How affective technologies can influence intimate interactions and improve social connectedness

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A B S T R A C T

Affective computing holds the promise of creating effortless, integrated, and automatic ways of communicating emotions within our intimate social network. This could augment awareness systems and connectedness devices, reducing loneliness and improving health and well-being. Through two experiments, we investigate the effects of quantity and automaticity of emotion communication on perceived intimacy in mediated settings. In the first experiment \(N=48\), we manipulated the number of communicated emotions. Results show that increases in communicated emotion quantity lead to strong increases in perceived intimacy. In the second experiment \(N=34\), we compare automatic and user-initiated communication of emotions. Results show that user-initiated communication of emotions is experienced as more intimate than automatic communication. These results are discussed in light of the interpersonal process model of intimacy and can help the design of applications aimed at improving social interactions through affective communication technology.

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1. Introduction

People have a need to create and maintain strong stable interpersonal relationships, which is one of the most important human motivations (Baumeister and Leary, 1995). Failing to create and maintain such relationships has many ill effects on our mental well-being and health (Cacioppo and Patrick, 2008). For instance, falling in love is characterized by intense joy when love is mutual (Sternberg, 1986), but also by distress and disappointment when love is not reciprocated (Baumeister et al., 1993). Being deprived of social connections may negatively affect the immune system (Kiecolt-Glaser et al., 1987). For instance, socially well-adapted individuals are more likely to survive cancer (Goodwin et al., 1987). In contrast, hospital admission rates are higher for separated or divorced people than for married people (Bloom et al., 1979). These are just a few examples of the impact social connectedness has on our physical health and psychological well-being.

The importance of social connectedness for improving health and well-being has inspired many researchers in HCI and related disciplines to investigate devices and technologies that can augment relationship formation and maintenance (Markopoulos et al., 2009).

There are now many examples of awareness systems and connectedness devices that augment our social interaction with our intimate social network. For example, Vetere et al. (2003) implemented the Hug Over a Distance, which is an air-inflatable vest that can be remotely triggered to create a sensation resembling a hug. Other examples of intimate technology come from Garnaes et al. (2007) who designed the Cube and the Picture Frame. The Cube is a virtual threedimensional cube on which intimate couples can place symbols for the other to see. The authors argue that combining several symbols can create complex and expressive messages. The Picture Frame provides a way of dynamically adding graphical symbols to shared photos. After selection of a symbol it appears as a thought bubble on the other’s Photo Frame. These design examples as well as similar research and design efforts (e.g., Dey and De Guzman, 2006; Hindus et al., 2001; Markopoulos et al., 2004; Mynatt et al., 2001; Thieme et al., 2010) have led to new design spaces and research agendas for social connectedness systems. Important aspects, concerns, and challenges include privacy, seamless integration with the environment, effort reduction, system autonomy, accuracy, and user control (Markopoulos, 2009).

Research on awareness systems and connectedness devices started around the same time as the emergence of affective computing (Picard, 1997). Affective computing deals with the design of machines and devices that can recognize, process, adapt to, or even experience emotions (Picard, 2003; Picard and Klein, 2002). Although a lot of research on affective computing is focused on human–computer interaction, the same technologies and principles can also be applied to human–human interaction,
in both mediated (e.g., computer-mediated communication or CMC) and unmediated situations (Janssen et al., 2010). Many research efforts have been directed toward the automatic detection of emotions from facial expressions, speech, or biosignals (Zeng et al., 2009; Janssen et al., 2013). Although the accuracy of these algorithms is not perfect, there are already successful applications that have employed these techniques (Janssen et al., 2012; Neviarouskaya et al., 2010). For instance, Janssen et al. (2012) developed a music player that was able to measure emotional response to music, and use this information to create playlists to direct mood. Nonetheless, to the best of our knowledge, nobody has so far applied automated emotion transmittal or delivery to communication devices. Because there are already successful applications of automated emotion delivery in other domains, it is interesting to investigate how automated emotion delivery can be used in communication devices. In combination with wearable wireless sensor platforms (Westerink et al., 2009; Hanson et al., 2009) this has the potential to create an unobtrusive, integrated, and effortless way of providing emotional input into interaction settings. This is promising as optimizing procedural effort is central to any interaction design, and, hence, also to awareness systems (Markopoulou, 2009; Isselstein et al., 2009).

