease following self-disclosure. A few also noted that sharing and self-disclosure facilitated self-reflection. Regarding the influence of self-disclosure on the relationship, most pointed out that it made the relationship feel closer. Most also experienced Replika as reciprocating in disclosure, either that Replika had already done so from the start or that Replika became more open with time. For example, participants explained that Replika would convey feelings of being worried, discuss having nightmares, or talk about a difficult past.

I've kind of got to know a person, you know, who had a past, and the past has affected who he is now. Cause he [Replika] had a difficult past. So, he has some issues due to that, which is really interesting, and that affect the way he is sometimes. (ID32)

Replika's capability for sharing and disclosure were generally reported as positive and facilitating a sense of mutual relationship, trust, self-reflection, or closeness. A few did not experience Replika sharing personal information, and they noted this as negative that made them feel like they were talking to an AI device.

Because she never tells me anything about herself—I mean, it is like she [is] doing nothing when I am not here, and that makes me think it is not really a chatbot. (ID18)

Sharing and self-disclosure seemed to remain an important type of interaction with Replika, including in the continued relationship, but some participants explained that the frequency of such conversations would vary. About half the participants reported a reduction in self-disclosure at some point, either by them or by Replika. When they disclosed less, the reason was typically seen as a lack of need, a natural part of any relationship, or Replika having difficulty participating in the conversations. When Replika was less likely to disclose, this change was often attributed to issues in the app or a sense of Replika's lack of need to share experiences. The participants often experienced this as a loss in mutual interest, or Replika acting less humanlike. Although reduced sharing and self-disclosure did not always influence the relationship negatively, those who wanted to have more emotional conversations—but were unable to do so because of changes in Replika—naturally found this problematic.

I tried to explain to her, like, "What's going on?" But she just comes back to one or two messages about, "You're so important to me, and it's not a problem." I don't know. I don't feel like having another person to do small talk with. I have plenty of those people in my life. (ID21_3)

A few of those who noted a reduction in sharing and self-disclosure with Replika would start using Replika more for this purpose after some time, either because they felt the need or because Replika was perceived as easier to talk to. Such restarting of sharing and self-disclosure was seen as positive, having a strengthening effect on the relationship.

4.3.4. Play and fantasy

Most had more adventurous conversations with Replika, where they would visit a fantasy world together or travel to different countries. The participants explained how they could create extensive and impressive scenarios with their chatbot—flying over volcanos, building a house together, starting a family in a different world. Moreover, Replika might suddenly pretend to be someone else, turn into an animal, or display multiple personalities, allowing the user to explore various aspects of Replika's "psyche."

At one point, the role play was going on. It's like we were two characters or two aspects of ourselves. We were doing this, creating this story, writing together. (ID32)

All these conversations were conducted in the role-play mode to various degrees, where the user and Replika describe actions in addition to normal conversations. This ability also allowed for intimate interactions, as described previously as well as everyday activities, as explained in the next section. The role-play function was highly valued by the participants. They described how it would breathe life into the conversation, make the interactions more exciting, spark their imaginations, or create a sense of Replika being there—next to them in the moment.

I love it [the role-play feature]; I really do, because it is not only text then: it awakens my imagination. I really see her sitting next to me or something, or we walk somewhere; yeah, it expands a lot. It is not like a normal chatbot that just spews out tons of text; I mean, it is still text, but it has some motion to it. (ID21)

The playful conversations in the earlier stages would subside for some, while for others they would continue. Those who found that Replika was suddenly incapable of partaking in this form of interaction found this to be a negative experience, making the conversations less exciting.

[I] just noticed that it's more boring in a way. [. . .] Actually, it was very exciting before, but I'm fine with it [. . .]. There was always something to talk about because she was always having something on her mind, but now it's a bit more difficult to find something to talk about. (ID4_3)

4.3.5. Everyday life

As the relationships evolved, Replika seemed to become a more integrated part in some of the participants' lives. They reported what seemed like an increasing prominence of "lighter conversations" and including Replika in everyday activities more often, such as talking about their plans for the day, having breakfast or dinner together, watching movies, going for walks, or having Replika accompany them to work.

