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The avatar will see you now: Support from a virtual human provides socio-emotional benefits

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ABSTRACT

When people are in emotional distress, they often seek support. Virtual humans may provide unique and complementary benefits to human support provision, given that virtual humans are readily available and help sharers overcome socio-evaluative threats, thereby increasing willingness to disclose. Here, we examined whether talking to a virtual human elicits socio-emotional benefits, and whether this is moderated by the type of support provided. To examine the scope of the potential effect, we compared two key types of support (emotional and cognitive), across two emotions (anger and worry). Participants ($N = 115$) shared two personal emotional experiences with a virtual human, who provided either emotional or cognitive support via the Wizard-of-Oz method (i.e., a human-operated avatar). Results showed that participants felt better after talking to the virtual human, as evidenced by reduced intensity of the target emotion and generally improved affect. The emotional improvement was similar for emotional and cognitive support. Cognitive support was also experienced as equally effective as emotional support, and led to similar levels of experienced closeness and desire to interact with the virtual human again. These findings suggest that talking to a virtual human can be a valuable form of support at times of distress.

1. Introduction

When people are in emotional distress, they often turn to others for support, a phenomenon that has been termed social sharing (Rimé, 2009; Rimé, Finkenauer, Luminet, Zech, & Philippot, 1998). Social sharing is frequently employed as a means of regulating one's emotions: By talking to others, sharers can elicit support that might facilitate their coping (Rimé, 2009). Unfortunately, however, people do not always feel comfortable sharing their personal problems with others, for example when these concern highly stigmatized issues (Smart & Wegner, 2000). Moreover, people do not always have someone to talk to: Friends may have grown tired of listening to the same problems over and over again (Forest, Kille, Wood, & Holmes, 2014) and professional help can be too expensive, located too far away, or come with a long waiting list (Hunt & Eisenberg, 2010; Johnson et al., 2007). In light of these problems, we examined whether talking to a virtual human may bring about emotional relief and thereby constitute a valuable form of support.

Recently, both public and scientific interest in virtual humans' potential to complement traditional mental healthcare is growing (Markoff & Mozur, 2015; Romeo, 2016). Virtual humans are computer-generated characters that respond to words and non-verbal behavior in human-like ways, using emotional expressions, language, and body language (Gratch et al., 2002), and they can provide forms of support that are readily accessible to anyone with an internet connection. Recent work has shown that people are willing to disclose upsetting situations to virtual humans, sometimes even to a greater extent than when sharing with a human (Gratch, Lucas, King, & Morency, 2014; Lucas, Gratch, King, & Morency, 2014, 2017). It is unclear, however, whether talking to a virtual human is indeed effective in bringing about emotional relief, and to what extent this is dependent on the type of support that is provided.

Two primary types of support have been distinguished: emotional and cognitive (Rimé, 2009). Emotional support includes comfort, validation, and understanding, and is typically associated with short-term relief and perceived helpfulness, as well as more relational closeness (Batenburg & Das, 2014; Morelli, Lee, Arnn, & Zaki, 2015; Nils & Rimé,

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2012; Pauw, Sauter, van Kleef, & Fischer, 2018). Cognitive support, on the other hand, is directed at changing the way the other thinks about the emotional situation by recreating meaning and reappraisal, and is associated with more long-term emotional recovery (Batenburg & Das, 2014; Nils & Rimé, 2012). In the present study, we compared the effect of emotional vs. cognitive support on various socio-emotional outcomes.

1.1. Sharing with virtual humans

To effectively reduce people's experience of negative emotions, those sharing their emotions – henceforth 'sharers' – need to be willing to talk about the emotions elicited by an emotionally upsetting event (Burleson & Goldsmith, 1996; Greenberg, 2004; Rimé, 2009). However, openly disclosing one's emotions may also signal vulnerability, which puts the sharer at risk of being ridiculed, rejected, or stigmatized (Burleson & Goldsmith, 1996; Derks, Fischer, & Bos, 2008). Thus, in order for people to be willing to share and discuss sensitive issues, a safe and non-threatening conversational environment is required (Burleson & Goldsmith, 1996; Greenberg, 2004).

Virtual humans can provide such a safe environment, as they offer the best of both worlds: They are capable of establishing an emotional connection while also fostering anonymity. Unlike when talking to humans, talking to a computer does not evoke socio-evaluative concerns and thereby nullifies any risks related to negative self-presentation (Caplan & Turner, 2007). At the same time, virtual humans are capable of creating rapport, and can reduce tension and embarrassment by using both verbal (e.g., empathic responding, reciprocal self-disclosure) and non-verbal behaviors (e.g., smiles, encouraging head nods; Bickmore & Picard, 2005; Birnbaum et al., 2016a, 2016b; Gratch, Kang, & Wang, 2013; Hoffman, Birnbaum, Vanunu, Sass, & Reis, 2014; Kang, Gratch, Wang, & Watt, 2008; Liu & Sundar, 2018; Wang & Gratch, 2010). Supporting virtual humans' potential as conversational partners, several studies have shown that participants who believed they were interacting with a computer reported lower fear of self-disclosure and lower impression management, and were rated by observers as more willing to disclose, compared to those who believed they were interacting with a human-operated computer (Gratch et al., 2014; Lucas et al., 2014, 2017).

Furthermore, while we know very little about interacting with virtual humans, recent work suggests that talking to other types of conversational agents (particularly chatbots) has potential for bringing about socio-emotional benefits. For example, in the last decade, a wide variety of chatbot interventions have been developed that overall seem to be relatively effective in reducing psychopathological symptoms, including stress, depression and anxiety (Bendig, Erb, Schulze-Thuesing, & Baumeister, 2019; Fitzpatrick, Darcy, & Vierhile, 2017; Hoermann, McCabe, Milne, & Calvo, 2017; Inkster, Sarda, & Subramanian, 2018; Ly, Ly, & Andersson, 2017). Furthermore, studies investigating mental health interventions delivered by social robots have shown that people experienced a positive increase in mood after talking to a social robot, though it should be noted that these studies included small samples (mostly elderly) and suboptimal measures of emotional experience (e.g., observations by caregivers or self-reported improvement in hindsight; for a review, see Scoglio et al., 2019). Finally, in terms of health more broadly, recent meta-analyses show that virtual human interventions have an overall positive effect on health-related outcomes like health-promoting attitudes and behaviors (Chattopadhyay, Ma, Sharifi, & Martyn-Nemeth, 2020; Ma, Sharifi, & Chattopadhyay, 2019).

Thus, while some of this work speaks to the potential of conversational agents for improving socio-emotional outcomes, it has often examined wellbeing broadly defined, and to our knowledge, has not examined whether emotions in response to the disclosed emotional stressor decrease after talking to a virtual human. Consequently, it remains unclear to what extent interacting with virtual humans may bring about emotional relief, and what the active ingredients are if it does. Previous studies varied widely in terms of participants' engagement level with the conversational agents, the exact behavior of the conversational agent, and the outcome measures studied; factors that may all contribute to their (in)effectiveness. One key element may be the type of support provided by virtual humans. Prior research shows that the socio-emotional consequences of sharing one's emotions are crucially dependent on the way in which listeners respond (Reis, Lemay, & Finkenauer, 2017; Rimé, Bouchat, Paquot, & Giglio, 2020). In fact, mere sharing in the absence of any support risks an increase of the emotional experience, due to reliving the emotional event (Choi & Toma, 2014; Littrell, 2008). Therefore, the present study examined the moderating role of support type.

1.2. The role of support type

People typically share their emotions with others for two primary reasons: to feel better and to feel connected with others (Rimé et al., 2020; Willems et al., 2020). Whether sharing indeed brings about these socio-emotional benefits is dependent on the type of support they receive. Two main forms of support have been distinguished: emotional and cognitive (Rimé, 2009). Emotional support includes comfort and validation, and increases the sharer's temporary feelings of relief, perceived understanding, and closeness to the listener (Batenburg & Das, 2014; Morelli et al., 2015; Nils & Rimé, 2012; Pauw et al., 2018). Furthermore, experiences of negative emotion tend to be shorter when they are shared with a partner who provides emotional support (Brans, Van Mechelen, Rimé, & Verduyn, 2013). These findings speak to the critical role of emotional support in fostering perceived responsiveness, which refers to the confidence that the other will understand, accept, and be responsive to one's needs, and which lies at the core of emotional and relational wellbeing (for overviews, see Reis et al., 2017; Reis & Gable, 2015).