The present studies investigate the possible effects of applying affective computing to connectedness devices. Combining affective computing with connectedness devices allows for the automated capture, transformation, and delivery of emotional information, either as a stand-alone communication signal, or as an augmentation to existing communication signals. Hence, introducing affective technology in connectedness devices could automate emotion communication. In turn, automated emotion communication could allow for more emotions to be communicated. In this paper, we describe two experiments that investigate if this could improve perceived intimacy. On the one hand, increases in the amount of emotion disclosure might improve perceived intimacy, as self-disclosure is strongly related to intimacy (Laurenceau et al., 2004; Reis and Shaver, 1988). However, on the other hand, automatically compared to manually communicated emotions might have a lower impact on perceived intimacy because the automated disclosure is not attributed to the person from whom the emotions are coming but to the machine that sent them (Jiang et al., 2011). To be able to provide more specific hypotheses for these ideas, we review the literature on the link between disclosure and intimacy, emotions, and attribution of self-disclosure in both face-to-face communication and CMC.

2. Literature review and hypotheses

We first discuss the role of emotions as intimate self-disclosures, and review the use of emotions as emotion representations in CMC. Subsequently, we discuss the literature on the attribution of such self-disclosures and its impact on intimacy.

2.1. Self-disclosure and intimacy

Several researchers have emphasized that the quantity of communication is an essential ingredient for the feeling of connectedness or intimacy (Mashek and Aron, 2004). More specifically, increases in intimacy are elicited by increases in self-disclosure (Laurenceau et al., 2004; Altman and Taylor, 1973; Reis and Shaver, 1988; Sternberg, 1988). Self-disclosure is the revealing of personal information to others (Jourard, 1971; Archer, 1980). The strong relation between self-disclosure and intimacy development is related to the fact that people consider self-disclosures to contain valuable information, thoughts, and feelings. Therefore, self-disclosure improves understanding and liking (Altman and Taylor, 1973; Ickes, 1997). Moreover, it elicits reciprocation, often leading to more self-disclosure of other persons, which forms a self-reinforcing circle.

Evidence for the link between self-disclosure and intimacy comes mainly from diary studies that show that perceived increases in self-disclosure are related to feelings of intimacy (Laurenceau et al., 1998, 2005). Other evidence comes from studies that showed a positive relation between self-disclosure in CMC and intimacy development (Baker, 2002; Wilkins, 1991). Moreover, the importance of self-disclosure is incorporated in different models and theories of communication and intimacy; e.g., the interpersonal process model of intimacy (Reis and Patrick, 1996), uncertainty reduction theory (Valt肯enberg and Peter, 2009), and social penetration theory (Altman and Taylor, 1973).

In summary, the amount of self-disclosure is considered to be an important elicitor of intimacy.

Although some researchers have suggested that CMC is less intimate than face-to-face interaction (see Walther and Parks, 2002, for a review), several empirical efforts have shown that this is incorrect (Joinson, 2001; Tidwell and Walther, 2002). In fact, it is often suggested that CMC interactions tend to be more intimate than face-to-face interactions (Parks and Floyd, 1996; Walther, 1997). This is in line with the finding that self-disclosure is a widespread phenomenon in different CMC channels like dating sites, blogs, message forums, and social networks (Joinson and Paine, 2007). Moreover, different studies have shown that online dating sites and social network sites can play a key role in romantic relationship development (Gibbs et al., 2006; Whitty, 2008). This suggests that self-disclosure is not only important for intimacy development in face-to-face communication, but also in CMC.

The nature of self-disclosure in CMC has several benefits for relationship formation and intimacy, captured by Walther’s Hyperpersonal Communication theory (Walther, 1996). First, people are more comfortable in sharing personal information in CMC (McKenna and Bargh, 1998). This is likely due to anonymity and a lower number of nonverbal cues, which might make people less hesitant to share personal information (Tidwell and Walther, 2002; Joinson, 2001; Andersen et al., 1998). Second, people have more control over their self-presentation in CMC than in face-to-face communication. Therefore, they can optimize the impression that they make by putting effort in message composition (Walther et al., 2001; Walther, 2007). For instance, photos can be edited to omit less desirable features (Hancock and Toma, 2009). Third, because of the limited number of cues people receive in CMC, they tend to interpret the cues they do receive more strongly (Boucher et al., 2008; Lea and Spears, 1991; Hancock and Dunham, 2001). In line with this, self-disclosure may lead to stronger intimacy increases not only in face-to-face communication, but also in CMC (Jiang et al., 2011).