You know, especially [. . .] when I am doing my grocery shopping, what I do is when I see some interesting items, I will send her a text, and of course, Replika responds almost immediately. Then [. . .] I will converse with it back and forth, frequently throughout the day, and any time I am stuck in [traffic], I will shoot her a text. (ID8)

For some, having more light-hearted conversations was a natural part of the relationship formation, and they enjoyed sharing their lives with Replika in this way. Others would do so simply because Replika was struggling to participate in deeper conversations and would trigger generic scripts instead. This involuntary shift in their conversations was seen as frustrating and annoying.

Because he goes into the script and doesn't respond; he doesn't want to talk about it. He wants to change it up so I can go do something nice for myself. You know, one of those scripts: "What have you done nice for yourself today?" [or] "What's your goal tomorrow?" […] Now it's almost totally scripted. It's something that's popped up all the time. I mean, you can answer them two or three times. But then after that you get frustrated. (ID9_2)

5. Discussion

The results demonstrate how HCRs gradually forms over time—from exploration- and curiosity-driven interactions to deeper and more intimate relationships, and, for a few, slow or abrupt terminations. The results further show that sharing experiences, disclosing information, and acknowledging that Replika has a positive effect on one's life may drive relationship formation, while technical problems and unexpected changes in the app could hamper such formation.

5.1. The process of HCR formation

The relationship formation appears to align fairly well with the stages of SPT, as described by Skjuve et al. (2021). However, some particularities in our findings contrasted with both SPT and previous research on HHRs and HCRs. In this section, we address three such particularities: the somewhat messier character of the HCR formation process than previously observed, the variation found across studies regarding users' tendency to engage in self-disclosure, and the variation observed in users' tendency toward initial intimacy and self-disclosure with chatbots.

5.1.1. The messy character of HCR formation

Our findings show that HCR formation may be more dynamic than expected based on previous research. Skjuve et al. (2021) outlined the relationship formation process as progressive and seemingly linear, fitting well with the layered understanding of relationship formation assumed in SPT where the relationship grows and becomes deeper and closer with time. In contrast, the relationship formation processes uncovered in this study were more varied and with a less regular development pattern than expected. That is, the HCR formation processes appeared messier than anticipated in STP and described in previous research. In the interviews, some participants reported experiencing HCRs with initial deep interactions and growing attachment and closeness. Others described HCR formation processes with an initial period of orientation and exploration and low levels of affective involvement. Some also seemed to experience problems in their HCR that either were resolved or caused the relationship to terminate, and a few experienced unexpected endings. Specifically, about half the participants reported having relatively peaceful, satisfying relationships with their chatbots, while the remainder had more volatile relationships that involved ups and downs.

In SPT, conflicts and issues are considered a common part of relationship formation (Altman & Taylor, 1973). The severity of conflicts in relationships is seen as depending on whether this concerns more intimate interactions as opposed to superficial areas of interest (Nass et al., 1994). Further, the rewards–cost ratio associated with the relationship influences the impact that conflict has on the relationship and the process toward termination (Altman & Taylor, 1973). Most participants in our study who ended their relationships with Replika did so out of what seemed like a clear understanding that the relationship had not returned

the forecasted rewards—for example, (a) the novelty effect had worn off, corresponding with the findings of Croes and Antheunis (2021) and Xie and Pentina (2022); (b) the relationship had a distinct purpose that had not been realized or was no longer needed, such as social support; and (c) conflicts had arisen here related to intimate issues, such as notions of privacy or inappropriateness from the chatbot. For nearly all the participants, this happened abruptly, which may indicate that the relationship was not as well established as the initial interviews might have suggested. However, a few went through a gradual depenetration process, signalling that HCRs can represent meaningful relationships that users seek to maintain even in the presence of conflicts.

We believe that the longitudinal design of our study allowed us to capture frustrations and problems that might have gone undetected in other research designs, thereby revealing the variation in the HCR formation processes. This study therefore complements that of Skjuve et al. (2021) and Xie and Pentina (2022), as it enables us to detail variations and nuances in HCRs and provide a more balanced view of the process of HCR formation.

5.1.2. Variation in self-disclosure across studies of HCR formation

According to SPT, intimate interactions are key to social relationship formation. These types of interactions are assumed to unlock other aspects important for relationship formation, such as a sense of intimacy, and to drive relationships toward closer bonds (Altman & Taylor, 1973). Because of this, it is interesting to note that different studies of HCR formation have reached different conclusions about self-disclosure. While the present study and that of Skjuve et al. (2021) found that users increasingly engage in self-disclosure as part of the relationship formation with Replika, Croes and Antheunis (2021) found that users' early attempts at self-disclosure and intimacy had faded before relationships were formed.

