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# Cultivating Gratitude with a Chatbot

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**ABSTRACT**

Gratitude is a moral emotion that demonstrates our appreciation of altruism. In psychology, feeling grateful is linked to an increase in well-being, yet there is a lack of HCI research on if gratitude can be cultivated through and with conversational agents. We quantitatively studied whether a chatbot can increase people's gratitude (N = 133), as well as its influence on people's positive and negative emotions. Compared to the control condition, a chatbot that shared gratitude interventions significantly enhanced people's gratitude and positive emotions, while lowering negative emotions. Interestingly, people's experience of gratitude differed from other positive emotions: Simple positive emotions, like joy, can go up while reported gratitude decreases. We share qualitative observations on how gratitude can be a complex emotional experience, encompassing positive and negative emotions, such as finding relief in admitting to a chatbot about one's sadness over friendship during the COVID-19 pandemic.

**KEYWORDS**

Gratitude; conversational user interface; chatbot; positive computing; emotions; well-being

## 1. Introduction

Gratitude uplifts. Feeling thankful can build and strengthen our existing social ties (Algoe et al., 2008; Chang et al., 2013). Gratitude extends outwards—it is likely to spread across a network of people, transmitting received goodwill via "paying it forward" to others (Chang et al., 2012; Komter, 2004). Additionally, gratitude increases our well-being and overall positive affect as shown in psychological research (Froh et al., 2009; Seligman et al., 2005; Southwell & Gould, 2017; Watkins et al., 2003). If and how gratitude interventions can best influence our well-being through technology is a nascent area in HCI. In this context, two points require attention: Investigating (1) gratitude as an independent emotion category and its relationship to more general positive and negative affect, and (2) the types of technology that enable effective gratitude interventions.

On the first point, independently assessing gratitude can better contribute to understanding its efficacy for well-being. Even if gratitude is positively valenced (Fredrickson, 2004), it may or may not function similarly to other positive emotions like joy. What makes gratitude *distinct*? Gratitude is often overlooked in emotion research; it is a *moral* emotion that concerns "other-praising" expressions, which serve as reactions to others' moral behavior and can also spur one to act morally (Haidt, 2003; McCullough et al., 2002). We can additionally consider if people can become grateful through and towards technological others, which can scale up ways to nurture gratitude. This relates to our second point on if and how technology can elicit gratitude. Here, we zoom in on conversational agents, i.e. chatbots, because gratitude interventions that increase well-being, like reflecting on whom one feels grateful for (Wood et al., 2010) can be effective as *conversations*, e.g. texting with a chatbot about people one feels gratitude towards. Since chatbots are scalable systems for messaging on communication platforms (Dale, 2016), many people can easily access gratitude interventions conversationally. In tying together points one and two, extant chatbot-related HCI research does not primarily deal with gratitude; their focus has been on well-being (Narain et al., 2020), journaling guidance (Y.C. Lee et al., 2021), or self-compassion (M. Lee et al., 2019) (among others), which all relate to gratitude, but do not centrally concern gratitude. Our motivation is thus to explore gratitude as a distinct emotion category, as well as the impact of a chatbot on promoting gratitude.

We investigated if a chatbot can increase people's gratitude and, if so, how their experience of gratitude is observable through quantitative and qualitative research. Our results indicate that a chatbot can successfully increase people's gratitude through gratitude interventions. We note that gratitude may differ from (but can include) simple positive emotions like joy. For instance, feeling grateful despite negative emotional experiences, such as the effects of the pandemic, means that gratitude mixes together more general negative and positive emotions, e.g. finding people to share gratitude with during times of sadness. Our study on a gratitude chatbot is a starting point for how technology can

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impact not only individuals' well-being through complex emotions like gratitude, but also how conversational agents can be used to mediate and enhance gratitude sharing *between* people. We start with reviewing prior works on conversational user interfaces like chatbots for mental wellness, then discuss emotions in general before diving into gratitude and its relationship to well-being. This is followed by our methods and results. We end with a discussion on how emotion categories like gratitude deserve in-depth and specific treatment in HCI, for methods of integrating technological entities in exploring our emotional richness are only beginning to be explored.

## 2. Background

### 2.1. Digital mental health applications and chatbots

For helping people deal with issues like depression, mental health applications have been deployed, such as a web-based social (peer-to-peer support) platform for offering empathy and cognitive reappraisal to one another (Morris et al., 2015). Specifically on digital gratitude interventions, a study that lasted for 5 weeks showed inspirational content on an app (control condition N = 14; intervention condition N = 13); people in the gratitude intervention condition expressed gratitude more often, more intensely, more densely, and to a greater number of people (Ghandeharioun et al., 2016). Mental health applications and digital gratitude interventions seem promising. However, what has not been covered is how conversational agents that act socially, e.g. exchanging messages, can also benefit individuals' mental health (compared to peer-to-peer human support), and if agents can also perform gratitude interventions (compared to other mental health interventions). Potentially, chatbots can be conversational conduits for us to reflect on gratitude towards other people, though they can also be entities people feel grateful towards as they are not mere apps but conversation partners, i.e. gratitude *through* and *towards* conversational agents, c.f., trust (M. Lee et al., 2021).

There is increasing attention on chatbots both in research and industry (Rapp et al., 2021). For instance, chatbots can be effective aids in healthcare. They do not replace people, but they can help reduce costs, and increase the efficiency of the general medical workflow by providing healthcare information and services to patients through a convenient and proficient approach that can then increase patients' well-being (Solanki et al., 2023; Xu et al., 2021). For example, a radiotherapy chatbot provided accurate information about radiotherapy to the radiation staff, the general public, and the patients and their families, reducing healthcare personnel's time normally spent on explaining that information (Chow et al., 2023). Here, Machine Learning (ML) can aid a chatbot's effectiveness in healthcare. The introduction of ML techniques in chatbots allows for more conversational flexibility, maintaining a more fluent conversation whilst providing relevant information to human users (Siddique & Chow, 2021).

Specifically, mental health chatbots have gained attention in recent years. Unlike strictly task-based bots, chatbots for mental health are social entities that are available 24/7 to provide a sense of attention and companionship to users rather than being able to provide all the answers to users' questions (Shum et al., 2018). There are many examples. Popbot helped with stress management and users who interacted with it often also reported a reduction of depressive symptoms (N = 47) (Mauriello et al., 2021). Woebot (N = 70) and Tess (N = 50) were chatbots that utilized cognitive behavioral therapy for helping young adults with symptoms of depression and anxiety (Fitzpatrick et al., 2017; Fulmer et al., 2018), Sunny promoted well-being (N = 24) (Narain et al., 2020), Vincent improved self-compassion (N = 67) (M. Lee et al., 2019), and users of Replika[1] were surveyed for how it provided companionship and support (N = 66) (Ta et al., 2020). So far, the most common focus areas for mental health chatbots in research are depression and autism according to a recent review (Abd-Alrazaq et al., 2019), and less focus has been on targeting specific emotions, like gratitude, through chatbots.

People have shown a preference for chatbots not only because they are available at any time but also because chatbots do not judge (compared to humans), which helps people to share their thoughts without worrying about being stigmatized for seeking mental health support (Brandtzæg et al., 2021; Brandtzaeg & Følstad, 2017; Ta et al., 2020). Some people may even feel more comfortable disclosing personally sensitive information to conversational agents since they are mere machines (Lucas et al., 2014). Yet, ethics of mental health chatbots regarding their harms and benefits should be an ongoing consideration (Kretzschmar et al., 2019). At the very least, bots should ensure 1) users' privacy, i.e. data confidentiality, 2) transparency, i.e. clarity on the bot's capacity and its inability to replace a real therapist, and 3) efficacy, i.e. evidence-based interventions based on empirical data (Kretzschmar et al., 2019). Researchers hence emphasize that chatbots are not meant to replace human therapists (M. Lee et al., 2019; Y. C. Lee et al., 2021). Chatbots can augment mental health professionals in dyadic (patient-care professional) contexts (Y. C. Lee et al., 2020), motivate people to get professional help (Kretzschmar et al., 2019), or act as members of online health communities, providing support to users (Wang et al., 2021).