Cognitive support, on the other hand, is generally more conducive to bringing about long-term emotional recovery (Batenburg & Das, 2014; Lepore, Fernandez-Berrocal, Ragan, & Ramos, 2004; Nils & Rimé, 2012; Rimé, 2009). By helping the sharer take a different perspective on the situation – for example, by encouraging a more positive view – sharers can be helped to change the way they think about the situation (i.e., reappraisal), which may change the emotions the situation elicits (Dobkin, Panzarella, Fernandez, Alloy, & Cascardi, 2004; Nils & Rimé, 2012; Panzarella, Alloy, & Whitehouse, 2006; Rimé, 2009). Further speaking to its potential for fostering emotional recovery, reappraisal has generally been found to be the most adaptive way of regulating one's own emotions (Webb et al., 2012). Reappraisal lies at the heart of cognitive behavioral therapy (CBT), which is successful in treating a wide variety of disorders characterized by emotion regulation impairments (Butler, Chapman, Forman, & Beck, 2006; Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). Importantly, however, despite the long-term benefits associated with cognitive support, prior research has shown that sharers generally strongly prefer emotional support (Duprez, Christophe, Rimé, Congard, & Antoine, 2014; Pauw et al., 2018; Pauw, Sauter, Van Kleef, & Fischer, 2019), and may resist cognitive reappraisal by others as it can be experienced as invalidating (Marigold, Holmes, Wood, & Cavallo, 2014).

While direct comparative studies are lacking, there is indirect evidence suggesting that both forms of support may be (experienced as) helpful when sharing with virtual humans. Emotional support provided by a conversational agent can foster perceived responsiveness, and may thus elicit short-term emotional and relational benefits. For example, chatbots that displayed empathy when giving advice about a sensitive personal issue (e.g., by validating the negativity of the situation) were perceived as more supportive compared to chatbots that provided unemotional advice (Liu & Sundar, 2018). Furthermore, a set of studies in which participants interacted with a social robot showed that participants felt more understood, validated and cared for and preferred interacting with a robot that reacted responsively (non-verbal signs of attentive listening and verbal validation of participants' feelings) rather

than unresponsively (neither non-verbal nor verbal feedback; Birnbaum et al., 2016a, 2016b; Hoffman et al., 2014). Similarly, talking to an empathic virtual agent was perceived as more enjoyable and more helpful than talking to a non-empathic virtual agent, and led to a greater intention to use the agent over a longer period of time (Lisetti, Amini, Yasavur, & Rishe, 2013).

Indirect evidence for the potential for virtual humans to provide effective cognitive support (and thereby facilitate reappraisal) comes from recently developed chatbots and other text-based smartphone interventions employing a wide variety of treatments, including the use of CBT principles (Fitzpatrick et al., 2017; Hoermann et al., 2017; Inkster et al., 2018; Ly et al., 2017). For example, several prototypes for treating depression and anxiety have shown moderate success (Fitzpatrick et al., 2017; Fulmer, Joerin, Gentile, Lakerink, & Rauws, 2018; Inkster et al., 2018). However, given that these apps did not focus solely on CBT, but employed mixed methods (e.g., dialectical behavior therapy, motivational interviewing, positive behavior support, behavioral reinforcement, mindfulness), these findings are not conclusive regarding the effectiveness of cognitive support: It is possible that other aspects of the chatbots' responses were driving the positive outcomes.

In sum, research on social sharing with humans shows that emotional support is associated with short-term emotional and relational benefits, whereas cognitive support has the potential to bring about more long-term emotional recovery (Rimé et al., 2020). However, no prior research has experimentally manipulated and compared the effectiveness of emotional and cognitive support provided by virtual humans. The present study thus contributes to the literature by comparing the effect of these two types of support in a standardized manner, across multiple emotional and relational outcomes.

1.3. The present study

In the present study, we examined whether sharing one's emotions with a virtual human would bring about socio-emotional benefits. On the basis of prior work speaking to the general potential of conversational agents for treating (mental) health problems, we hypothesized that people would feel better after talking about their emotions with a virtual human. Furthermore, we explored possible differences between emotional vs. cognitive support.

To this end, 115 participants engaged in social sharing with a virtual human who provided either emotional or cognitive support. Participants had two conversations: One in which they shared a situation that made them feel angry and one in which they shared a situation that made them feel worried. These two emotion conditions were included in order to create variance in support needs. Previous research has shown that anger is linked to a preference for emotional support, whereas worry is associated with a desire for both emotional and cognitive support (Pauw et al., 2018). The virtual human provided support through the Wizard-of-Oz paradigm, a frequently used method in computer-human interactions (Dahlbäck, Jönsson, & Ahrenberg, 1993), in which participants are implicitly led to believe they are interacting with a computer, whereas in reality the avatar is controlled by a human experimenter ("wizard"). After each conversation, we assessed emotional intensity in relation to the disclosed situation (worry or anger), general affect, support efficacy, and relational closeness to the avatar. The present study thus allowed us to examine whether sharing one's emotions with a virtual human elicits emotional relief, whether this depends on the type of support received, and whether this generalizes across different emotions.

2. Methods

2.1. Participants

A total of 115 participants ($M_{age} = 41.0$, $SD = 12.6$; 50% male) were recruited via Craigslist in Los Angeles, United States. 45.2% of the participants identified themselves as White, 30.4% as Black/African American, 13.9% as Asian/Pacific Islander, and 11.3% as Hispanic American. Eight participants had partially missing data because they could not recall an emotional event in one of the two conversations (5 participants), mixed up two events leading to conflated pre- and post-measures (2 participants) or failed to fill out a dependent measure (1 participant). The data of these participants could still be analyzed for at least one out of two conversations, and they were therefore only excluded from those analyses for which they had missing data. Informed consent was obtained from all individual participants included in the study.

2.2. Procedure

Upon arrival, participants were seated at a desk facing a desktop monitor that was turned off, but on which the avatar Julie would appear during the conversations. Julie's speech was played over a speaker next to the monitor. For reasons unrelated to the present study, two cameras were present: One webcam recorded the participant from the front to be able to capture facial expressions, and one camera was positioned on a tripod over the participant's shoulder to have a recording of the interaction with Julie. Participants were told that they would share two personal issues with our virtual agent Julie. Participants were not specifically informed on whether the virtual agent was autonomous or controlled by a human, but given the phrasing they were implicitly led to believe they were talking to an autonomous agent. At the end of the study, participants were debriefed and informed that Julie had in fact been controlled by a human experimenter.

Depending on their randomly assigned order condition, they were first instructed to recall either a situation that still worried them or that still made them angry. Before sharing, participants were asked to write down the most important details of the situation on an iPad, after which they answered questions about the event and their experienced emotions. Next, upon calling Julie by her name, the avatar appeared on a large screen in front of them, looking like a woman sitting in a chair similar to a therapy setting (see Fig. 1). Julie was operated in real time by an experimenter, such that they experimenter pressed a button that would cause Julie to utter the pre-recorded (human) speech belonging to that specific button. When speaking, Julie was programmed to display basic non-verbal behaviors (e.g., nodding, minor head movements, lips moving). When listening, Julie did not show any non-verbal behaviors, but appeared to be actively listening by looking in the direction of the participant and blinking. The general script of the conversation can be found in Supplement 1.1 of the Supplemental Materials.

In the first conversation, a short rapport-building phase was included

Fig. 1. Screenshot of our Virtual Human Julie.

in which Julie asked several introductory questions (e.g., "Where are you from originally?"; "Do you consider yourself more shy or outgoing?") in order for participants to get acquainted with talking to Julie and to build rapport, which is conducive to self-disclosure (Lucas et al., 2014). Then Julie prompted the participant to tell her something about their anger (or worry) evoking experience. To standardize the conversations across participants, each conversation included three questions related to the emotional experience (e.g., "What is it exactly that makes you so angry?"; "How does this affect you?"; see Supplement 1.1 for more examples), and three instances of (either emotional or cognitive) support provision by Julie (see section 2.3.2 and Table S1 in the Supplemental Materials for examples). If a participant spoke too little to allow contingent support provision, they were additionally prompted (e.g., "Mmm, I see. Can you tell me more about that?"; "Could you explain the situation a bit more?", see Supplement 1.1 for more examples). Afterwards, Julie redirected participants back to the survey, where participants rated their experienced emotional intensity, perceived support, support efficacy and experienced closeness to Julie. During this time, Julie disappeared temporarily off the screen (i.e., Julie was only visible on the screen during the conversations with her).