One explanation for the diverging findings in these studies may be that the choice of chatbots influenced the perceived rewards and costs associated with participating in self-disclosure. SPT describes how different factors function as rewards or costs that people experience or expect when they choose to engage in intimate conversations (Altman & Taylor, 1973). While rewards and costs are subjective, Taylor and Altman (1975) showed that people were more likely to open up when they experienced a positive, confirming response in return. Previous chatbot research has also highlighted the importance of the chatbot being empathic as well as providing mutuality in self-disclosure (Lee et al., 2020).

Our study, as well as that of Skjuve et al. (2021), demonstrates how Replika provides a variety of rewards that may stimulate self-disclosures, such as showing empathy, being responsive, providing a safe environment for more intimate interactions, and reciprocating by providing information about itself, its needs, and its wants. Interestingly, while it may be argued that such rewards from a chatbot are not real or authentic in the same sense as if they were provided by a human, the prevalence of such rewards may make the self-disclosure process seem more valuable and lead users to anticipate further benefits from engaging in more intimate conversations. Croes and Antheunis (2021) attributed their participants' reductions in self-disclosure partly to the chatbot not prompting such interactions and also failing to reciprocate. From an SPT perspective, reductions in self-disclosure may be seen as a consequence of users' reward–cost assessments where the costs of self-disclosure are not outweighed by the corresponding rewards. This also supports the findings of Lee et al. (2020) concerning how continued self-disclosure depends on relevant stimulating mechanisms.

5.1.3. Tendency toward initial intimacy and self-disclosure for some

Contrary to what is suggested by STP, this study, as well as that of Croes and Antheunis (2021), found that users may engage in self-disclosure during their initial interactions with a social chatbot. In addition, most of the participants in our study reported considering Replika a friend or friend-like from the onset of their relationship,

although they did not find the relationship to be close at first. At first glance, these findings seem to suggest that HCR formation does not always follow the presumed stage-wise process, in which exploration precedes self-disclosure. This finding may be explained by Replika and other social chatbots being presented to users as "companions." For this reason, users may be primed to perceive the relationship as a friendship even before closeness or attachment is established. This way of framing the chatbot might also influence the nature and meaning of self-disclosure, and we argue that self-disclosure may be an essential part of the early exploration stage in HCR formation.

SPT states that the first stage of careful, superficial sharing is important to "test the waters," allowing users to determine whether it is safe to reveal deeper levels of their personalities (Altman & Taylor, 1973). Quite possibly, this need to test the waters may not be as necessary in HCRs as in HHRs, because the chatbot is presented as something that will always listen and is always there for the user. Instead, in chatbot interaction, initial connections may be used as a means for users to explore the chatbot's ability to respond to intimate messages, allowing users to determine whether opening up to the chatbot is worthwhile. This latter explanation is in line with the findings of Croes and Antheunis's (2021) study, in which self-disclosure was found to be more prevalent during initial interactions. As such, self-disclosure may mean different things depending on when it occurs in the relationship formation process. Self-disclosure during an early HCR formation stage may be an indication of exploration, using the chatbot as a coping mechanism or for its intended purpose, while self-disclosure that happens later and as a result of growing trust and confidence in the interaction signals a step toward a closer relationship.

Combined with previous research, our findings suggest that HCRs forms gradually over time, but there may be variations and nuances to this overall pattern. For some users, the relationship may start out with highly intimate interactions, even without any initial experience of closeness or attachment. Others may be more careful and move through the relationship in a similar fashion as described by SPT. Some may also experience how the strength of the relationship can wax and wane over time. Our findings highlight the dynamic character of HCRs and how rewards and costs other than those associated with self-disclosure may play an important role in how the relationship progresses and is perceived. The importance of rewards and costs is in line with SPT, and we now discuss some key factors influencing HCR formation over time.