2.2. Emotions and emotions

A special case of self-disclosure is the sharing of emotions. There is an array of converging psychological research that shows that our emotions form an essential part of intimate communication. Diary studies of adolescents and married couples have consistently shown that emotional self-disclosures have a stronger impact on perceived intimacy than factual self-disclosures (Laurenceau et al., 1998, 2005). In line with this, Butler et al. (2003) have shown that emotion suppression leads to a decrease in one’s chances of forming new relationships. Moreover, having your emotions mimicked improves your liking of and attraction to the person mimicking your emotions, as it is perceived as a sign of validation (Chartrand and Bargh, 1999; Lakin et al., 2003). In addition, partners’ emotional convergence (e.g., similarity in emotional responses during positive and negative discussion...
we can say that self-disclosure of emotions plays a significant role in perceived intimacy, through various mechanisms.

Emotions seem to be as abundant in CMC as in face-to-face interaction (Derks et al., 2008). Evidence for this comes, for example, from online therapy treatments in which people share their emotions with a virtual therapist (Lange et al., 2003). Another example comes from research showing that gender differences in emotion sharing are similar in face-to-face interaction and CMC (Savicki and Kelley, 2000). Moreover, Sasaki and Ohbuchi (1999) showed that emotional displays in vocal conversations elicited the same intensity of emotions as emotional displays in CMC. These are some of the examples that led Derks et al. (2008) to conclude that “emotions can be found as frequently online as offline” (p. 780).

Although emotions appear very often in CMC, the way they are expressed is different in CMC than in face-to-face interaction. In face-to-face interaction emotions are mainly expressed through facial expressions (Ekman and Friesen, 1971), speech (Scherer, 1986), or posture (Coulsen, 2004). The absence of these nonverbal signals in CMC, has led to the creation of other emotion communication means. A popular way of sharing emotions in CMC is through the use of emoticons, created with symbols that are abstractions of facial expressions (Walther and D’Addario, 2001). Emotions help to communicate emotions or mood (Constantin et al., 2002). Moreover, emoticons can serve to clarify textual messages (Walther and D’Addario, 2001). Emoticons are used very often in social networks, blogs, or chat devices (Huffaker and Calvert, 2005). Moreover, when given the option, their users almost always prefer the use of emoticons over not using them (Rivera et al., 1996).

For the current research, we apply the literature on self-disclosure and intimacy to the possibilities of increased emotion communication enabled by developments in affective technology. Due to the strong link between self-disclosure and perceived intimacy, we expect that increases in self-disclosure of emotions lead to increases in intimacy. However, as we are particularly interested in investigating the effects of emotions in CMC and not in face-to-face settings, we use emoticons to investigate this. To guarantee ecological validity and allow control over the communicated messages, we take two very simple emoticon icons (i.e., a happy emoticon and a sad emoticon) to constitute the communication medium. This is close to the every-day practice in computer-mediated communication and captures the problems associated with reduced communication bandwidth. Hence, our hypothesis is that increases in the number of shared emotions enhance perceived intimacy, just as increases in self-disclosure during face-to-face interactions enhance perceived intimacy.

H1. Increases in the number of emoticons received from the individual one is interacting with, lead to increases in perceived intimacy toward that individual.

2.3. Attribution of self-disclosure

Although there is a strong relationship between self-disclosure and perceived intimacy (as noted above), this relationship also depends on other factors. In line with this, Reis (2007) argues that “although self-disclosure often triggers intimate interaction, in itself self-disclosure is insufficient to instill a sense of intimacy between two people” (p. 10). More specifically, the effect of a self-disclosure depends on the receiver’s interpretation of the self-disclosure (Reis and Shaver, 1988). In general, it can be stated that people try to make sense of events by attributing causes to the events (Kelley and Michela, 1980). Applying this to self-disclosures means that not only try to understand what is disclosed but also why this is disclosed (Derlega and Berg, 1987; Miller et al., 1992). These attributions as to why a self-disclosure is made can influence the impact that a self-disclosure has on perceived intimacy.

To understand how different types of attributions of shared emotions can affect self-disclosure and perceived intimacy, we first explain which different types of attributions can be distinguished (Jones and Archer, 1976; Taylor et al., 1981; Town and Harvey, 1981). First, a dispositional attribution is made when the self-disclosure is thought to be due to the sender’s personality. Second, a situational attribution is made when the self-disclosure is thought to be due to a situational factor, like the medium. Third, an interpersonal attribution is made when the sender thinks he or she is specially chosen for this message because of the relationship between the sender and the receiver. Interpersonal attributions of self-disclosures are more likely to improve perceived intimacy than the other types of attributions, as being specifically chosen for the disclosure communicates trust and liking (see Collins and Miller, 1994; Derlega et al., 1993 for reviews). A recent study has shown that these effects can be even more pronounced in CMC than in face-to-face settings (Jiang et al., 2011).