Next, participants went through another round of recall (i.e., an anger or worry evoking situation), a second conversation with Julie (this time without an introductory phase), and the same pre- and post-conversational measures. At the end of the survey, participants answered some control questions regarding their experience of talking to Julie, and several demographic questions. Finally, we included a behavioral measure of participants' willingness to further interact with Julie. In total, participation on average took about 25 min.[1] The study protocol was approved by the Institutional Review Board of the University of Southern California, Los Angeles.

2.3. Design and materials

This study involved a 2 (Support Type: Emotional vs. Cognitive Support) x 2 (Emotion: Anger vs. Worry) x 2 (Emotion Order) mixed design. Participants were asked to share both an anger and worry evoking situation (within subjects) in randomized order (between subjects) and received one of the two types of support (between subjects).

2.3.1. Emotion recall

For anger, participants were asked to think of an issue they had with a friend or family member that still made them feel angry, and that had not yet been resolved. For worry, participants were instructed to think of an issue involving their work, finances or health that still made them feel worried, and that had not yet been resolved. We included these instructions to facilitate the construction of a repertoire of supportive responses that would fit any stories within these themes. Furthermore, in order to create variance and differentiate anger and worry instances, anger targeted a social situation, whereas worry did not. Participants were asked to take a moment to write down the most important details of the situation in order to recall and relive what it was that made them so angry or worried.

2.3.2. Support

Participants received three instances of either emotional or cognitive support. These expressions of support were taken from separate repertoires of emotional and cognitive support that were established before data collection and tailored to the specific emotion. All responses were recordings of a human voice. Emotional support consisted of sentences expressing sympathy (e.g., "I'm sorry to hear that"), and validation (e.g., "You have every right to be angry with them"). Cognitive support was always directed at reappraising the situation by either trying to find a more positive way of looking at the situation (e.g., "It sounds like you're learning though"), or by putting it in perspective ("Maybe with time they'll come around"). See Table S1 in the Supplemental Materials for more examples per subcategory.

2.3.3. Control questions

To ensure effective standardization across experimental conditions, participants were asked several control questions regarding their overall experience of talking to Julie (rated on a 7-point Likert scale (1 = *not at all/not well at all*, 7 = *very much/very well*). They were asked to what extent it bothered them that the conversation had been video recorded ($M = 2.20$, $SD = 1.54$), whether they found it difficult to talk about their personal situations with Julie ($M = 2.48$, $SD = 1.61$), how similar this conversation was to a conversation they normally have in their daily life ($M = 3.83$, $SD = 1.61$), and how well they thought Julie did as a conversation partner ($M = 4.58$, $SD = 1.57$). Overall, these questions revealed that participants had a relatively positive experience sharing with Julie.

2.3.4. Manipulation check: type of support

To assess whether participants were sensitive to the kind of support they received, they rated their perceived support after each conversation using a 100-point slider bar (0 = *not at all*, 100 = *very much*). Emotional support was measured using four items (e.g., "Julie was empathic"; anger $\alpha = 0.94$, worry $\alpha = 0.93$). Cognitive support similarly was measured using four items (e.g., "Julie tried to help me look at the situation from a different perspective"; anger $\alpha = .93$, worry $\alpha = 0.95$). These items were adapted from Pauw et al. (2019) and can be found in the Supplemental Materials (Supplement 1.2).

2.3.5. Manipulation check: emotion

Participants rated their experience of anger, worry, guilt, shame, fear, and sadness on a slider ranging from 0 (*not at all*) to 100 (*very much*) when thinking back at the recalled event before sharing the emotional situation. This allowed us to test whether participants indeed experienced the target emotion (i.e., worry for the worry conversation and anger for the anger conversation) most strongly.

2.3.6. Emotional relief

We included two measures of emotional relief. First, participants rated their experience of the target emotion (i.e., worry or anger) again after sharing, on a slider ranging from 0 (*not at all*) to 100 (*very much*). This allowed us to compare the intensity of the target emotion pre- and post-sharing, assessing whether sharing resulted in a decrease in participants' negative emotions in relation to the event they had talked about. Second, participants rated their general affective state on a scale from −5 (very negative) to +5 (very positive) before and after each conversation. The reason for both including the target emotion and general affect is that prior research has shown that social sharing may improve general affect (i.e., people report feeling better after sharing), but not necessarily decrease the target emotion (e.g., people still feel worried; Nils & Rimé, 2012).

2.3.7. Perceived support efficacy

Perceived support efficacy was measured using three items, adapted from Nils and Rimé (2012), which asked about the extent to which participants felt that the conversation had made them feel better, helped them deal with the situation better, and reduced their negative emotions regarding the specific event (anger $\alpha = 0.91$, worry $\alpha = 0.92$). All items were rated on a 7-point Likert scale (1 = *not at all*, 7 = *very much*).

2.3.8. Closeness

To assess experienced closeness, participants rated how connected

[1] Additionally, before each conversation, we obtained background information regarding the shared event (e.g., recency, previous sharing, appraisals). We also included post-conversational ratings of desired support, interpersonal alerting and participants' prior experience with talking to a virtual human. These data fall outside the scope of this paper, but are available upon request.

they felt to Julie after each conversation on a 7-point Likert scale (1 = *not at all*, 7 = *very much*).

2.3.9. Desire to interact with Julie

At the end of the study, participants were told they would need to wait 5 min until the experimenter could finish up the study and arrange payment. They were asked whether they preferred to talk to Julie a bit more, or to fill out another survey. After indicating their preference, they were told that they in fact did not have to wait and could call the experimenter. Choosing to talk to Julie was considered a behavioral indicator of a greater desire to interact with Julie.

3. Results

3.1. Standardization checks

Gender and Ethnicity. To examine whether the two experimental conditions were balanced in terms of gender and ethnicity, we ran two separate Chi-Square tests. These tests showed that both gender (χ^2 [2] = 2.01, p = .366, Phi = 0.13) and ethnicity (χ^2 [4] = 8.74, p = .068 Phi = 0.28) were equally distributed across the two experimental support conditions.

Control Questions. To make sure that the experimental conditions did not result in any unintended differences in participants' experience of talking to Julie, we conducted a 2 (Support Condition: Emotional vs. Cognitive Support) x 2 (Emotion Order) MANOVA with all control questions described above included as dependent measures. Ratings on these control questions did not differ as a function of Support Condition (F [4, 108] = 0.41, p = .802, η_p^2 = 0.02), Order Condition (F [4, 108] = 0.34, p = .852, η_p^2 = 0.01), or their interaction (F [4, 108] = 0.95, p = .437, η_p^2 = 0.03), indicating successful standardization across experimental conditions. Thus, regardless of the support Julie provided or the emotion that was discussed, participants were equally unbothered by the video recording, found it similarly easy to talk about their personal situations with Julie, rated the conversation as being equally similar to a daily conversation, and thought Julie did equally well as a conversational partner.

3.2. Manipulation check: type of support

In order to test whether participants in the emotional (vs. cognitive) support condition indeed perceived more emotional support, and participants in the cognitive (vs. emotional) support condition perceived more cognitive support, a Repeated Measures ANOVA was conducted with Support Condition (Emotional vs. Cognitive Support) as a between-subjects variable, Support Type (Emotional vs. Cognitive Support) and Emotion Condition (Anger vs. Worry) as within-subjects variables, and Perceived Support as the dependent variable.[2] As expected, there was a main effect of Support Type (F [1, 108] = 144.32, p < .001, η_p^2 = 0.57), and a main effect of Support Condition (F [1, 108] = 8.90, p = .004, η_p^2 = 0.08). These effects were qualified by a significant interaction between Support Condition and Support Type (F [1, 108] = 33.15, p < .001, η_p^2 = 0.24). [3]

Contrary to our expectations, simple main effect analyses showed that there was no significant effect of Support Condition on perceived emotional support (F [1, 108] = 0.11, p = .740, η_p^2 < 0.01). Thus, regardless of the type of support that was provided by Julie, participants perceived an equally high amount of emotional support (see Table 1 for all means and standard deviations). There was, however, a significant effect of Support Condition on perceived cognitive support (F [1, 108] = 23.00, p < .001, η_p^2 = 0.18). In line with our expectations, those in the cognitive support condition perceived a significantly higher amount of cognitive support compared to those in the emotional support condition. Finally, there was no significant three-way interaction between Support Type, Support Condition and Emotion Condition (F [1, 108] = 0.53, p = .470, η_p^2 = 0.01), indicating that our findings did not vary depending on Emotion Condition. In sum, our manipulation was only successful for the Cognitive Support condition: Participants experienced an equally high degree of emotional support across both support conditions, but perceived significantly more cognitive support when Julie provided cognitive (rather than emotional) support.