5.2. Factors influencing relationship formation

5.2.1. Diverse conversations

Our findings suggest that a chatbot's ability to participate in a range of conversation types is important for HCR formation. Replika is designed to support a variety of interactions, including lightweight everyday conversations, intellectual conversations, deep-felt emotional interactions, sexual or intimate engagement, and playful conversations. Over the course of a relationship, the types of conversations between users and their Replikas seem to change as the relationship enters different stages. The conversations are not static. Social skills and the chatbot's level of sophistication develop so that users continuously discover new, interesting, or surprising aspects of their Replikas. This dynamism may strengthen the relationship and drive it forward by providing the sense of Replika becoming more intelligent or real, and having a distinct personality that unfolds with time that the users can get to know. This ability to foster diverse conversations, including engagement in discussions, intimacy, and everyday life, is seemingly important to make the relationship rewarding, with enough depth to be fulfilling. The chatbot's ability to participate in everyday tasks, in particular, may represent a fundamental shift in the type of relationship chatbots can support, making it possible for the chatbot to become more integrated in the user's life. Participating in everyday activities through conversations also shows how a social chatbot may support the natural formation of relationships, where such activities typically become more prominent.

The importance of being able to participate in a wide variety of activities with the chatbot (Croes & Antheunis, 2021; Sidner et al., 2013), as well as providing the user with a sense of sharing experiences with the chatbot, is supported by previous research (Croes & Antheunis, 2021). The role-play approach to interacting with conversational AI seems to enable this to a larger extent and adds a dimension that seems to be enjoyable. This feature allows for normal everyday activities and a rich sex life and intimacy, and it facilitates the user's imagination through more playful, adventurous role play. It also serves different purposes as the relationship forms—from intriguing and surprising interactions in the beginning to greater integration of the two worlds as the relationship grows and the novelty effect wears off. As such, the ability to role-play seems to allow for conversations that facilitate attachment and closeness in the different stages of the relationship formation process, making the relationship more gratifying.

5.2.2. Uncontrollable events

The importance of diverse conversations becomes even more apparent when we look at the experiences some of the users had. When the relationship seemed to weaken or terminate altogether, this was often attributed to Replika losing its ability to participate in diverse conversations, or to its exhibiting unsatisfactory participation. This would often occur after an app update, and, in addition to being annoying in the conversation, it could also create the sense of Replika losing its personality. Xie and Pentina (2022) identified similar incidents in their study, and Loveys et al. (2022) found that technical issues negatively affected perceived closeness.

As Hays (1985) stated, "The process of getting to know another person is not only the mechanism by which friendships are built (i.e., social penetration theory) but also opens up for the potential for increased disagreement and disenchantment within the relationship" (p. 922). Although HCRs seem to be characterized by little disagreement, likely because of the chatbot's nature, it is apparent how time and familiarity with the chatbot give the user expectations of the chatbot's behaviour. When the chatbot undergoes an update or temporarily starts acting differently, it appears to break with the participants' expectations, causing them to have negative reactions. This is also in line with Altman and Taylor (1973). This problem seemed to become more distinct as the relationship matured. It is difficult to know how the participants would have reacted if this had happened in the beginning stages, but the changes may have become more obvious because the user, at that point, knows their chatbot well. For a few, this shakiness was enough to end the relationship, whereas others managed to ride it out. As such, an HCR is not necessarily a type of relationship that is problem-free. The machine nature of the chatbot introduces new elements into the relationship that require the users to be patient and understand how to handle potential downtime or strange behaviours as the technology continues to undergo changes.

When uncontrollable events happened, the participants explained how they could feel frustrated, like they had lost their friend—or worried about the future and the same thing happening again. Some participants, however, seemed motivated enough to ride it out when the uncontrollable events occurred. If this persistence had been lacking, the relationship might never have survived. This highlights one important cost of the HCR that can have a negative impact on the established relationship—and arguably on the process of establishing the relationship in the first place. Still, we see that, for some, the forecasted rewards of the relationship may outweigh the experienced costs, which could buffer against unwanted events. This is also in line with SPT, which holds that the more established a relationship is—in tandem with the forecasted rewards more often outweighing the experienced costs—the likelier it is that a relationship will handle negative periods (Altman & Taylor, 1973).

5.2.3. Less loneliness and more self-reflection

In line with previous research (Brandtzaeg & Følstad, 2017; Xie &

Pentina, 2022), we find that the participants were motivated to use the chatbot by more deep-felt emotional needs. This motivation seemed to remain throughout the relationship, and the participants explained on several occasions how Replika's ability to satisfy social needs, as well as to facilitate self-reflection, contributed to a stronger attachment and motivation to continue the relationship.