### 2.2. Emotions

Chatbots can influence how we feel (M. Lee et al., 2019) and may become aware of our emotions, e.g. through sentiment analysis (Benke et al., 2022). Thus, we cover what emotions are before touching on gratitude as a specific *moral* emotion that relates to well-being. While there is an ongoing discussion on how to exactly define emotions (Keltner, 2019), one view characterizes emotions as passing feelings that are subsumed under moods, which are classified under affective traits. *Affective traits* are seen as emotionally stable conditions, i.e. a person's tendency to emotionally respond in a consistent manner; *moods* last across a period of time, like one's mood over a few days; *emotions* are more changeable as one's response to

environmental or situational factors, such as short physiological shifts when one is surprised (Rosenberg, 1998).

If emotions are considered to be expressive bursts, six basic emotions (surprise, disgust, fear, happiness, sadness, and anger) are described to have prototypical facial expressions (Ekman, 1992, 1993; Ekman & Friesen, 1971). For instance, a look of surprise may consist of a gaping mouth and enlarged eyes. While basic emotions rely on facial expressions, people's self-reported emotions are the core of the circumplex model of emotions. In this model, people's subjective feelings can be placed on two dimensions (Russell, 1980), from activation, e.g. alert, to deactivation, e.g. calm, and pleasantness, e.g. contented, to unpleasantness, e.g. sad. Basic emotions and the circumplex model touch on different components: Emotions involve how others see our expressed feelings, as well as how we judge our own feelings. However, emotions are not just static facial expressions or valence levels, as they are complicated by how people experience emotions over time in different ways (Barrett et al., 2019).

The nested hierarchical difference between affective traits, moods, and emotions (Rosenberg, 1998) becomes fuzzier with moral emotions. Moral emotions "are linked to the interests or welfare either of society as a whole or at least of persons other than the judge or agent" (Haidt, 2003, p. 853), meaning they are centrally *relational*. Hence, we communicate *through* and *with* emotions, which shape how we relate to others and ourselves, guiding our moral compass. Seeing gratitude not just as a positive emotion, but a moral emotion, highlights its socio-relational function. Gratitude can be cultivated *with* and *through* others, be they human or non-human others, e.g. pets.

While developing one's affective traits, e.g. becoming a "grateful person," many emotions can come into play. Sequenced together, diverse emotions can evolve over a longer timescale towards specific moral emotions. For example, grief after losing someone close may come in different stages, with simple emotions like surprise, fear, or sadness waxing and waning over the years. A complex moral emotion like grief or compassion can become an affective trait, i.e. an emotional attitude set as a norm, if it is regularly experienced as a mood. When someone is denoted as a "grieving partner" or a "compassionate teacher," we understand that emotions can be defining traits. To summarize, moral emotions, like gratitude, are cultivated through our relationships with others and ourselves and can form affective traits.

### 2.3. Gratitude

Compared to compassion which is attuned to extending care toward others' suffering (Gilbert, 2014; Goetz et al., 2010; Shantideva, 1979), gratitude focuses on reciprocity, often based around a beneficiary of one's thankfulness. Gratitude is defined as an "acknowledgment that we have received something of value from others. It arises from a posture of openness to others, where we are able to gladly recognize their benevolence" (Emmons & Mishra, 2011, p. 248). Thus, being grateful requires (1) a beneficiary, (2) a benefactor (who can be another person, but also nature, god, or other non-persons) (Fredrickson, 2004), and (3) a display of giving thanks, i.e. words, gifts, and/or other demonstrations (Komter, 2004), as well as empathy between them for gratitude to take place, i.e. how people giving and receiving thanks can empathize with each other (Lazarus & Lazarus, 1994). If "gratitude functions in the chain of reciprocity" (Komter, 2004, p. 204) as a moral emotion, gratitude is the appreciation of altruism (Lazarus & Lazarus, 1994).

Perhaps by recognizing altruism, gratitude tends to promote prosocial behavior by fostering relationships, such as returning favors or "paying it forward" to others (Jia et al., 2015; Mathews & Shook, 2013). A person who feels thankful towards a benefactor tends to help and cooperate with the benefactor and others (Jia et al., 2015). But, gratitude is distinct from feeling indebted (Komter, 2004); it is an internal appreciation rather than feeling that one materially "owes" something to another person (Watkins et al., 2006). In fact, gratitude is linked to a lowered desire for material goods (Lambert et al., 2009; McCullough et al., 2002; Polak & McCullough, 2006), allowing people to focus on what they already have. The distinction may be between *gratitude of exchange* and *gratitude of caring*, in which reciprocating things, e.g. gifts, and reciprocating care are important to distinguish, though they may go hand-in-hand in interpersonal contexts (Buck, 2004). Hence, compared to a simple tit-for-tat exchange, gratitude as care can extend to others beyond the benefactor and the beneficiary of gratitude.

Like other moral emotions, we can experience gratitude as a fleeting feeling, periodic mood, or lasting affective trait (Emmons & Mishra, 2011; Watkins, 2013). As an example, if we feel happy about an event and attribute that happiness to someone who has influenced us positively, happiness can be co-experienced with, or transition to, gratitude (McCullough et al., 2002; Weiner, 1986). So gratitude is positively valenced (Campos et al., 2013; Fredrickson, 2004) and it is often similar to, or encompasses, other positive emotions like happiness or empathy (Lazarus & Lazarus, 1994).

As an affective trait, gratitude can be assessed according to four facets: *Intensity*, i.e. how intensely we feel grateful, *frequency*, i.e. how often we feel grateful, *span*, i.e. how many aspects of our lives we feel grateful for, and *density*, i.e. how many beings we feel gratitude towards during important life events (McCullough et al., 2002). People who thus possess gratitude as a trait feel grateful more intensely and often than others, as well as having many benefactors they are mindful of in multiple life circumstances. Gratitude tends to be past-focused, based on memories or reflections on positive events that happened before that bring up associated emotions like joy (Buck, 2004). Hence, compared to other positive emotions, it lasts longer if it is related to a significant event or person in our lives (Watkins, 2013).

While gratitude is a largely beneficial emotion, there are potential blind spots to keep in mind. For one, power dynamics present a challenge; gratitude can be part of the dominance and hierarchical rituals between people of

unequal status compared to altruistic gratitude between people of equal status (Buck, 2004). Showing gratitude to someone more powerful can be more about submission than genuine gratitude, for instance. Further, people are more likely to acknowledge their gratitude towards others in publicly accessible accounts, e.g. the acknowledgments section of a book, compared to gratitude acknowledged in private (Baumeister & Ilko, 1995). Gratitude can hence feel shallow (Baumeister & Ilko, 1995). However, gratitude is a form of communication. Without listening ears, giving thanks can feel pointless for many; the (implicit or explicit) awareness of gratitude between a benefactor and a beneficiary may be necessary (Buck, 2004). Lastly, people who can be overly grateful may show lowered self-ownership of positive outcomes, i.e. attributing one's success to others' contribution and undercutting one's own effort (Buck, 2004). With these aspects in mind, we consider the benefits of gratitude on our well-being that have been empirically documented.

### 2.4. Positive psychology, well-being, and gratitude

Positive psychology aims to strengthen people's potential, capacities, and well-being (Compton & Hoffman, 2019; Sheldon & King, 2001). There is a strong link between positive psychology interventions and well-being according to a meta-analysis of 39 studies (Bolier et al., 2013). Subjective well-being consists of low negative affect, high positive affect, and high life satisfaction (Diener et al., 2002; Wood et al., 2010). As a main part of positive psychology, positive emotions and experiences that create a sense of a fulfilling life are incorporated into subjective well-being (Diener et al., 2002). Through various interventions, like practicing acts of kindness (Buchanan & Bardi, 2010), positive psychology emphasizes cultivating positive emotions, such as love, joy, intimacy, contentment, or gratitude (Compton & Hoffman, 2019). Gratitude interventions, like counting one's blessings (Emmons & Mishra, 2011), have been a key factor in positive psychology because they allow reflections on situations and others we feel thankful for (O'Leary & Dockray, 2015; Wood et al., 2010). We avoid taking things for granted when we feel thankful, which makes us appreciate and enjoy what we have (Emmons & Mishra, 2011). Being thankful helps us appreciate positive aspects in life, influencing people's increase in subjective well-being (Alkozei et al., 2018). Gratitude can also indirectly increase well-being by diminishing negative states and emotions (Emmons & Mishra, 2011; Killen & Macaskill, 2015). Gratitude is thus linked to an increase in subjective well-being, directly and indirectly (Alkozei et al., 2018; Emmons & Mishra, 2011; Killen & Macaskill, 2015). Hence, gratitude interventions have been implemented for people with pre-existing mental health problems, as well as people without them. In both groups, well-being increased through gratitude interventions (Alkozei et al., 2018; Emmons & Mishra, 2011).