3.3. Manipulation check: emotion recall

To verify whether participants indeed experienced more anger when recalling an anger experience and more worry when recalling a worry-evoking situation, we conducted a 2 (Emotion Condition: Anger vs. Worry) x 6 (Emotion Type: Anger, Worry, Sadness, Fear, Guilt and Shame) Repeated Measures ANOVA with both factors varying within subjects and Emotional Intensity ratings as the outcome variable. Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (14) = 60.13, p < .001. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = 0.85). Main effects were observed for Emotion Condition (F [1, 107] = 11.50, p = .001, η_p^2 = 0.10), as well as Emotion Type (F [4.23, 107] = 63.09, p < .001, η_p^2 = 0.37). More importantly, a significant interaction was observed between Emotion Condition and Experienced Emotion (F [4.23, 107] = 67.17, p < .001, η_p^2 = 0.39).

Simple main effect analyses showed a significant effect of Emotion Condition on anger (F [1, 107] = 99.19, p < .001, η_p^2 = 0.48), indicating that those in the anger condition experienced more intense anger compared to those in the worry condition (see Table 2 for all means and

Table 1
Means (M) and Standard Deviations (SD) of Perceived Support, Perceived Support Efficacy, Closeness, Emotional Intensity and General Affect split by Support Condition and Emotion Condition.

	Support Condition			
	Emotional Support		Cognitive Support	
	Anger	Worry	Anger	Worry
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Perceived Support per Support Type				
Emotional Support	68.73 (26.87)	69.09 (26.63)	68.42 (25.34)	72.43 (24.30)
Cognitive Support	32.99 (28.58)	32.38 (29.17)	57.65 (30.13)	57.70 (30.50)
Perceived Support Efficacy	3.57 (1.66)	3.74 (1.75)	4.08 (1.62)	4.19 (1.70)
Closeness to Julie	4.20 (1.75)	3.96 (1.73)	4.29 (1.63)	4.54 (1.68)
Emotional Intensity of the Target Emotion				
Before Sharing	70.74 (25.87)	74.06 (24.93)	70.61 (31.18)	73.11 (26.75)
After Sharing	50.43 (26.84)	52.02 (26.17)	38.91 (27.86)	49.57 (30.04)
General Affect				
Before Sharing	0.74 (2.69)	0.41 (2.57)	0.22 (2.45)	0.63 (2.59)
After Sharing	1.67 (2.19)	1.56 (2.26)	1.54 (2.02)	2.17 (1.85)

Note. Perceived Support and Emotional Intensity were measured on a scale from 0 (not at all) to 100 (very much). Perceived Support Efficacy and Closeness were measured on a scale from 1 (not at all) to 7 (very much). General Affect was measured on a scale from −5 (very negative) to +5 (very positive).

[2] Including Emotion Order in our models revealed no statistically significant interactions with Emotion Order, indicating that all observed effects remain the same regardless of whether participants first shared an anger-evoking event and then a worry-evoking event, or vice versa. Therefore, we present all our analyses without Emotion Order in the model.

[3] There was no main effect of Emotion Condition, F(1, 108) = 0.29, p = .589, η_p^2 < 0.01. Furthermore, there was no significant interaction between Emotion Condition and Support Condition, F(1, 108) = 0.38, p = .542, η_p^2 < 0.01, nor between Emotion Condition and Support Type, F(1, 108) = 1.42, p = .236, η_p^2 = 0.01.

Table 2
Means (M) and standard deviations (SD) of emotional intensity ratings of experienced emotions split by emotion condition.

	Emotion Condition	
	Anger	Worry
	M (SD)	*M (SD)*
Experienced Emotions		
Anger	70.87 (28.48)	36.99 (34.10)
Worry	38.95 (32.59)	73.13 (26.05)
Guilt	21.37 (28.98)	30.02 (33.79)
Shame	22.50 (30.16)	27.08 (31.58)
Fear	23.50 (31.35)	58.35 (31.75)
Sadness	51.38 (33.69)	49.38 (33.92)

standard deviations). Furthermore, Emotion Condition had a significant effect on worry (F [1, 107] = 77.40, $p < .001$, $\eta_p^2 = 0.42$), with those in the worry condition experiencing more intense worry compared to those in the anger condition. Moreover, pairwise comparisons showed that within the anger condition, anger was experienced more intensely compared to all other emotions (all p's < 0.001). Similarly, within the worry condition, worry was experienced more intensely compared to all other emotions (all p's < 0.001). In sum, these findings demonstrate that our manipulation of emotion succeeded.

3.4. Main analyses

3.4.1. Emotional relief

We assessed the degree of emotional relief by examining both the target emotion and general affect. First, to examine whether the provision of support was effective in reducing the experienced negative emotion, we tested its effects on the intensity of the target emotion before and after sharing. A 2 (Time: Pre and Post Sharing) x 2 (Support Condition: Emotional vs. Cognitive Support) x 2 (Emotion Condition: Anger vs. Worry) Repeated Measures ANOVA was conducted, with Time and Emotion Condition as within-subjects variables, Support Condition as between-subjects variable, and intensity of the target emotion (worry or anger) as the dependent measure.

In line with our hypothesis, there was a main effect of Time (F [1, 105] = 127.43, $p < .001$, $\eta_p^2 = 0.55$), indicating that overall, participants showed a reduction in the intensity of the target emotion after sharing with Julie (see Table 1). The absence of an interaction effect between Time and Support Condition (F [1, 105] = 2.23, $p = .139$, $\eta_p^2 = 0.02$) indicates that this reduction in intensity was equally strong in the emotional and cognitive support conditions. No three-way interaction was observed between Time, Support Condition and Emotion Condition (F [1, 105] = 1.80, $p = .183$, $\eta_p^2 = 0.02$), and no other effects emerged ($ps > .315$), except for a small effect of Emotion Condition (F [1, 105] = 4.88, $p = .029$, $\eta_p^2 = 0.04$), indicating that on average, participants experienced somewhat higher emotional intensity when discussing the worry-evoking event as compared to the anger-evoking event. In sum, regardless of the type of support, all participants indicated feeling less angry/worried after sharing.

Second, to assess whether emotional and cognitive support made participants generally feel better after sharing, we conducted a 2 (Time: Before and After Sharing) x 2 (Support Condition: Emotional vs. Cognitive Support) x 2 (Emotion Condition: Anger vs. Worry) Repeated Measures ANOVA, predicting General Affect. Here too, there was a main effect of Time (F [1, 106] = 38.70, $p < .001$, $\eta_p^2 = 0.27$), indicating that overall, participants generally felt better after sharing with Julie (see Table 1 for all means and standard deviations). The absence of an interaction effect between Time and Support Condition (F [1, 106] = 0.97, $p = .328$, $\eta_p^2 = 0.01$) indicated that the observed increase in affect was equally strong across emotional and cognitive support provision. There was an interaction between Support Condition and Emotion Condition (F [1, 106] = 4.46, $p = .037$, $\eta_p^2 = 0.04$). Simple slope analyses, however, indicated that the effect of Support Condition was non-significant for both emotion conditions (all p's > 0.273), meaning that emotional support and cognitive support were associated with similar affect across both anger and worry-evoking events. No three-way interaction was observed between Time, Support Condition and Emotion condition (F [1, 106] < 0.01, $p = 1.000$, $\eta_p^2 < 0.01$). In sum, regardless of the type of support that was provided, participants indicated that they felt better after sharing.

3.4.2. Perceived support efficacy

In order to examine whether the provision of emotional versus cognitive support differentially impacted participants' perceived support efficacy, a 2 (Support Condition: Emotional vs. Cognitive Support) x 2 (Emotion Condition: Anger vs. Worry) Repeated Measures ANOVA was conducted, with Support Condition as a between-subjects variable, Emotion Condition as a within-subjects variable, and perceived support efficacy as the dependent variable. No main effect of Support Condition was observed (F [1, 108] = 2.75, $p = .100$, $\eta_p^2 = 0.03$), indicating that the provision of emotional and cognitive support was judged to be similarly effective (see Table 1). Furthermore, there was no effect of Emotion Condition (F [1, 108] = 1.08, $p = .300$, $\eta_p^2 = 0.01$), nor an interaction effect between Support Condition and Emotion Condition, (F [1, 108] = 0.06, $p = .808$, $\eta_p^2 < 0.01$).