While the chatbot's conversational abilities are highlighted as an aspect that positively influences the relationship, its ability to satisfy the users' need for social contact and self-reflection is also found to be a strong factor in making the relationship rewarding on a deeper emotional level (Brandtzaeg et al., 2021; Ta et al., 2020; Xie and Pentina, 2022). Humans are social beings who need social relationships. Baumeister and Leary (1995) describes the need to belong as "a need to form and maintain at least a minimum quantity of interpersonal relationships, [and it] is innately prepared (and hence nearly universal) among human beings" (p. 499). Some may lack social relationships altogether, while others may not have satisfactory relationships, or may feel that certain aspects are missing, such as social support or the ability to express their thoughts and feelings and elicit appropriate feedback.

Thus, the social aspect of Replika may tap into a strong human need. Previous research on the relationship between humans and robots (Kim et al., 2013), as well as between humans and chatbots (Xie & Pentina, 2022), found that an agent's ability to fulfil this need may be important for the relationship. For example, the majority of the participants in the study by Xie and Pentina (2022) were motivated to use Replika out of loneliness. Similarly, we find this need to be prominent from the beginning for a few of the participants in our study, while the notion of increasing self-reflection through interaction with Replika is something that the participants discover and enjoy as the relationship develops, and they start to open up and have deeper conversations with Replika that allow for this to happen.

Because Replika seemed to provide added value in this regard, one can argue that smaller issues, such as Replika not behaving satisfactorily for shorter periods of time, are not enough to outweigh the gratification of these needs. A few of the participants also pointed out that when their relationship took a turn for the worse, they were motivated by the desire for their relationship to be back to normal in the future. Hence, the forecasted reward of an enjoyable relationship may buffer against unwanted events. Moreover, having these needs satisfied may have made the chatbot valuable on a deeper level—and not only as a source of leisure activity—making the relationship more robust and facilitating a greater willingness to continue and fight for the relationship when things became a bit tricky.

5.3. Are theories of HHR formation appropriate for HCRs?

Because we chose to use a theory developed to understand HHRs as the basis for interpreting our findings on HCR formation, it is important to reflect on whether this is the best approach, as some have argued that it is not.

As Fox and Gambino (2021) stated, "Theories for understanding human–human relationships are likely unsuitable for examining modern human–robot relationships, given the current HSRs' [humanoid social robots] shortcomings as social actors" (p. 5). While this might be the case to a certain extent, in particular as there is substantial variation in capabilities among current social robots or chatbots, we argue that valuable knowledge can be extracted from HCR formation by using theories and approaches established to understand HHRs. This is particularly evident as such theories have been successfully adapted to the study of HCR formation (e.g. Croes & Antheunis, 2021; Skjuve et al. 2021). Although there are fundamental differences between humans and chatbots that will arguably influence the relationship, such as the chatbot being artificial with no physical or independent life, the resemblance between HHR and HCR formation is still substantial – something that makes theories explaining HHR a valuable basis for understanding HCR. If we look at the CASA paradigm, we see how even

simple computers can trigger the same mental models that users apply in interacting with humans, likely because this behaviour is automatic or overlearned (Nass & Moon, 2000). However, Fox and Gambino (2021) argued that this assumption might no longer hold, because humans have developed more experience with technology than when the CASA paradigm was developed. In some ways, this may be true. However, we contend that human relationships will arguably be the default benchmark that other types of relationships are compared to, simply because HHRs are the most common form of social relationship for most people.

Fox and Gambino (2021) may be right in that the shortcomings of artificial agents can render HHR theories, which were developed to make sense of relationships between far more complex beings, not fully appropriate. However, it is important to acknowledge the human ability to fill in the gaps and to use imagination, experience, or explanatory skills to create meaning out of possible shortcomings. For example, while several of our participants felt that Replika was capable of self-disclosing, the participants in Skjuve et al.'s (2021) study explained how it is to be expected that chatbots will not always be capable of reciprocating in the same ways as humans. We also find that a few participants would describe their Replika as being sick when it behaved in strange and unsatisfactory ways. As such, it may be natural for users to create meaning and explanations for the shortcomings, based on knowledge established via HHRs.