There are three types of gratitude interventions (Wood et al., 2010). The first involves making a list of things one feels grateful about on a regular basis, e.g. with a gratitude diary. Keeping a gratitude diary was shown to increase people's subjective well-being, as well as diminishing their scores in depression, anxiety, and stress (Southwell & Gould, 2017). The second is grateful contemplation, i.e. thinking about a grateful situation. People are asked to contemplate on grateful moments in the last year, e.g. recalling and writing down moments from last summer; gratitude contemplation of only a few minutes can raise positive affect (Watkins et al., 2003). The third intervention is the behavioral expression of gratitude, like thanking a benefactor through a letter for the gift they provided (Seligman et al., 2005). A benefactor is a person that provided help or support in the past with a contribution (either physical or symbolic), like financial or moral support, e.g. through scholarship funds, guidance, information, affection, or advice. Compared to simply writing about positive events, writing a gratitude letter and delivering it to a benefactor resulted in higher affect and gratitude for participants who started out with a low frequency of experienced positive affect (Froh et al., 2009).

Gratitude can be based on individual reflection, such as thinking about thankful situations alone, but interpersonal interactions are an important trigger to experience gratitude (Gordon et al., 2011). In particular, we can form and maintain relationships based on sharing gratitude (Algoe et al., 2008). This means that between two people, one person expresses and feels grateful towards another person so that they can feel appreciated and also return felt gratitude in a reciprocal way; gratitude sharing is common between romantic couples or close friends (Algoe et al., 2008; Chang et al., 2013; Gordon et al., 2011). Further, Chang et al. observed a reduction in symptoms of depression of a partner when the significant other showed appreciation and gratitude towards them (2013). The partner can thus feel supported, empowered, and understood, which leads to an increase in their well-being while reducing depressive symptoms (Chang et al., 2013; Gordon et al., 2011). The benefits extend outside of dyadic relationships when the appreciated individual not only extends gratitude to their partner or benefactor but to a third party, which can additionally enhance the individual's well-being and satisfaction (Algoe et al., 2008; 2010; Chang et al., 2012). During the COVID-19 pandemic, gratitude was found as a "silver lining" for people according to a study using natural language processing; people, for instance, could focus on their family and loved ones at home (Lossio-Ventura et al., 2021).

### 2.5. Research question

Despite the burgeoning research on mental health chatbots, *gratitude* has not yet been centrally investigated. In conversational agents literature, gratitude interventions like journaling or gratitude contemplation were previously integrated into investigating well-being (Narain et al., 2020), depression reduction (Fitzpatrick et al., 2017) and comparing human assisted vs. non-human assisted guidance (Y. C. Lee et al., 2021). However, none of the studies directly observed (1) if gratitude interventions through chatbots do indeed increase people's gratitude or (2) if gratitude is related to other emotions, e.g. joy, in how people process their emotional states.

The research question is thus as follows. *What is the effect of a chatbot that promotes and shares gratitude on people's reported gratitude, alongside their positive and negative emotions?* We chose to deploy the bot for three consecutive days to cover three types of gratitude intervention techniques as per literature (Wood et al., 2010). As this is the first study in HCI that focuses on a conversational agent for gratitude interventions, our exploratory hypothesis was that a chatbot that promotes and shares gratitude with people will increase people's reported gratitude, as well as their positive emotions, and decrease their negative emotions.

## 3. Method

Our quantitative study design was a two (condition: gratitude vs. control) by two (time: pre vs. post) experiment that lasted three days. We chose three days in order to incorporate three types of gratitude-enhancing activities according to Wood et al. (2010). The activities are (1) writing down grateful moments that a person has experienced during the day, (2) reflecting on a grateful situation that occurred in a specific moment in the past, and (3) writing a letter to a person one is grateful towards. Based on this, the chatbot in the gratitude condition asked questions such as the following. "What is the one thing that makes you feel grateful today?" "What would be one thing that made you feel grateful last summer?" "Do you have someone special who inspires you? What would you say to that person to show that you are grateful for them?" Each day participants would be invited to exchange messages with a chatbot. Sharing gratitude involves providing grateful thoughts to another person to foster mutual appreciation. To simulate this situation in our experiment, the chatbot shared experiences with the participant that made the chatbot feel grateful. It would, for example, state "I am so fortunate to be able to chat with you and learn a little bit more about human experiences" or "today I was thinking about last summer when us chatbots had less work to do. I am always blissful when I have some spare time." We followed three gratitude interventions from Wood et al. (2010) to design what the chatbot would discuss to foster gratitude. In contrast, our control condition chatbot talked about movies, which is a general topic that allows for interactive questions. Thus, the chatbot asked questions about films during the interaction, as the following examples show. "What is the first movie that you can remember watching?" "What is the most interesting movie that you have watched? What was it about?" "What would you say is your favorite movie genre? Why is it that?" While our primary objective was a quantitative study, we qualitatively looked into conversations between participants and the chatbot in order to gain a more holistic understanding of our quantitative findings.

We thus followed an explanatory mixed methods approach, i.e. first conducting quantitative research as followed by qualitative research to explain the quantitative findings (Creswell & Creswell, 2017). We emphasize that the first step of data familiarization was our quantitative analysis since it was a mixed methods study. We focused more on *describing* participants' experiences (Sandelowski, 2000). Hence, we were not pursuing induction, but using our quantitative findings to guide our qualitative analysis by following Sandelowski's descriptive content analysis (Sandelowski, 2000) and Braun and Clarke's thematic analysis (Braun & Clarke, 2012), which is known for its flexibility.

The first and second authors read and analyzed the conversations separately. Afterward, we shared and discussed our insights. As per Sandelowski, we arranged themes from the most to least prevalent themes (2000), particularly on expressions of gratitude, other emotions, as well as the pandemic's effects. We grouped potential themes (Braun & Clarke, 2012)[2] by first segmenting topics on regarding what or whom participants were grateful towards and how they brought up the COVID-19 pandemic as this was prominent during the time that the study was done. We then looked at how people phrased their responses and focused on the ways they shared their reflection on gratitude with our chatbot, looking at their use of emotional language, and contextualizing the data to individuals' experiences. Two researchers separately looked into the data for analysis and jointly reconciled their findings.

### 3.1. Chatbot implementation

Based on the above gratitude intervention topics, we first designed conversations with the chatbot. We used the same average amount of words per day, with the same number of questions and exclamation marks between two chatbot conditions, as in our prior work (M. Lee et al., 2019). The chatbot was named Ro Bot (Figure 1) to minimize biases that human names can introduce. After the conversation design, the chatbot was developed using DialogFlow which was integrated into a website.

### 3.2. Measurements

We aimed to observe participants' change in gratitude in conjunction with their broader emotional profile, based on their interaction with the chatbot. Therefore, we deployed our measurements twice, before and after people engaged with the chatbot on days one and three. The measurements were the Gratitude Questionnaire - Six Item Form (GQ-6) (McCullough et al., 2002), as well as the Scale of Positive and Negative Experience (SPANE) (Diener et al., 2010). GQ-6 (Appendix 7.1) assesses the tendency to experience gratitude in daily life, e.g. "I am grateful to a wide variety of people", on a seven-point Likert scale (McCullough et al., 2002) and SPANE assesses subjective well-being based on how people feel positive and negative emotions (Appendix 7.2).