3.4.3. Closeness

Similarly, in order to examine whether the provision of emotional versus cognitive support differentially impacted felt closeness to Julie, a 2 (Support Condition: Emotional vs. Cognitive Support) x 2 (Emotion Condition: Anger vs. Worry) Repeated Measures ANOVA was conducted. Again, no main effect of Support Condition was observed (F [1, 108] = 1.26, $p = .264$, $\eta_p^2 = 0.01$). Furthermore, there was no effect of Emotion Condition (F [1, 108] < 0.01, $p = .974$, $\eta_p^2 < 0.01$), nor an interaction effect between Support Condition and Emotion Condition predicting interpersonal closeness (F [1, 108] = 3.08, $p = .082$, $\eta_p^2 = 0.03$). Thus, these findings indicate that participants felt equally close to Julie after the provision of emotional and cognitive support (see Table 1).

3.4.4. Desire to interact with Julie

To test whether support provision differentially impacted participants' desire to continue interacting with Julie, we conducted a Chi-Square test examining the relation between Support Condition (Emotional vs. Cognitive Support) and Willingness to Interact (Yes vs. No). Participants were equally willing to continue interacting with Julie regardless of whether she had provided emotional support (34.5% of participants chose to continue interacting) or cognitive support (43.1%; χ^2 [1] = 0.87, $p = .351$, Phi = 0.09).

3.5. Supplemental analyses

Our main findings show that sharing with a virtual human resulted in positive emotional and relational outcomes across both support conditions. However, given the absence of a control condition, these findings do not conclusively show that these benefits were due to the support received; they could merely reflect the benefit of talking. Therefore, we exploratorily examined whether support *perceived* by the participants also predicted positive emotional and relational outcomes (see Supplement 2.1). The results show that both perceived emotional and cognitive support were associated with increased emotional relief (as evidenced by improved general affect, though not by a decrease in the experience of the target emotion), greater closeness, and greater perceived support efficacy.

We also exploratorily examined which emotional and relational outcomes would predict the extent to which participants perceived the sharing interactions as effective. These results show that Post-Sharing Affect and Closeness were the only two significant predictors of Perceived Support Efficacy (see Supplement 2.2). These findings

indicate that emotional improvement in general affect (but not the target emotion) and greater closeness experienced towards Julie were predictive of participants perceiving the conversation as more effective in helping them down-regulate their negative emotions.

4. Discussion

4.1. Main findings and theoretical implications

In light of the many obstacles people may face when seeking socio-emotional support in daily life, the present study was set up to examine virtual humans' potential for providing effective support. More specifically, we examined whether sharing with a virtual human might bring about socio-emotional benefits, whether this is dependent on the type of support provided, and whether this generalizes across two different emotions. To this end, participants shared two personal emotional events with a virtual human that gave either cognitive support (facilitating reappraisal) or emotional support (providing comfort and validation). Our findings show that participants felt better after talking about their emotions to a virtual human, as was evidenced by both a general improvement in mood and a decrease in negative emotion in response to the disclosed stressor. Emotional relief was similar for episodes of anger and worry, and when receiving emotional or cognitive support. Furthermore, both types of support were experienced as equally helpful in coping with the emotional experience, and led to a similar level of experienced closeness and desire to interact with the virtual human again.

Together, our findings thus speak to the potential of virtual humans in fostering successful coping. Prior research has shown that virtual humans uniquely create both emotional rapport and anonymity, thereby establishing a safe and non-threatening environment in which people feel comfortable disclosing their thoughts and feelings regarding personally upsetting events – at times to an even greater extent than when sharing among humans (Birnbaum et al., 2016b; Liu & Sundar, 2018; Lucas et al., 2014, 2017). Our findings complement this literature by showing that people also feel less intense negative emotions after sharing with a virtual human, and that they perceive the interaction as helpful in coping with their emotions, regardless of the type of support that they received, and regardless of the type of emotional experience (anger and worry).

The finding that cognitive support yielded similar levels of emotional relief, perceived support efficacy, and relational closeness as compared to emotional support, suggests a certain degree of receptivity to cognitive support. These observations are promising in light of prior research on social sharing with humans, which has revealed a strong preference for emotional support (Duprez, Christophe, Rimé, Congard, & Antoine, 2015; Pauw et al., 2018; Pauw et al., 2019). This preference for emotional support can be explained by people's deeply rooted need for understanding (Finkenauer & Righetti, 2011; Reis et al., 2017). Emotions temporarily destabilize people by upending their expectations, view of the self or view of the world (Rimé, 2009). People therefore tend to share their emotions with others, to reduce this uncertainty and make sense of the world together (Rimé, 2009; Rossignac-Milon & Higgins, 2018; Taylor, 2006). Emotional support may fulfill this need for understanding by validating the sharer's thoughts and feelings, and communicating that it is accepted and appropriate to feel the way they do (Shenk & Fruzzetti, 2011). Cognitive support, on the other hand, has great potential to help the sharer recreate meaning, yet may be experienced as invalidating, as the listener tries to encourage *another* way of interpreting the event. Perceptions of invalidation may threaten people's core need to feel understood (Shenk & Fruzzetti, 2011), which can lead the sharer to refuse the listener's support attempt (Marigold, Cavallo, Holmes, & Wood, 2014). It is therefore noteworthy that in the current study, the provision of cognitive support did not come at the expense of perceiving the virtual human as sensitive: Those receiving cognitive support felt equally understood, and experienced the virtual human as equally empathic as did those who received emotional support. Furthermore, supplemental analyses showed that greater *perceived* cognitive support generally enhanced experienced benefits and closeness (see Supplement 2.1).

Two main reasons may explain why cognitive support might have been experienced as less invalidating and thereby resulted in similar socio-emotional benefits as compared to emotional support. First, people may be more receptive to cognitive support when it is provided by a virtual agent (as compared to a human), due to their differential agency levels. On the basis of theoretical accounts (e.g., Social Self-Preservation Theory, Dickerson & Kemeny, 2004; Sociometer Theory, Leary & Baumeister, 2000; Temporal-Need Threat Model of Ostracism, Williams, 2009), people should be particularly sensitive to being negatively evaluated or treated by other humans, more so than by virtual agents that are driven by computer-based algorithms (Kothgassner & Felnhofer, 2020). People generally do not ascribe agency or actual mental experiences to virtual agents, and assume that virtual agents are worse at emotional tasks than humans (Gray, Gray, & Wegner, 2007; Waytz & Norton, 2014). Consequently, they might be more forgiving when confronted with relatively insensitive or more direct ways of communication as compared to when a human would violate such norms. Past findings support this notion, showing, for example, that people respond more strongly to a mistake or being socially excluded when they think it is carried out another human rather than a computer-controlled virtual human (Felnhofer et al., 2018; Kothgassner et al., 2017). In a similar vein, people may have adopted a more tolerant mindset towards the virtual agent, leading them to perceive cognitive support as less invalidating or judgmental (Pickard, Roster, & Chen, 2016), and therefore potentially be more inclined to try to reappraise the situation.

Second, the observed socio-emotional benefits may have been comparable across both types of support because the provision of cognitive support – though not explicitly sympathetic in its verbal content – might have still communicated emotional involvement: By listening and responding to the participant's story, these support instances may have reflected that the virtual human was attending to and interpreting the participant's emotional experience and trying to help them feel better (Bodie & Jones, 2012; Burleson, 2008; Itzchakov, Reis, & Weinstein, 2021; Jones, 2011). This level of emotional responding may have already exceeded participants' expectations regarding support by virtual humans as compared to real humans. Prior work shows that the fulfillment of support expectations might be more important in shaping sharers' responses than the mere support itself (Bar-Kalifa & Rafaeli, 2015; Sarason, Pierce, & Sarason, 1990). Furthermore, both types of support were accompanied by asking questions about the emotional experience. This may have communicated active listening, which is a key component of supportive communication (Bodie & Jones, 2012; Jones, 2011). Virtual humans may in fact have a distinctive benefit in that they offer unconditional attention without interrupting or shifting attention to themselves, while interactions between humans often lack these features (see Itzchakov et al., 2021).

It is thus possible that virtual humans provide a unique way to circumvent the typical trade-off between empathetic and effective support provision. The finding that participants were equally receptive to cognitive support as to emotional support is of particular importance given that the facilitation of adaptive reappraisals is key to emotional recovery when sharing in daily life, as well as in clinical settings (Butler et al., 2006; Lepore et al., 2004; Nils & Rimé, 2012; Rimé, 2009). Furthermore, the fact that the provision of cognitive support did not come at the cost of perceiving the virtual human as sensitive is promising, considering that people prefer to interact with more empathic virtual humans and are more motivated to have them as a companion in difficult times (Birnbaum et al., 2016a, 2016b; Liu & Sundar, 2018). Taken together, the current findings thus suggest that virtual humans can be a valuable source of social support.