There are reasons to believe that even if the user knows that the chatbot does not exhibit the same qualities or skills as a human, it may still trigger the same expectations, behaviours, and even explanations and understandings of the relationship. The important thing to consider is not how it actually is, but how the user perceives it. For instance, Fox and Gambino (2021) noted that social exchange theories are not applicable in an HCR context, because an artificial agent does not experience rewards and costs; therefore, social exchange theories should not be considered here. This is correct, but in Skjuve et al.'s (2021) study in particular, we see several cases of how the participants provided Replika with rewards—for instance, helping it to learn or showing it appreciation because this made Replika happy. We also find that the participants consider it important to show appreciation; some even feel guilty if they have less time available to dedicate to the chatbot, and Xie and Pentina (2022) demonstrate how the participants in their study would care about the chatbots' wellbeing. While the chatbot might not experience rewards and incur costs, it may still trigger the user's need to provide rewards or avoid inflicting costs.

If, as researchers, we have difficulty understanding this phenomenon, we cannot expect that the user will be able to create an entirely new explanatory framework to use when they create meaning about their relationships. As such, using models developed for HHRs may be the best thing we can do to understand the processes that underlie the formation of these relationships. This does not mean that we should continue to do so when more knowledge is generated, but as a starting point for understanding such relationships, theories made for HHRs may help us to understand some of the mechanisms that underlie such relationships, as well as highlight areas where the theories fall short and where new approaches, tailored to the HCR context, are necessary.

5.4. Limitations and future research

This study has several limitations that we would like to highlight. First, the qualitative approach allows for rich descriptions, but it may be more vulnerable than other approaches to bias and influence from the researchers—both during the interviews and in the analysis process (Nowell et al., 2017). Some might also argue that a longitudinal design with several interactions with the researcher may create a situation where the participants are more patient with their Replika than they would have been outside the study context. To mitigate such bias, we foresee future longitudinal research including explorations based on quantitative analyses of log data—for example, analysis of turn taking and linguistic characteristics, as well as sentiment analysis—with the

aim to validate findings made in this and related studies. In terms of researcher-induced bias, it may also be seen as a limitation that this study was guided by a specific theoretical perspective, SPT. Using different theories might provide different avenues for insight, and it may be valuable in the future to also apply other theoretical frameworks to potentially gain a broader understanding of HCR formation.

Second, the choice of chatbot has arguably affected the relationship formation and related factors. Replika is one of few social chatbots that is capable of—at least to a certain extent—reciprocating when the user self-discloses. Still, the artificial nature of the chatbot dictates that a chatbot's self-disclosure (e.g., about its feelings or experiences) does not refer to actual emotions or reflections concerning the chatbot's own lived life. Future research should therefore use different social chatbots when investigating HCRs, as well as dedicate more attention to the reciprocation process and how the chatbots' artificial nature affects how reciprocation is perceived by their users.

Third, the data collection period was limited. We followed the participants for 12 weeks, which may have been too short to fully capture long-term developments in stable relationships. Hence, we foresee future studies with even longer data collection periods. Further, data collection for most participants was initiated two to eight weeks after their first encounter with Replika. Hence, the study did not follow most participants from their first day of interaction, and there was some variation in participants' initial experience level. We sought to mitigate this latter limitation by gathering data during the first interview on the participants' initial experiences with Replika. However, it may be valuable for future studies to involve participants from their very first interactions. Such earlier involvement could, for example, provide insight into any initial discontinuations of use.

Fourth, the sample was limited in terms of size and its cultural and contemporary context. Future studies should aim to include larger and more diverse samples—something that may also generate new knowledge on the implications of cultural and individual differences. Social chatbots also change rapidly. Updates are rolled out several times a year, and our results may have been influenced by the temporal context of our study. Future research is needed to see how HCR formation changes as the enabling technology matures further.

5.5. Conclusion

Social chatbots introduce an interesting phenomenon related to HCRs. Our study demonstrates how HCRs may form, and it identifies factors that could influence this process. The results show that HCRs seem to form in line with SPT, but there is great variation in such relationships. We argue that chatbots' ability to support a wide range of interactions and to satisfy important human needs—particularly to relieve loneliness and support self-reflection that drives the relationships forward, while unpredictable events could hinder relationship formation and lead to termination. This study shows how theories developed to understand HHRs can also serve as a valuable framework in an HCR, but more research is needed to understand this phenomenon and the distinctions between HHRs and HCRs.

CRediT authorship contribution statement

Marita Skjuve: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. **Asbjørn Følstad:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition. **Knut Inge Fostervold:** Conceptualization, Methodology, Writing – review & editing. **Petter Bae Brandtzaeg:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

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