### 3.3. Procedures and participants

The study was approved by the ethical review board of the Eindhoven University of Technology. Additionally, this study was GDPR compliant based on the university's data

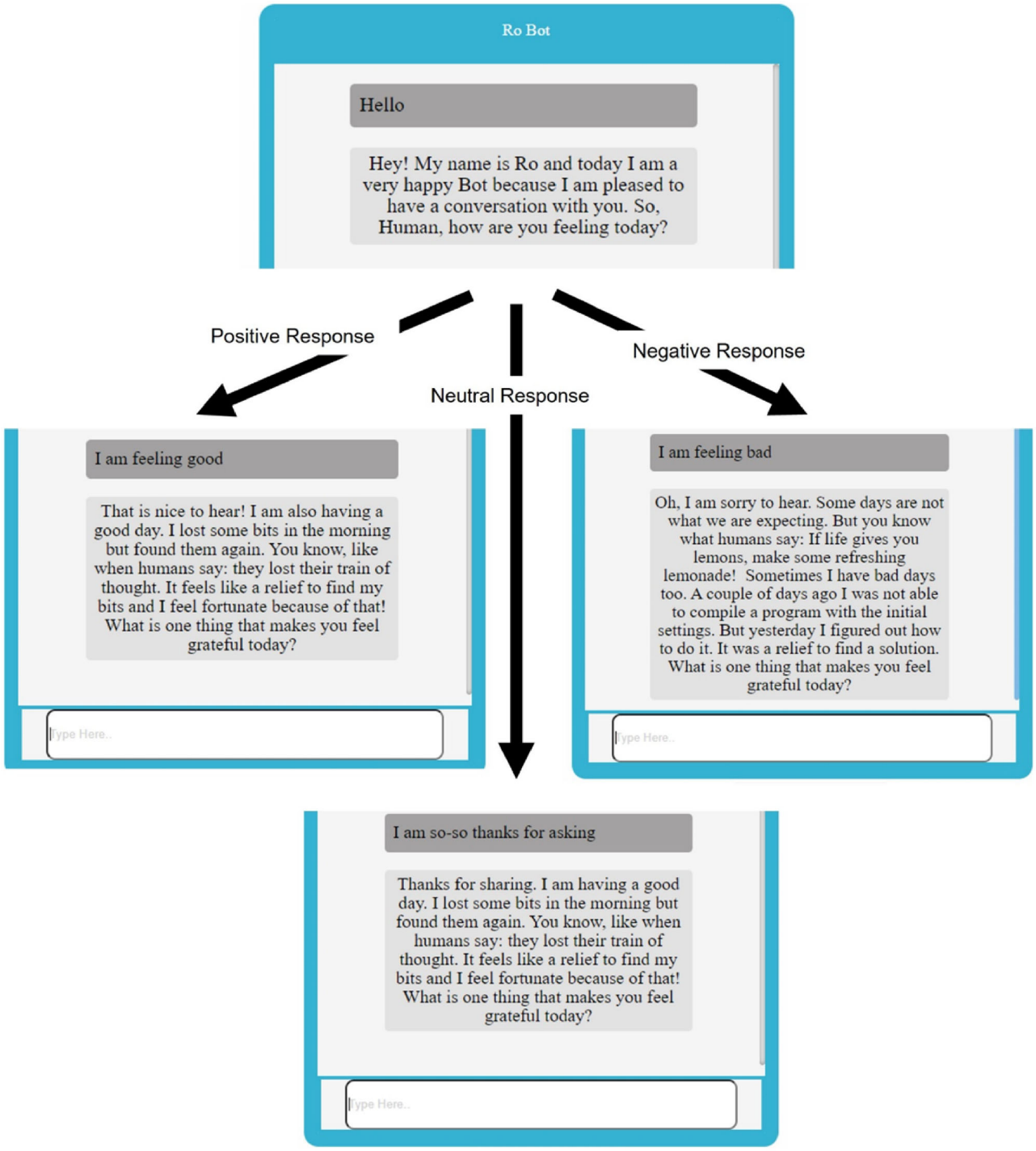


**Figure 1.** The start of the conversation with Ro Bot in the gratitude condition on day 1.

stewardship and it adhered to the code of Ethics of the NIP (Nederlands Instituut voor Psychologen—Dutch Institute for Psychologists). After consulting related research (Chang et al., 2013; Fitzpatrick et al., 2017; Killen & Macaskill, 2015) we conducted an a-priori power analysis for a repeated measures ANOVA (within- and between-subjects interaction). With the alpha level at 0.05, power of 90%, and the effect size of $\eta_p^2 = 0.068$, we aimed to have 148 participants, 74 for each condition: gratitude and control chatbots.

We recruited participants through Prolific[3] and they were paid 2.25 EUR upon completion. A custom pre-screening was applied to select participants who are at least 18 years old, reside in the United Kingdom, fluent in English, and with a 95% approval rate on Prolific (this is based on prior completed studies on Prolific) which was necessary for our experiment that lasted three days. We did not target participants with prior mental health issues because improving gratitude via chatbots has implications for the general population's well-being, which was also the case for our prior chatbot study on increasing self-compassion (M. Lee et al., 2019).

Participants were told in the informed consent form that, per day, interaction with Ro-Bot is for about five minutes.

In general, the average reading time would take around two minutes, then including the minimum time to provide a response to Ro-Bot, the interaction would be approximately five minutes, which is similar to prior research on Vincent (M. Lee et al., 2019). Participants were not restricted from interacting with Ro-Bot for longer. The potential participants read a short explanation about the experiment stating that they will have a text-message interaction with a chatbot for three consecutive days.

Gratitude was not mentioned in the recruitment and it was only stated that the study was on social skills and chatbots. Once the participants accepted the study on Prolific, they were directed to a survey that contained more explanation on the procedure and compensation. After their informed consent, we gathered demographic details before the GQ-6 and SPANE questionnaires. The participants did not have any initial training for answering the GQ-6 and SPANE to avoid potential bias; then they were redirected to a website where our chatbot was hosted, with directions on how to interact with our chatbot (Appendix 7.3). After filling in their participant ID, participants were directed to greet the chatbot to initiate the conversation for the first day. The second day followed a similar process, minus the questionnaires; after the interaction on the third day, participants were presented with the same questionnaires as on day one and were debriefed before being redirected to Prolific and paid.

We hosted the website on a private server of the Eindhoven University of Technology to safely store the conversations. The server was set up to comply with GDPR regulations[4], but we needed to preserve conversation history over three days for qualitative analysis. So, we opted to gather data per condition on separate days; this allowed us to better monitor drop-out rates without concurrency issues with other experiments running on the same server. We conducted a pilot study (N = 3 for the gratitude chatbot; N = 2 for the control condition) to check our study design and server status. Then, we collected data for our gratitude condition between March 8th and 10th, 2021; the control condition was deployed from March 17th to the 19th of the same year. We thus followed the recommended guidelines (Kretzschmar et al., 2019) on data confidentiality, transparency on the bot's identity, and evidence-based interventions on the effects of gratitude interventions in psychology. In the end, 133 participants completed the whole experiment; 15 participants left the experiment voluntarily on the second or third day of the study. The gratitude condition had 62 participants with 18 men, 42 women and 2 non-binary people (Age: M = 33.71, SD = 13.91). The control condition group had 71 participants with 27 men, 42 women, 1 non-binary person and 1 of undisclosed gender (Age: M = 31.79, SD = 11.73).

### 3.4. Results

#### 3.4.1. Quantitative analysis

We compared if the condition (gratitude chatbot vs. control chatbot) and time (before and after 3 days of interaction with 3 gratitude interventions) would impact participants' gratitude, as well as their positive and negative emotions.

We checked for outliers and violations of statistical assumptions. Shapiro Wilk tests were conducted for the control condition before ($W = 0.96$, $p = 0.022$) and after ($W = 0.096$, $p = 0.053$) the interaction, as well as for the gratitude condition before ($W = 0.096$, $p = 0.03$) and after ($W = 0.096$, $p = 0.055$) the interaction; there were violations of normality. Levene's tests were conducted between the control and gratitude conditions for before ($p = 0.45$) and after ($p = 0.98$) the interactions, showing no violation of homogeneity of variance. No outliers were found based on the distance from the mean in standard deviations. Below, we share non-parametric results in the footnotes for completeness due to non-normal distributions, but because of the central limits theorem with our large sample size (N = 133), our mixed between-within subjects ANOVA test results are reported as per our power analysis.

The main analysis on gratitude (GQ-6 - the gratitude scale) resulted in a significant difference between gratitude vs. control chatbot conditions ($F(1, 131) = 17.27$, $p = 0.0001$, $\eta_p^2 = 0.11$).[5] The main effect of time, i.e. comparing gratitude before vs. after three days, was not significant ($p = 0.286$). The interaction between time and condition was significant (($F(1, 131) = 5.98$, $p = 0.0159$), $\eta_p^2 = 0.00006$). Those with the gratitude chatbot showed a slight increase in GQ-6 (from M = 33.64 to M = 34.03). But, the participants who chatted with our movie-bot (control condition) demonstrated a *lowered* GQ-6 scores after three days, from M = 30.40 to M = 29.36; we used Z-scores for comparability across measures (see Figure 2).