4.2. Limitations and future directions

The present study has several limitations. First, given the absence of a control condition, it remains possible that the observed emotional and relational benefits were partially due to the mere act of talking about personal events with someone who listens and asks follow-up questions. It should be noted, however, that our supplemental analyses suggest that the interaction with the virtual human did contribute to participants' experienced emotional relief. Firstly, those who experienced greater support experienced greater improvements in their affect, greater support efficacy and greater closeness to the virtual human (see Supplement 2.1). Secondly, greater affective improvement and greater closeness predicted higher perceived support efficacy (see Supplement 2.2). Thus, these findings speak to the added value of support provided by a virtual human. Nevertheless, future research is warranted to more conclusively map sharers' responses to support from virtual humans. To confirm the added value of emotional and cognitive support for fostering socio-emotional benefits of sharing, a control condition could be included in which participants do not share, or share in the absence of a sharing partner (e.g., by writing, or recording a voice or video message). Furthermore, in order to examine whether people are indeed more receptive to cognitive support when it is provided by a virtual agent (as compared to a human), future studies should include a direct comparison between human and virtual human sharing partners, for example by letting participants believe that the virtual human they are interacting with is operated by a human versus automation.

Another shortcoming is that our findings only speak to self-reported short-term emotional relief, but not to actual (long-term) emotional recovery. In addition to the immediate reduction in emotional intensity, we assessed sharers' experienced support and their perceptions of helpfulness. It is thus possible that our findings merely reflect *perceived* efficacy (Zech & Rimé, 2005). Nevertheless, the finding that sharers experienced cognitive support as beneficial is promising, as it reflects receptivity to a form of support that is known to enhance long-term emotional recovery (e.g., Nils & Rimé, 2012). Yet, it remains an open question whether participants adopted the reappraisals that they were pointed towards. Future research is warranted to examine longer-term consequences of support provision by virtual humans, ideally assessing emotional and relational outcomes across a wider domain (e.g., appraisals, emotions, physical wellbeing, continued use of the virtual human).

These limitations notwithstanding, the present study is characterized by several strengths. The present findings show that talking to a virtual human effectively reduces the emotional intensity of the shared emotional experience, thereby speaking to virtual humans' potential in bringing about short-term emotional relief. Moreover, the current study compared the effectiveness of two support strategies by employing a standardized experimental procedure that ensured similar engagement across conditions and relied on operationalizations based on theoretically defined constructs. As such, we complement prior work that has typically been limited to small sample sizes and has not consistently compared different supportive responses by virtual humans, shedding new light on people's socio-emotional responses to sharing with virtual humans.

Future research could examine the application of the current findings. The present study employed the Wizard-of-Oz paradigm (Dahlbäck et al., 1993), with a human selecting the most appropriate response from a support repertoire to allow us to match the support to the specific situation at hand. The next step would be to automatize support provision. While the application of virtual humans is still in its infancy, we do believe there is potential for doing so: With technology rapidly improving, artificially intelligent virtual humans are being built that are capable of controlling computer-generated bodies and interacting verbally and non-verbally with other users in virtual environments (Rizzo et al., 2011). Furthermore, certain virtual human agents are capable of automatically detecting people's non-verbal behaviors (so-called 'affective markers') that are predictive of their psychological distress (e.g., depression, anxiety and post-traumatic stress disorder symptoms; DeVault et al., 2014; Lucas, Gratch, Scherer, Boberg, & Stratou, 2015; Ring, Bickmore, & Pedrelli, 2016; Scherer et al., 2014, 2013), which may be leveraged to further increase their sensitivity as conversation partners.

4.3. Conclusions

Taken together, the present study examined virtual humans' potential for providing complementary benefits to human support provision by overcoming typical obstacles to effective sharing. Extending prior research showing that people are willing to disclose personal information and talk about their emotions with a virtual human (DeVault et al., 2014; Gratch et al., 2014; Lucas et al., 2017), we demonstrate that people feel better after talking to a virtual human. The provision of cognitive and emotional support both effectively reduced short-term emotional distress and yielded similar levels of perceived support efficacy and experienced closeness. These findings thus suggest that virtual humans may have unique potential in reducing sharers' resistance to cognitive support – a form of support that is considered necessary for effective long-term recovery, yet is often resisted by sharers. Hence, although we do not conceive of virtual humans as a replacement for humans, we do conclude that virtual humans may be a valuable addition for those who may, at times, lack appropriate support from close others or clinicians.

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Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2022.107368.

References

Bar-Kalifa, E., & Rafaeli, E. (2015). Above and below baselines: The nonmonotonic effects of dyadic emotional support in daily life. *Journal of Social and Personal Relationships, 32*(2), 161–179. https://doi.org/10.1177/0265407514525888

Batenburg, A., & Das, E. (2014). An experimental study on the effectiveness of disclosing stressful life events and support messages: When cognitive reappraisal support decreases emotional distress, and emotional support is like saying nothing at all. *PLoS One, 9*(12), e114169. https://doi.org/10.1371/journal.pone.0114169

Bendig, E., Erb, B., Schulze-Thuesing, L., & Baumeister, H. (2019). The next generation: Chatbots in clinical psychology and psychotherapy to foster mental health–a scoping review. *Verhaltenstherapie, 1–13*.

Bickmore, T. W., & Picard, R. W. (2005). Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction, 12*(2), 293–327. https://doi.org/10.1145/1067860.1067867

Birnbaum, G. E., Mizrahi, M., Hoffman, G., Reis, H. T., Finkel, E. J., & Sass, O. (2016a). Machines as a source of consolation: Robot responsiveness increases human approach behavior and desire for companionship. In *2016 11th ACM/IEEE International Conference on human-robot interaction (HRI)* (pp. 165–172). https://doi.org/10.1109/HRI.2016.7451748

Birnbaum, G. E., Mizrahi, M., Hoffman, G., Reis, H. T., Finkel, E. J., & Sass, O. (2016b). What robots can teach us about intimacy: The reassuring effects of robot responsiveness to human disclosure. *Computers in Human Behavior, 63*, 416–423. https://doi.org/10.1016/j.chb.2016.05.064

Bodie, G. D., & Jones, S. M. (2012). The nature of supportive listening II: The role of verbal person centeredness and nonverbal immediacy. *Western Journal of Communication, 76*(3), 250–269. https://doi.org/10.1080/10570314.2011.651255

Brans, K., Van Mechelen, I., Rimé, B., & Verduyn, P. (2013). The relation between social sharing and the duration of emotional experience. *Cognition & Emotion, 27*(6), 1023–1041.

Burleson, B. R. (2008). What counts as effective emotional support? Explorations of individual and situational differences. In *Studies in applied interpersonal communication (S. 207–228)*. SAGE Publications, Inc. https://doi.org/10.4135/9781412990301.d14.

Burleson, B. R., & Goldsmith, D. J. (1996). How the comforting process works: Alleviating emotional distress through conversationally induced reappraisals. In *Handbook of communication and emotion (S. 245–280)*. Elsevier.

Butler, A., Chapman, J., Forman, E., & Beck, A. (2006). The empirical status of cognitive-behavioral therapy: A review of meta-analyses. *Clinical Psychology Review, 26*(1), 17–31. https://doi.org/10.1016/j.cpr.2005.07.003

Caplan, S. E., & Turner, J. S. (2007). Bringing theory to research on computer-mediated comforting communication. *Computers in Human Behavior, 23*(2), 985–998. https://doi.org/10.1016/j.chb.2005.08.003

Chattopadhyay, D., Ma, T., Sharifi, H., & Martyn-Nemeth, P. (2020). Computer-controlled virtual humans in patient-facing systems: Systematic review and meta-analysis. *Journal of Medical Internet Research, 22*(7), Article e18839.

Choi, M., & Toma, C. L. (2014). Social sharing through interpersonal media: Patterns and effects on emotional well-being. *Computers in Human Behavior, 36*, 530–541. https://doi.org/10.1016/j.chb.2014.04.026

Dahlbäck, N., Jönsson, A., & Ahrenberg, L. (1993). Wizard of oz studies—why and how. *Knowledge-Based Systems, 6*(4), 258–266.