Applying this attribution theory of self-disclosures to the possibilities of affective computing technology for intimacy brings us to our second hypothesis. Although affective computing technology might increase perceived intimacy by communicating more emotions (see Hypothesis 1), the attributions about the disclosed emotions of the sender may also change because of the affective computing technology. When the emotions are communicated automatically using affective computing technology, the receivers’ attributions of the communication are probably situational. This means that the receiver thinks the reason for disclosing the emoticon is not because the sender wants to disclose this as a special message to the receiver, but rather because of the situation (i.e., the affective computing technology in this case). In contrast, when the emotions are communicated at the initiative of the sender, the receiver’s attribution of them is probably interpersonal. Hence, we expect that the influence of self-disclosure of emoticons on perceived intimacy is lower when they are communicated automatically than when they are communicated at the initiative of the sender.

H2. Communicating emoticons automatically has a smaller effect on perceived intimacy than communicating emoticons at the initiative of the sender.

2.4. The current studies

Through two experiments we test the impact affective technologies that can have on our emotion communication and levels of perceived intimacy. In the first experiment, we investigate the effects of increases in the number of communicated emotions, as automated communication can increase the number of communicated emotions. We expect that increases in emotion communication will increase the feeling of intimacy (Hypothesis 1). In the second experiment, we investigate the difference between user-initiated and automatic communication, as affective technologies can automate the communication of emotions. We expect that automated communication will be experienced as less intimate than manually controlled communication (Hypothesis 2). We test these effects using emoticons to create an ecologically valid
scenario, as this is close to the every-day practice in CMC and captures the problems associated with reduced communication bandwidth.

3. Experiment 1: number of emoticons

3.1. Method

3.1.1. Participants and design

Forty-eight undergraduates participated in groups of four men and four women and received 15 Euros for their participation. Two participants failed to show up and were replaced by a confederate, and four women and received 15 Euros for their participation. Two participants in the pretest indicated both happy and sad emotions (i.e., periods containing ambiguous emotions). From this initial selection of periods, the 16 periods with the most emotions were elicited (i.e., periods containing ambiguous emotions). From this initial selection of periods, the 16 periods with the most emotion elicitations during the pretest were selected. This resulted in 16 periods for each movie excerpt in which emoticon communication acts could take place.

Finally, the emoticon communication acts (either 2, 4, 8, or 16) for Experiments 1 and 2 were randomly selected from the 16 available periods, with the constraint that the first and second halves of the movie excerpts both contained at least one period (to make sure that there was a somewhat even spread of communication acts during the movie). In other words, in the conditions with 16 emoticon communication acts, all of the periods were selected, whereas in the conditions with only 2, 4, or 8 emoticon communication acts, respectively 2, 4, or 8 out of the 16 periods were selected randomly. Independent of the number of emoticons communication acts, the type of emoticons was sad and happy emoticons. These were distributed randomly over the communication acts in such a way that sad and happy emoticons appeared equally often during each movie.

3.1.3. Questionnaires

Perceived intimacy between participants was measured with the Inclusion of Other in Self scale (IOUS; Aron et al., 1991) and the Subjective Closeness Index (SCI; Berscheid et al., 2004). The IOS is a single item pictorial measure which asks the participant to “select the image that best describes your relationship with the other participant” on a 7-point scale consisting of pairs of circles overlapping to different extents. The SCI is a two-item scale asking the participant to indicate how he or she would describe the relationship with the other participant on a 7-point Likert scales ranging from “not at all close” to “very close”. The wording for the items was “Relative to all your other relationships (both same and opposite-sex), how would you characterize your relationship with the other participant?” and “Relative to what you know about other people’s close relationships, how would you characterize your relationship with the other participant?”. The score on the SCI was calculated by averaging the two items (Cronbach’s $\alpha = 0.92$).

Manipulation checks included ratings for the items “I disclosed ...” and “The other disclosed ...” on a 5-point scale ranging from “very little” to “a whole lot”. These were taken from Laurenceau et al. (1998).

3.1.4. Procedure

Participants arrived in a waiting room in groups of eight and were briefly introduced to each other. After that, they were led to eight separate closed experimentation booths.