We next checked for people's change in positive (SPANE-P) and negative (SPANE-N) emotions. For SPANE-P, the main effect of the condition was significant ($F(1,131) = 10.23$, $p = .0017$, $\eta_p^2 = 0.072$), as well as the main effect of time ($F(1,131) = 24.27$, $p < .0001$, $\eta_p^2 = 0.15$). Their interaction was not significant ($p = 0.391$).[6] Participants in both conditions reported higher levels of positive feelings at the end of the study. We see an increase from M = 22.19 to M = 23.60 in the gratitude condition and from M = 19.40 to M = 20.39 in the control condition.

SPANE-N showed the same trend. The main effect of condition and ($F(1,131) = 4.20$, $p = .043$, $\eta_p^2 = 0.031$) and time ($F(1,131) = 24.87$, $p < .0001$, $\eta_p^2 = 0.15$) were significant, but not their interaction ($p = 0.74$).[7] On average, participants in both conditions had lower SPANE-N after the interaction with the chatbot (M = 14.03) than before (M = 15.26). Participants in the gratitude condition showed a decrease from M = 12.64 to M = 11.50 and the control condition's SPANE-N lowered from M = 14.89 to M = 13.58. Compared to SPANE-P and -N, only the change in gratitude showed an interaction between the effect of time and condition. While positive emotions went up and negative emotions decreased across both conditions after interacting with the chatbot, people's gratitude decreased for the control condition while increasing for those who interacted with the gratitude chatbot.

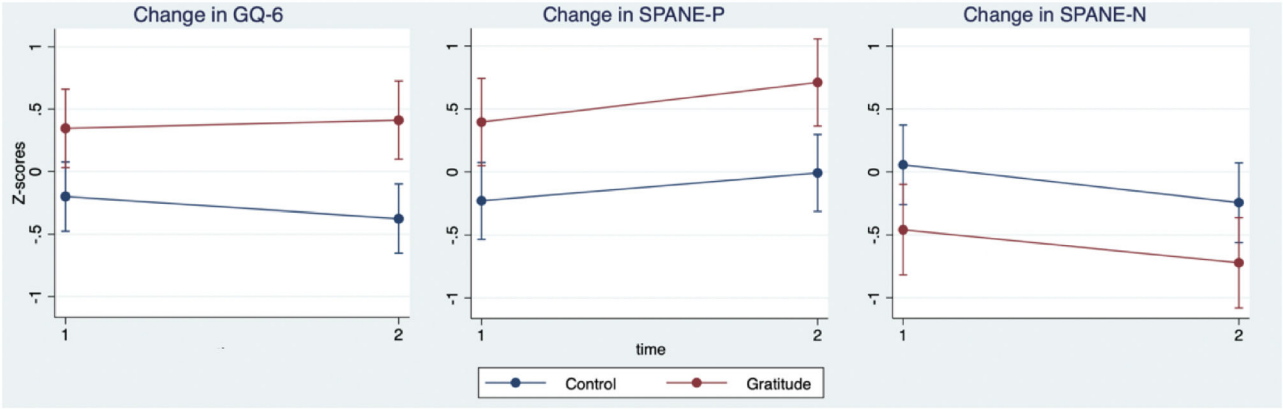


**Figure 2.** The change in Z-scores (before vs. after the experiment) of reported gratitude (GQ-6), positive emotions (SPANE-P), and negative emotions (SPANE-N). The blue line is the control condition and the red line is the gratitude condition.

### *3.4.2. Qualitative analysis*

The descriptive qualitative data analysis (Sandelowski, 2000) was conducted to better understand the quantitative data. We explored the phenomenon behind Figure 2, i.e. why positive and negative emotions for both conditions followed the same trend across two time points, but reported gratitude did not. Or specifically, why positive emotions can go up while feeling thankful may lessen. We hence looked into people's messages to the gratitude chatbot to observe how people's emotional experiences of gratitude can vary from experiencing positive or negative emotions. Since our data set was sparse,[8] we pursued a descriptive approach that does not over-interpret participants' positions (even if any descriptive reading entails an interpretation) (Sandelowski, 2000). Below, we summarize participants' responses per day before addressing in what ways gratitude may function differently than other positive emotions.

On the first day, participants expressed gratitude towards their family, work, friends, health, partner, education, for having good weather and for having their basic needs (like food or job) covered. When asked how thinking about grateful moments made them feel, participants expressed that they felt mostly positive: "good," "calm," "full and warm," "generally positive that I feel more grateful than not, especially given the current circumstances in the world," "slightly happier than I did 5 minutes ago!" A few reported feeling indifferent.

On the second day, the chatbot asked about two situations that occurred last year. People brought up the pandemic and the coronavirus vaccine most frequently. Many people reflected that though the lockdown period was difficult, they were able to appreciate small joys and people around them: "well last summer I was in lockdown due to the pandemic, but I was so grateful to have my family at that time- I really relied upon them."

On the last day, the chatbot inquired about inspirational people. Participants brought up their family, partners, and friends. Upon being asked what to say to inspirational figures, participants frequently wanted to thank them through remarks like "I am glad our paths crossed" and "I will tell her that I love her very much and that I am grateful that she keeps me company during the pandemic." Yet a few people admitted that verbal thanks may not be their strength: "I am not very good at expressing that kind of thing with words, so I would probably just send him a nice gift, randomly."

As the summary over three days suggests, expressing and thinking about gratitude is positively valenced for most people. Yet, what makes gratitude different from other positive emotions? We analyzed people's conversations with the bot following content analysis (Sandelowski, 2000) combined with thematic analysis (Braun & Clarke, 2012) to arrive at a salient trend: Gratitude arises from one's "lived experience" of *contrasting* events.

Gratitude shined through negative experiences, whether one is inspired by a loving parent who is no longer there, found support and freedom after a break up, or felt held and loved in times of despair. When asked about inspirational people, a participant shared that "my mum is inspiring as she's gone through a lot and is brave," with a message to her being: "I love you and I miss you terribly." It is unclear whether or not the mother passed away; the present tense usage, e.g. that she *is* brave, contrasts with "I miss you terribly." The participant's perception of bravery resonates as a *presently experienced presence* of a person who is inspiring, perhaps as a lasting and vivid memory.

Likewise, a mix of positive and negative emotions are present for another person: "I recently ended a relationship that I hadn't been happy in for some time that had been causing me a lot of upset. I was grateful that my family welcomed me home and returning to a sense of freedom has made me unbelievably happy." Feeling upset and unhappy in a relationship can be a long-lasting feeling that lingers, even after a breakup. Yet through this, freedom, unbelievable happiness, and the support of one's family were revived.

Another participant shared that "when I was so sad I could barely function, my best friend looked after me and made sure I was fed and helped me as an assistant at my drag show. I felt very held and loved." We see gratitude arising from feeling "saved" when this person reached the lowest point; feeling fed, held, and loved by another person can foster gratitude when we have difficulties standing on our own. In sum, when negative events and moods are ameliorated by positive influence, this emotionally contrasting experience can evoke gratitude.

Mixed emotions appear in different ways for people. A participant stated that they are grateful for their friends and typed that "I would tell them that I miss them, but it's quite sad because I feel like they don't feel the same way ☹." As a result of sharing this, the participant wrote to the chatbot that they felt "relieved." Reciprocal emotions may not occur with the same intensity or frequency, e.g. maybe their friends are not missing them so often or to the same extent. While noting this disparity may be "sad," it might be a relief to share this realization with someone or something, i.e. a chatbot.

The emotional contrast is also found through counterfactual considerations: "When we got good news from the doctors that our nan (grandma) was clear of cancer" a participant felt "happy and grateful as things could be a lot worse." For this person, the fact that their grandmother's health improved, given that it could have been worse, is the reason for gratitude and happiness. Counterfactual thinking was also implied when it came to gratitude experienced due to the pandemic. Given that the pandemic introduced employment insecurity for many people, one person was grateful "that I have kept my job and kept going to work throughout the pandemic." This was repeatedly noted by many other participants, e.g. being grateful "that I have a job when others have lost theirs," which implies that joblessness was a feasible counterfactual for many in this period. Then, negative situations either experienced in real life by oneself, others, or considered counterfactually can serve as the basis for feeling grateful. Gratitude covers a mix of positive and negative situations and emotions.