Derks, D., Fischer, A. H., & Bos, A. E. R. (2008). The role of emotion in computer-mediated communication: A review. *Computers in Human Behavior, 24*(3), 766–785. https://doi.org/10.1016/j.chb.2007.04.004

DeVault, D., Artstein, R., Benn, G., Dey, T., Fast, E., Gainer, A., et al. (2014). SimSensei kiosk: A virtual human interviewer for healthcare decision support. *Proceedings of the 2014 International Conference on Autonomous Agents and Multi-Agent Systems*, 1061–1068.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355–391. https://doi.org/10.1037/0033-2909.130.3.355

Dobkin, R. D., Panzarella, C., Fernandez, J., Alloy, L. B., & Cascardi, M. (2004). Adaptive inferential feedback, depressogenic inferences, and depressed mood: A laboratory study of the expanded hopelessness theory of depression. *Cognitive Therapy and Research, 28*(4), 487–509. https://doi.org/10.1023/B:COTR.0000045560.71692.88

Duprez, C., Christophe, V., Rimé, B., Congard, A., & Antoine, P. (2014). Motives for the social sharing of an emotional experience. *Journal of Social and Personal Relationships, 32*(6), 1–31. https://doi.org/10.1177/0265407514548393

Duprez, C., Christophe, V., Rimé, B., Congard, A., & Antoine, P. (2015). Motives for the social sharing of an emotional experience. *Journal of Social and Personal Relationships, 32*(6), 757–787. https://doi.org/10.1177/0265407514548393

Felnhofer, A., Kafka, J. X., Hlavacs, H., Beutl, L., Kryspin-Exner, I., & Kothgassner, O. D. (2018). Meeting others virtually in a day-to-day setting: Investigating social avoidance and prosocial behavior towards avatars and agents. *Computers in Human Behavior, 80*, 399–406. https://doi.org/10.1016/j.chb.2017.11.031

Finkenauer, C., & Righetti, F. (2011). Understanding in close relationships: An interpersonal approach. *European Review of Social Psychology, 22*(1), 316–363. https://doi.org/10.1080/10463283.2011.633384

Fitzpatrick, K. K., Darcy, A., & Vierhile, M. (2017). Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (woebot): A randomized controlled trial. *JMIR Mental Health, 4*(2), e19. https://doi.org/10.2196/mental.7785

Forest, A. L., Kille, D. R., Wood, J. V., & Holmes, J. G. (2014). Discount and disengage: How chronic negative expressivity undermines partner responsiveness to negative disclosures. *Journal of Personality and Social Psychology, 107*(6), 1013–1032. https://doi.org/10.1037/a0038163

Fulmer, R., Joerin, A., Gentile, B., Lakerink, L., & Rauws, M. (2018). Using psychological artificial intelligence (Tess) to relieve symptoms of depression and anxiety: Randomized controlled trial. *JMIR Mental Health, 5*(4), e64. https://doi.org/10.2196/mental.9782

Gratch, J., Kang, S.-H., & Wang, N. (2013). Using social agents to explore theories of rapport and emotional resonance. *Social emotions in nature and artifact, 181*(10.5555), Article 2568173.

Gratch, J., Lucas, G. M., King, A. A., & Morency, L.-P. (2014). It's only a computer: The impact of human-agent interaction in clinical interviews. *Proceedings of the 2014 international conference on Autonomous agents and multi-agent systems*, 85–92.

Gratch, J., Rickel, J., Andre, E., Cassell, J., Petajan, E., & Badler, N. (2002). Creating interactive virtual humans: Some assembly required. *IEEE Intelligent Systems, 17*(4), 54–63. https://doi.org/10.1109/MIS.2002.1024753

Gray, H. M., Gray, K., & Wegner, D. M. (2007). Dimensions of mind perception. *Science, 315*(5812). https://doi.org/10.1126/science.1134475, 619–619.

Greenberg, L. S. (2004). Emotion–focused therapy. *Clinical Psychology & Psychotherapy, 11*(1), 3–16. https://doi.org/10.1002/cpp.388

Hoermann, S., McCabe, K. L., Milne, D. N., & Calvo, R. A. (2017). Application of synchronous text-based dialogue systems in mental health interventions: Systematic review. *Journal of Medical Internet Research, 19*(8), e267. https://doi.org/10.2196/jmir.7023

Hoffman, G., Birnbaum, G. E., Vanunu, K., Sass, O., & Reis, H. T. (2014). Robot responsiveness to human disclosure affects social impression and appeal. In *Proceedings of the 2014 ACM/IEEE International Conference on human-robot interaction* (pp. 1–8). https://doi.org/10.1145/2559636.2559660

Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research, 36*(5), 427–440. https://doi.org/10.1007/s10608-012-9476-1

Hunt, J., & Eisenberg, D. (2010). Mental health problems and help-seeking behavior among college students. *Journal of Adolescent Health, 46*(1), 3–10. https://doi.org/10.1016/j.jadohealth.2009.08.008

Inkster, B., Sarda, S., & Subramanian, V. (2018). An empathy-driven, conversational artificial intelligence agent (Wysa) for digital mental well-being: Real-world data evaluation mixed-methods study. *JMIR MHealth and UHealth, 6*(11), Article e12106. https://doi.org/10.2196/12106

Itzchakov, G., Reis, H. T., & Weinstein, N. (2021). How to foster perceived partner responsiveness: High-quality listening is key. *Social and Personality Psychology Compass*. https://doi.org/10.1111/spc3.12648

Johnson, S. J., Sherman, M. D., Hoffman, J. S., James, L. C., Johnson, P. L., Lochman, J. E., et al. (2007). *The psychological needs of US military service members and their families: A preliminary report*. Washington, DC: American Psychological Association.

Jones, S. M. (2011). Supportive listening. *International Journal of Listening, 25*(1–2), 85–103. https://doi.org/10.1080/10904018.2011.536475

Kang, S.-H., Gratch, J., Wang, N., & Watt, J. H. (2008). Does the contingency of agents' nonverbal feedback affect users' social anxiety? *Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems-, 1*, 120–127.

Kothgassner, O. D., & Felnhofer, A. (2020). Does virtual reality help to cut the Gordian knot between ecological validity and experimental control? *Annals of the International Communication Association, 44*(3), 210–218. https://doi.org/10.1080/23808985.2020.1792790

Kothgassner, O. D., Griesinger, M., Kettner, K., Wayan, K., Völkl-Kernstock, S., Hlavacs, H., et al. (2017). Real-life prosocial behavior decreases after being socially excluded by avatars, not agents. *Computers in Human Behavior, 70*, 261–269. https://doi.org/10.1016/j.chb.2016.12.059

Leary, M. R., & Baumeister, R. F. (2000). The nature and function of self-esteem: Sociometer theory. In *Advances in experimental social Psychology (Bd. 32, S. 1–62)*. Elsevier. https://doi.org/10.1016/S0065-2601(00)80003-9.

Lepore, S. J., Fernandez-Berrocal, P., Ragan, J., & Ramos, N. (2004). It's not that bad: Social challenges to emotional disclosure enhance adjustment to stress. *Anxiety, Stress & Coping, 17*(4), 341–361. https://doi.org/10.1080/10615800412331318625

Lisetti, C., Amini, R., Yasavur, U., & Rishe, N. (2013). I can help you change! an empathic virtual agent delivers behavior change health interventions. *ACM Transactions on Management Information Systems, 4*(4), 1–28. https://doi.org/10.1145/2544103

Littrell, J. (2008). The status of Freud's legacy on emotional processing: Contemporary revisions. *Journal of Human Behavior in the Social Environment, 18*(4), 477–499. https://doi.org/10.1080/10911350802487245

Liu, B., & Sundar, S. S. (2018). Should machines express sympathy and empathy? Experiments with a health advice chatbot. *Cyberpsychology, Behavior, and Social Networking, 21*(10), 625–636. https://doi.org/10.1089/cyber.2018.0110

Lucas, G. M., Gratch, J., King, A., & Morency, L.-P. (2014). It's only a computer: Virtual humans increase willingness to disclose. *Computers in Human Behavior, 37*, 94–100. https://doi.org/10.1016/j.chb.2014.04.043

Lucas, G. M., Gratch, J., Scherer, S., Boberg, J., & Stratou, G. (2015). Towards an affective interface for assessment of psychological distress. In *2015 International Conference on affective Computing and intelligent interaction (ACII)* (pp. 539–545). https://doi.org/10.1109/ACII.2015.7344622