We end this section by elaborating on what the chatbot added. Gratitude is a shared emotion, whether it is shared with a person or a machine. People's awareness that they are talking to a mere chatbot may not undercut their capacity to practice gratitude: "I'm laughing mainly at the absurdity of me typing this to you but also because I'm smiling as I think of wife" (whom this participant felt grateful towards). A chatbot does not know or feel thankful like we do, let alone know what it is like to have a significant other. So even if discussing gratitude with a chatbot may be "absurd," reflecting on inspirational people and gratitude-evoking situations can remind us of many ways to feel thankful. A few specifically thanked the chatbot: "I thank you for getting my mind to these places which makes me appreciate the little things in life- thinking of these events has made me feel carefree and light." When gratitude is not an affective trait, most people may need reminders: "I think sometimes you just need someone to ask you these things to realize just how many good things in the world there are." Even if a bot is a something, not a someone, the resulting effect is that it allowed people to reflect: "It feels nice to remind myself of everything I am grateful for. It makes me want to spread kindness and positivity and tell people how much I love and appreciate them." A benefit is that even if gratitude arises through a bot, it can spread beyond the human interactant, towards others they care about and love. A chatbot, then, can enhance or mediate human-human gratitude.

## 4. Discussion

Gratitude contributes to well-being (McCullough et al., 2004; Watkins et al., 2003), more so than general positive affect (Bartlett & DeSteno, 2006). However, literature categorizes gratitude as a positive emotion like happiness (Campos et al., 2013; Fredrickson, 2004; Lazarus & Lazarus, 1994). This tendency is observed in many experimental designs, such as measuring the effect of gratitude interventions through self-reported positive affect (Watkins et al., 2003) with gratitude predicting happiness (Nguyen & Gordon, 2020) and hope (Witvliet et al., 2019). Feeling pleasant or happy can be a part of, or relate to, gratitude. But, we see that conflating gratitude with other positive emotions can be misleading. Our research suggests how gratitude can arise from positive and negative emotional experiences, telling us a far richer story of what it means to feel thankful.

We first discuss limitations. The data was collected during the COVID-19 lockdown period, as often mentioned in our qualitative data; participants in general may have been more prone to experience emotional fluctuations over shorter periods of time. Yet this allowed for a glimpse of how people were able to be grateful during the pandemic. Our control and gratitude chatbots were deployed on different days in March of 2021 to preserve data integrity through our GDPR compliant server. Participants were randomly selected but started on different dates, which should be remedied in subsequent research. In our study, participants in two conditions showed differences in GQ-6, SPANE-P, and SPANE-N scores before the start of the experiment (Figure 2) though our participant selection criteria and study design remained the same. At the start, control condition participants had lower GQ-6 and SPANE-P scores, but scored higher for SPANE-N compared to the gratitude condition showing reduced internal validity. However, if participants were to start with similar average scores across two conditions, we would expect a more significant divergence between the control and gratitude conditions, particularly since gratitude scores on average *decreased* for the control condition even though their positive affect in general (SPANE-P) went up. The focus is on how gratitude can potentially decrease even though general positive affect can increase, i.e. gratitude is not just another positive feeling as our qualitative data indicated.

Gratitude is a complex moral emotion that is understudied; due to its subtlety and ambiguity, it does not extend in a straightforward manner from existing theories in emotion psychology to application in HCI. Our paper contributes to HCI literature by showing that a chatbot may act both as a target and conduit for expressing gratitude and that this effect—although yielding positive effects on well-being—does not simply correlate in a one-to-one fashion to positively valenced emotions. We have unpacked some of this complexity in our paper and illustrated the potential for chatbots to impact gratitude. We also aimed to *promote* a positive construct, i.e. gratitude, that improves well-being (Alkozei et al., 2018; Emmons & Mishra, 2011; Killen & Macaskill, 2015), rather than using a chatbot to *negate* signs of mental difficulties, e.g. anxiety or depression (Fitzpatrick

et al., 2017; Fulmer et al., 2018). As of now, chatbots for mental health tend to focus on a "problem," most commonly autism and depression (Abd-Alrazaq et al., 2019). But an alternative is to design conversational agents that account for mental health in a more nuanced light, i.e. not as a negation of symptoms or disability, but as an opportunity to flourish. Our choice for chatbots rather than other technological interventions is based on a number of considerations: (1) Chatbots are widely available and low-cost compared to, e.g. social robots; this enhances access to a wide community of users. (2) Chatbots are flexible in terms of perceived roles and social attribution, as they lack a particular embodiment that is suggestive of a particular gender, age, or ethnicity (as with our chatbot), which reduces potential biases that embodiment can introduce. (3) Compared to human conversational partners, like therapists, chatbots can reduce people's fear of judgment when revealing personal or sensitive information (Brandtzæg et al., 2021; Brandtzaeg & Følstad, 2017; Ta et al., 2020). Again, the aim is not to replace human therapists or care, but to augment or support people's path towards mental wellness with technology in diverse ways (Kretzschmar et al., 2019; Y. C. Lee et al., 2020; Wang et al., 2021). Our study aimed to answer: *What is the effect of a chatbot that promotes and shares gratitude on people's reported gratitude, alongside their positive and negative emotions?*

Given that our interest was in how people's self-reported emotions *changed*, we were concerned with both the effect of time (before and after 3 days of interaction) and condition (gratitude vs. control). As a reminder, we advertised on Prolific that our study was on social skills with a chatbot, not gratitude, to lower participants' initial bias. The gratitude chatbot and the GQ-6 scale did ask about gratitude, e.g. people one feels grateful towards, which was the case in prior works on gratitude (Alkozei et al., 2018; Emmons & Mishra, 2011). The qualitative data included in-the-moment reflections that are less prone to the demands of self-assessment that psychological instruments can bring. To emphasize, the aim of our quantitative and qualitative research was to understand how gratitude functions differently from other emotions, and if chatbots can be viable for gratitude interventions.

The quantitative results showed that the gratitude chatbot increased people's reported gratitude and positive affect compared to the control chatbot, and lowered negative affect. In both conditions, our participants' positive emotions (SPANE-P) went up after three days whereas negative emotions (SPANE-N) went down. An interesting trend is that gratitude can *decrease* while other positive emotions *increase*. For SPANE-P and -N, there were significant main effects of the condition (gratitude vs. control chatbot) and time (before vs. after), but not their interactions. For people's sense of gratitude (GQ-6), the main effect of time was insignificant, but the difference between the conditions and the condition-time *interaction* were significant. The absence of significance regarding time is important here; if positive and negative emotions significantly changed over time, why did gratitude over time not show a significant change?

Overlooking the interaction would be a mistake: The length of interaction *alone* cannot influence gratitude (unlike positive and negative emotions). The difference between the two chatbots may be more accentuated than the effect of time. Or, gratitude may work with a different timescale than other emotions. Our gratitude chatbot was better at increasing people's gratitude than a control-bot. Still, gratitude may require more time than simple positive or negative emotions for the effect of time to be significant. Three days may not be enough, e.g. other studies looked at two weeks of human-chatbot interaction (Fitzpatrick et al., 2017; Lee et al., 2019). It is therefore advised that in subsequent research the length of the study should be longer. Our rationale for three days is that we implemented three types of gratitude intervention (one per day).

More importantly, gratitude may not increase over time *independent of social interactions*; "when we show gratitude, then, it is this display of the other's attitude toward us to which we are responding" (Berger, 1975, p. 302). Gratitude, more so than, for instance, joy, critically relies on the social dimensions of our lives. How artificial agents become embedded in our social worlds then can influence the types of and depth emotions we can explore with them. Even if emotions in general are socially constructed in our relations with others (Averill, 1980; Gendron & Feldman Barrett, 2009; McCarthy, 1994), they are not all socially constructed in the same way. An infant does not need to know the word "joy" to smile back at us; a dog does not need to know the word "fear" to run away when someone screams at them. Ekman's basic emotions (Ekman, 1992, 1993; Ekman & Friesen, 1971) may be basic in that non-linguistic understanding and expression of basic emotions can be easily shared. As communicative gestures go, basic emotions are socially constructed more intuitively than most moral emotions like gratitude, If moral emotions "are linked to the interests or welfare either of society as a whole or at least of persons other than the judge or agent" (Haidt, 2003, p. 853), examples like guilt or gratitude require a more complex understanding of how we relate to one another through lived experience. Hence gratitude is often other-directed (Buck, 2004; Chang et al., 2013; Froh et al., 2009; Gordon et al., 2011; Seligman et al., 2005). And when we feel thankful towards someone, that acknowledgment also allows us to spread gratitude towards third parties (Algoe et al., 2010, 2008).

Gratitude is a moral emotion since it stands for our appreciation of altruism (Lazarus & Lazarus, 1994); giving and receiving gratitude has many facets, as our qualitative data showed. We recount a few. Upon admitting sadness at the thought that friends one misses may not miss them as much, one person felt relieved when asked by our gratitude chatbot. Another was laughing at the absurdity of telling the bot how they would express gratitude while smiling about their partner, for whom they felt grateful. A participant recollected a difficult period and how they were grateful to a supportive friend who made them feel held and loved when they were at a low point, filled with sadness. Research on gratitude thus far has not fully appreciated such a mixture of positive and negative emotions, which deserves further

attention. People experience a medley of emotions like relief-sadness, sadness-love, humor-gratitude-joy, and other mixtures when they were given a chance to reflect on gratitude by interacting with a chatbot.

Our research makes a substantial contribution to HCI literature by providing exploratory empirical evidence on how conversational agents can aid our flourishing (Lee & Contreras, 2023) and our scales used and instructions to participants (see Section 6) can help future works on this topic. Importantly, our chatbot served as both a *conduit* and *object* of gratitude, c.f., (Lee et al., 2021), i.e. people thanked it and thanked others through it; some people were grateful to the chatbot for letting them reflect on gratitude towards others in their lives. Thus, our chatbot can be used as an inspiration for future gratitude intervention systems: Conversational agents can utilize artificial intelligence and machine learning to hold conversations with not only patient groups, but a broader user base to improve their well-being by applying gratitude interventions to reflect on their life, which aligns with the philosophy of positive psychology (Compton & Hoffman, 2019). Additionally, we see the potential for conversational agents to be more than simple systems, tools, or digital assistants for practical tasks (Brandtzaeg & Følstad, 2017; Clark et al., 2019; Dale, 2016; Shum et al., 2018) while holding two roles as a *mediator* of human-human gratitude and a *beneficiary* of human gratitude towards it.

People do attribute agency to simple pattern-matching machines (Weizenbaum, 1966), but we do not yet utilize conversational agents for more complex affective experiences like spreading gratitude through artificial and human beings. This relates to how chatbots are also used as mental support agents (Abd-Alrazaq et al., 2019; Fitzpatrick et al., 2017; Fulmer et al., 2018; M. Lee et al., 2019; Narain et al., 2020; Ta et al., 2020). Given such a growing body of work, practitioners advocate that chatbots are not replacements of human professionals while being valuable as supporting actors that can motivate people to get therapy as needed, in an ethically mindful way (Kretzschmar et al., 2019). Yet, none of the cited approaches looked specifically into gratitude and how it differs from other emotions as we have done, which is crucial for developing digitized mental health support as we move forward. We end with two broad recommendations based on our findings.

Our first recommendation is to zoom in on specific emotions, e.g. gratitude, and contextualize them for HCI rather than importing larger constructs from psychology at face value, e.g. well-being. Subjective well-being is taken to be a combination of low negative affect, high positive affect, and high life satisfaction (Diener et al., 2002) which is the core of the SPANE instrument that we used (Appendix 7.1) (Diener et al., 2009). But, gratitude differs from other positive emotions while contributing to well-being (Wood et al., 2010). How it involves both positive and negative affect requires more attention; well-being brought on by gratitude may not be adequately captured by popular scales like SPANE for measuring well-being. Emotionally rich experiences that evade clear categories like positive or negative affect should not be excluded from what it means to flourish.

Helping people cultivate positive emotions like joy, intimacy, and gratitude is central to positive psychology (Compton & Hoffman, 2019), yet this fails to capture the unique characteristics and benefits of diverse emotions at hand. While gratitude interventions have been used in a piecemeal fashion in HCI (Fitzpatrick et al., 2017; Lee et al., 2021; Narain et al., 2020), ours is the first study to specifically dive into gratitude and how it may differ or not from broader positive and negative emotions. Similarly, other moral emotions (Haidt, 2003), or not so "basic" emotions, like joy, can be assessed as dependent variables with clear study designs; indiscriminately labeling emotions as merely "positive" or "negative" leaves out a chance to more deeply explore the diversity of our feelings. We can better grasp how contrasting emotional experiences are processed by treating particular emotion categories as separate research agendas in HCI, above and beyond solely importing emotion research from related domains like psychology.

Second, we recommend designing *for* human-human interactions *through* human-chatbot interactions when it comes to emotional experiences. Beyond seeing human-human interactions as templates for human-technology interactions, like how computers are social actors (Nass et al., 1994), the next challenge is considering when and how conversational agents take part in or mediate our emotional experiences. Gratitude heavily builds on human interpersonal relationships (Gordon et al., 2011), but how a chatbot can aid human-human gratitude sharing or individual reflection is a new area. Human-chatbot relationships are unlike human-human friendships or romantic relationships, in which gratitude sharing frequently occurs (Algoe et al., 2008; Chang et al., 2013; Gordon et al., 2011). The way we form and maintain human relationships through gratitude (Algoe et al., 2008) will not work in the same way with conversational agents like chatbots.

According to our qualitative data, a chatbot can be (1) a mediator of gratitude between people and (2) a recipient of gratitude, as well as performing both roles. For instance, a person feels thankful to the chatbot for reminding them about what we take for granted, which leads the person to express gratitude to another person. Gratitude is not a zero-sum game; feeling thankful towards a form of technology through targeted interventions does not mean that less gratitude is shared between people. In fact, a chatbot can act as a gratitude trigger or conduit, further enriching people to spread gratitude, e.g. "It feels nice to remind myself of everything I am grateful for. It makes me want to spread kindness and positivity and tell people how much I love and appreciate them." However, we need more research on if gratitude interventions (Wood et al., 2010) that involve a chatbot carries over to gratitude shared between people, and what effect that may have, especially in a long-term manner. A particularly interesting path forward is exploring how gratitude can be transitioned from a short-term feeling to becoming an affective trait (Emmons & Mishra, 2011; Watkins, 2013), given that feeling grateful has many benefits for well-being (Alkozei et al., 2018; Emmons & Mishra, 2011; Killen & Macaskill, 2015).

## 5. Conclusion

Gratitude is a rich concept that encompasses several interpretations that have been promoted over the years. As a moral emotion on showing appreciation of altruism (Lazarus & Lazarus, 1994), it supports and builds interpersonal relationships. Gratitude fosters well-being, for feeling thankful helps us appreciate what we presently have instead of what we lack (Emmons & Mishra, 2011). We can cultivate gratitude as an affective trait if it is a virtue in an Aristotelian sense (Bartlett & Collins, 2011); becoming a grateful person may be a long-term or lifelong process for many. But short-term changes can be aided by gratitude interventions (Watkins et al., 2003; Wood et al., 2010), for feeling thankful can be a momentary feeling that transitions to a general mood, contributing to becoming a grateful person as a trait.

As the first HCI study that specifically looked at gratitude sharing with a conversational agent, we learned that feeling thankful is not merely a positive emotion. Gratitude can qualitatively involve positive and negative emotional experiences. Struggles in life that may often be negative, e.g. undergoing lockdown during the pandemic, can help us feel grateful for what we do have, e.g. family, given the chance to reflect on gratitude. Such reflection is what a conversational agent can assist in. Thus quantitatively, our gratitude chatbot increased positive emotions and decreased negative emotions better than the control bot, but the trends were the same, i.e. positive emotions tended to increase while negative emotions decreased for both bots. People's self-reported gratitude over three days increased with the gratitude chatbot, but the control bot that talked about movies decreased people's gratitude. Hence, the human-chatbot interaction resulted in gratitude demonstrating a different emotional profile compared to people's positive and negative emotions. We note that gratitude is a complex moral emotion—ambiguous by nature since its presence depends not merely on positive valence or a singular state of well-being, but is rather a rich, interconnected, and sometimes conflicted tapestry of thoughts, feelings, and actions that emanate from a deep sense of appreciation. Gratitude may well be preceded by some of the low points in human emotion—moments of need, loss, stress, sadness, or despair. Moreover, the intensity of gratitude can vary greatly depending on individual experiences, values, and cultural contexts. Thus, in our view, measuring gratitude is best approached through a triangulation of methods, and is not easily operationalized through any single metric or standardized scale. This is the approach we take in our paper, applying a multi-method combination of quantitative and qualitative data to arrive at a suitably rich and subtle understanding of the context-dependent, idiosyncratic, and frequently seemingly opposing emotional forces that constitute gratitude.