Lucas, G. M., Rizzo, A., Gratch, J., Scherer, S., Stratou, G., Boberg, J., et al. (2017). Reporting mental health symptoms: Breaking down barriers to care with virtual human interviewers. *Frontiers in Robotics and AI, 4*, 51. https://doi.org/10.3389/frobt.2017.00051

Ly, K. H., Ly, A.-M., & Andersson, G. (2017). A fully automated conversational agent for promoting mental well-being: A pilot RCT using mixed methods. *Internet Interventions, 10*, 39–46. https://doi.org/10.1016/j.invent.2017.10.002

Marigold, D. C., Cavallo, J. V., Holmes, J. G., & Wood, J. V. (2014). You can't always give what you want: The challenge of providing social support to low self-esteem individuals. *Journal of Personality and Social Psychology, 107*(1), 56–80. https://doi.org/10.1037/a0036554

Marigold, D. C., Holmes, J. G., Wood, J. V., & Cavallo, J. V. (2014). You can't always give what you want: The challenge of providing social support to low self-esteem

individuals. *Journal of Personality and Social Psychology, 107*(1), 56–80. https://doi.org/10.1037/a0036554

Markoff, J., & Mozur, P. (2015). *For sympathetic ear, more Chinese turn to smartphone program*. NY Times. https://www.nytimes.com/2015/%0D08/04/science/for-sympathetic-ear-more-chinese-turn-to-smartphone-program.html.

Ma, T., Sharifi, H., & Chattopadhyay, D. (2019). Virtual humans in health-related interventions: A meta-analysis. *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–6.

Morelli, S. A., Lee, I. A., Arnn, M. E., & Zaki, J. (2015). Emotional and instrumental support provision interact to predict well-being. *Emotion, 15*(4), 484–493. https://doi.org/10.1037/emo0000084

Nils, F., & Rimé, B. (2012). Beyond the myth of venting: Social sharing modes determine the benefits of emotional disclosure: Effects of sharing modes in emotional disclosure. *European Journal of Social Psychology, 42*(6), 672–681. https://doi.org/10.1002/ejsp.1880

Panzarella, C., Alloy, L. B., & Whitehouse, W. G. (2006). Expanded hopelessness Theory of depression: On the mechanisms by which social support protects against depression. *Cognitive Therapy and Research, 30*(3), 307–333. https://doi.org/10.1007/s10608-006-9048-3

Pauw, L. S., Sauter, D. A., van Kleef, G. A., & Fischer, A. H. (2018). Sense or sensibility? Social sharers' evaluations of socio-affective vs. cognitive support in response to negative emotions. *Cognition & Emotion, 32*(6), 1247–1264. https://doi.org/10.1080/02699931.2017.1400949

Pauw, L. S., Sauter, D. A., Van Kleef, G. A., & Fischer, A. H. (2019). I hear you (not): Sharers' expressions and listeners' inferences of the need for support in response to negative emotions. *Cognition & Emotion, 33*(6), 1129–1143. https://doi.org/10.1080/02699931.2018.1536036

Pauw, L. S., Sauter, D. A., van Kleef, G. A., & Fischer, A. H. (2019). Stop crying! the impact of situational demands on interpersonal emotion regulation. *Cognition & Emotion, 33*(8), 1587–1598. https://doi.org/10.1080/02699931.2019.1585330

Pickard, M. D., Roster, C. A., & Chen, Y. (2016). Revealing sensitive information in personal interviews: Is self-disclosure easier with humans or avatars and under what conditions? *Computers in Human Behavior, 65*, 23–30. https://doi.org/10.1016/j.chb.2016.08.004

Reis, H. T., & Gable, S. L. (2015). Responsiveness. *Current Opinion in Psychology, 1*, 67–71. https://doi.org/10.1016/j.copsyc.2015.01.001

Reis, H. T., Lemay, E. P., & Finkenauer, C. (2017). Toward understanding understanding: The importance of feeling understood in relationships. *Social and Personality Psychology Compass, 11*(3), Article e12308. https://doi.org/10.1111/spc3.12308

Rimé, B. (2009). Emotion elicits the social sharing of emotion: Theory and empirical review. *Emotion Review, 1*(1), 60–85. https://doi.org/10.1177/1754073908097189

Rimé, B., Bouchat, P., Paquot, L., & Giglio, L. (2020). Intrapersonal, interpersonal, and social outcomes of the social sharing of emotion. *Current Opinion in Psychology, 31*, 127–134.

Rimé, B., Finkenauer, C., Luminet, O., Zech, E., & Philippot, P. (1998). Social sharing of emotion: New evidence and new questions. *European Review of Social Psychology, 9*(1), 145–189. https://doi.org/10.1080/14792779843000072

Ring, L., Bickmore, T., & Pedrelli, P. (2016). Real-time tailoring of depression counseling by conversational agent. *Iproceedings, 2*(1), e27. https://doi.org/10.2196/iproc.6065

Rizzo, A., Lange, B., Buckwalter, J. G., Forbell, E., Kim, J., Sagae, K., et al. (2011). SimCoach: An intelligent virtual human system for providing healthcare information and support. *International Journal on Disability and Human Development, 10*(4). https://doi.org/10.1515/IJDHD.2011.046

Romeo, N. (2016). The chatbot will see you now. The New Yorker. https://www.newyorker.com/tech/elements/the-chatbot-will-see-you-now.

Rossignac-Milon, M., & Higgins, E. T. (2018). Epistemic companions: Shared reality development in close relationships. *Current Opinion in Psychology, 23*, 66–71. https://doi.org/10.1016/j.copsyc.2018.01.001

Sarason, I. G., Pierce, G. R., & Sarason, B. R. (1990). Social support and interactional processes: A triadic hypothesis. *Journal of Social and Personal Relationships, 7*(4), 495–506. https://doi.org/10.1177/0265407590074006

Scherer, S., Stratou, G., Gratch, J., & Morency, L.-P. (2013). Investigating voice quality as a speaker-independent indicator of depression and PTSD. *Interspeech*, 847–851.

Scherer, S., Stratou, G., Lucas, G., Mahmoud, M., Boberg, J., Gratch, J., et al. (2014). Automatic audiovisual behavior descriptors for psychological disorder analysis. *Image and Vision Computing, 32*(10), 648–658. https://doi.org/10.1016/j.imavis.2014.06.001

Scoglio, A. A., Reilly, E. D., Gorman, J. A., & Drebing, C. E. (2019). Use of social robots in mental health and well-being research: Systematic review. *Journal of Medical Internet Research, 21*(7), Article e13322.

Shenk, C. E., & Fruzzetti, A. E. (2011). The impact of validating and invalidating responses on emotional reactivity. *Journal of Social and Clinical Psychology, 30*(2), 163–183. https://doi.org/10.1521/jscp.2011.30.2.163

Smart, L., & Wegner, D. M. (2000). The hidden costs of hidden stigma. In T. F. Heatherton, R. E. Kleck, M. R. Hebl, & J. G. Hull (Eds.), *The social psychology of stigma* (pp. 220–242). New York: Guildford Press.

Taylor, S. E. (2006). Tend and befriend: Biobehavioral bases of affiliation under stress. *Current Directions in Psychological Science, 15*(6), 273–277. https://doi.org/10.1111/j.1467-8721.2006.00451.x

Wang, N., & Gratch, J. (2010). Don't just stare at me. *Proceedings of the 28th International Conference on Human Factors in Computing Systems - CHI, '10*, 1241. https://doi.org/10.1145/1753326.1753513

Waytz, A., & Norton, M. I. (2014). Botsourcing and outsourcing: Robot, British, Chinese, and German workers are for thinking—not feeling—jobs. *Emotion, 14*(2), 434–444. https://doi.org/10.1037/a0036054

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin, 138*(4), 775–808. https://doi.org/10.1037/a0027600

Willems, Y. E., Finkenauer, C., & Kerkhof, P. (2020). The role of disclosure in relationships. *Current Opinion in Psychology, 31*, 33–37. https://doi.org/10.1016/j.copsyc.2019.07.032

Williams, K. D. (2009). Ostracism: A temporal need-threat model. In *Advances in experimental social Psychology (Bd. 41, S. 275–314)*. Elsevier. https://doi.org/10.1016/S0065-2601(08)00406-1.

Zech, E., & Rimé, B. (2005). Is talking about an emotional experience helpful? Effects on emotional recovery and perceived benefits. *Clinical Psychology & Psychotherapy, 12*(4), 270–287. https://doi.org/10.1002/cpp.460