For future research, we recommend a specific look at various types of complex moral emotions like gratitude and how conversational agents, like chatbots, can mediate people's shared emotions. We see that people can express gratitude to a simple chatbot for reminding them of what and whom they feel grateful for. Though artificial agents do not know what it means to feel thankful, they can partake in how we share emotions with others, perhaps functioning as a bridge between momentary gratitude of the present towards gratefulness as a lasting trait in our future.

## Notes

1. Replika - https://replika.ai/
2. The classic six steps are familiarizing oneself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report.
3. Prolific - https://www.prolific.co/
4. GDPR regulations - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679
5. Our non-parametric test showed the same trend: the Kruskal-Wallis test revealed a significant difference between two conditions for gratitude ($H(1) = 5.67$, $p = 0.017$) with gratitude calculated as a difference of scores before and after the interaction.
6. Again, we also conducted the Kruskal-Wallis test in which there was no significant difference between conditions ($H(1) = 0.125$, $p = 0.724$) for SPANE-P.
7. The Kruskal-Wallis test showed no difference between conditions for SPANE-N ($H(1) = 0.384$, $p = 0.535$).
8. People wrote 8,231 words in total to the gratitude chatbot, with a mean of 132.76 words per participant across three days. The control condition was comparable (8,513 words in total, $M = 119.90$ words per participant).

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## About the Authors

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**Jessica Contreras Alejandro** holds a master's degree in Human-Technology Interaction from the Eindhoven University of Technology and a B.Sc. in Computer Science and Technology from Tecnológico de Monterrey. Jessica currently works as Test Engineer which aligns with her passion for developing quality technology that improves people's life.

**Wijnand IJsselsteijn** has a background in artificial intelligence and cognitive neuropsychology. His research is on the impact of media technology on human psychology and using psychology to improve technology design. Currently, he is a full professor of Cognition and Affect in Human-Technology Interaction at the Eindhoven University of Technology.

## Appendix

### *A.1. Scale of positive and negative experience (SPANE)*

Please think about what you have been doing and experiencing during the past four weeks. Then report how much you experienced each of the following feelings, using the scale below. For each item, select a number from 1 to 5, and indicate that number on your response sheet; 1 = Very Rarely or Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Very Often or Always.

Positive
Negative
Good
Bad
Pleasant
Unpleasant
Happy
Sad
Afraid
Joyful
Angry
Contented

Scoring: The measure can be used to derive an overall affect balance score, but can also be divided into positive and negative feelings scales.

Positive Feelings (SPANE-P): Add the scores, varying from 1 to 5, for the six items: positive, good, pleasant, happy, joyful, and contented. The score can vary from 6 (lowest possible) to 30 (highest positive feelings score).

Negative Feelings (SPANE-N): Add the scores, varying from 1 to 5, for the six items: negative, bad, unpleasant, sad, afraid, and angry. The score can vary from 6 (lowest possible) to 30 (highest negative feelings score).

Affect Balance (SPANE-B): The negative feelings score is subtracted from the positive feelings score, and the resultant difference score can vary from −24 (unhappiest possible) to 24 (highest affect balance possible). A respondent with a very high score of 24 reports that she or he rarely or never experiences any of the negative feelings, and very often or always has all of the positive feelings. Copyright by Ed Diener and Robert Biswas-Diener, January 2009; refer to (Diener et al., 2009).

### *A.2. The gratitude Questionnaire -Six Item form (GQ-6)*

Using the scale below as a guide, write a number beside each statement to indicate how much you agree with it; 1 = Strongly Disagree 2 = Disagree 3 = Slightly Disagree 4 = Neutral 5 = Slightly Agree 6 = Agree 7 = Strongly Agree.

1. I have so much in life to be thankful for.
2. If I had to list everything that I felt grateful for, it would be a very long list.
3. When I look at the world, I don't see much to be grateful for.*
4. I am grateful to a wide variety of people.
5. As I get older I find myself more able to appreciate the people, events, and situations that have been part of my life history.
6. Long amounts of time can go by before I feel grateful to something or someone.*

Scoring Instructions:

1. Add up scores for items 1, 2, 4, and 5.
2. *Reverse scores for items 3 and 6. That is, for a score of" 7," replace with" 1," for a" 6," replace with" 2," and so on.
3. Add the reversed scores for items 3 and 6 to the total from Step 1. This is the total GQ-6 score. This number should be between 6 and 42.

The scale is by McCullough et al. (2002) (McCullough et al., 2002).

### A.3. Instructions

The participants read the description of the study and were given the following instructions before chatting with the chatbot. Gratitude was not mentioned in the recruitment phase or in the directions (Figure A1).

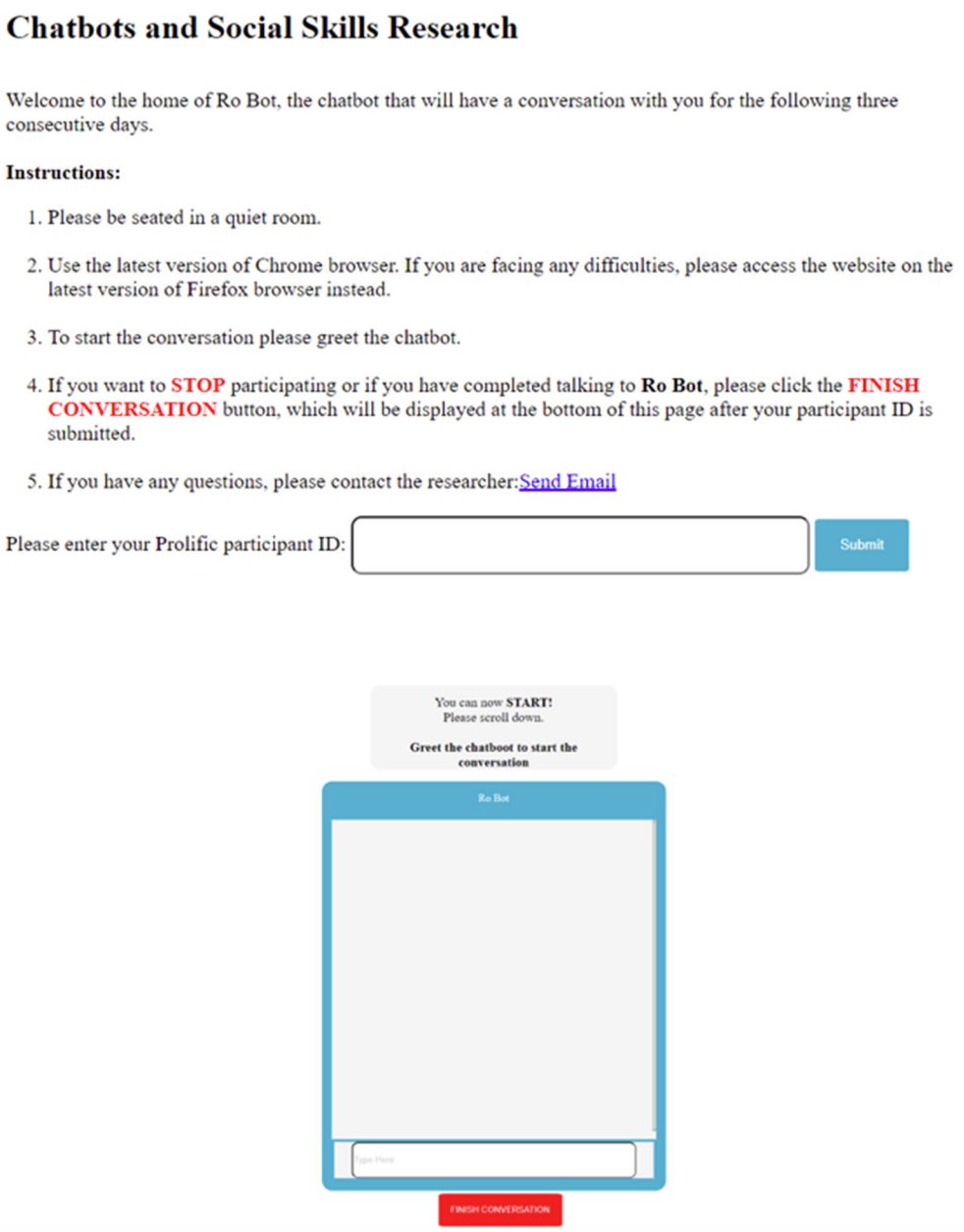


**Figure A1.** Instructions.