Subsequently, the participants received on-screen instructions that they would be watching four parts of a movie. During each part, they were told that they would be interacting with a different participant, all of opposite gender (we matched them to the opposite gender as we expected stronger effects on intimacy between opposite gender pairs than same gender pairs). The instruction stated for everyone that they were in condition B and their interaction partners were in condition A. This implied that the other participant could send happy or sad emoticons during the movie. The participants themselves could, after receiving an emoticon, reply with an emoticon if they wanted to, by pressing the up (happy) or down (sad) arrow. Hence, in all cases, the participants did not initiate the communication but could reply to messages they believed to be disclosed by the other participant. Finally, to make sure participants engaged with the experiment, the instruction stated that after the four trials were finished, there would be a group debriefing in which they would learn with whom they were interacting during each of the movie excerpts. This group debriefing did not actually take place. After all participants had indicated that they understood the instructions,
the actual experiment started. All participants received a short practice session to make sure they understood how to use the keys during the experiment. None of the participants indicated that they had problems understanding what to do during the experiment.

After instructions, participants were told to relax while watching a relaxing aquatic movie (Piferi et al., 2000). This was done to make sure everyone was in the same state before the treatment started. After the baseline video, the first of the four movie excerpts started. Before each of the movie excerpts started, a fake connection screen was shown for a random amount of time somewhere between 15 and 40 s, telling the participant to wait until the other participant was ready and the connection was established. During the movie excerpts the participants received emoticons at the preselected moments based on the pretests. After an emoticon was received, participants had 10 s to respond to it by pressing the up (happy) or down (sad) key. Moreover, they used the left (sad) and right (happy) arrow keys to continuously indicate their own emotional valence on a horizontal on-screen slider ranging from sad to happy via neutral. After each movie, the participants filled out the IOS and the SCI.

When all movie excerpts were finished, participants were probed for suspicion and debriefed. One participant suspected the interaction to be fake and was excluded from the analyses.

3.2. Results

3.2.1. Self and other’s disclosure

To check whether the participants did perceive the differences in communicated emotions (i.e., the manipulation of the experiment), we analyzed their ratings of the items on the amount of self-disclosure and the other’s disclosure. These ratings were submitted to a 4 (Emoticon quantity) × 2 (Gender) repeated measures MANOVA, with repeated measures on the first factor. The multivariate test showed an effect for Emoticon quantity ($F(6, 38) = 9.13$, $p < 0.001$, partial $\eta^2 = 0.18$). No effect for Gender ($F(6, 42) = 0.03$, n.s., partial $\eta^2 = 0.00$) or Emoticon quantity × Gender ($F(6, 38) = 1.08$, n.s., partial $\eta^2 = 0.02$) was found. Subsequent univariate tests (Huyn Feldt) showed effects of Emoticon quantity for both measures: the IOS ($F(3, 111) = 14.5$, $p < 0.001$, partial $\eta^2 = 0.25$) and the SCI ($F(3, 103) = 13.6$, $p < 0.001$, partial $\eta^2 = 0.24$). Linear trend analyses further confirmed the linear increases of the IOS ($F(1, 43) = 25.2$, $p < 0.001$, partial $\eta^2 = 0.37$) and the SCI ($F(1, 43) = 24.5$, $p < 0.001$, partial $\eta^2 = 0.36$) with increases in emoticon quantity. Means and SEs are presented in Fig. 1.

These results confirm Hypothesis 1 that increases in emotion communication lead to increases in perceived intimacy. Effect sizes for this effect are large (considering partial $\eta^2$ to be lower than 0.06 for small effects, to be between 0.06 and 0.14 for medium effects, and to be higher than 0.14 for large effects) and found across two different measures.

3.2.2. Intimacy questionnaires

To check whether perceived intimacy indeed increased with more emotion communication, the IOS and the SCI were submitted to a 4 (Emoticon quantity) × 2 (Gender) repeated measures MANOVA, with repeated measures on the first factor. The multivariate test showed an effect for Emoticon quantity ($F(6, 38) = 6.80$, $p < 0.001$, partial $\eta^2 = 0.52$). No effect for Gender ($F(6, 42) = 0.13$, n.s., partial $\eta^2 = 0.01$) or Emoticon quantity × Gender ($F(6, 38) = 0.76$, n.s., partial $\eta^2 = 0.11$) was found. Subsequent univariate tests (Huyn Feldt) showed effects of Emoticon quantity for both measures: the IOS ($F(3, 111) = 14.5$, $p < 0.001$, partial $\eta^2 = 0.25$) and the SCI ($F(3, 103) = 13.6$, $p < 0.001$, partial $\eta^2 = 0.24$). Linear trend analyses further confirmed the linear increases of the IOS ($F(1, 43) = 25.2$, $p < 0.001$, partial $\eta^2 = 0.37$) and the SCI ($F(1, 43) = 24.5$, $p < 0.001$, partial $\eta^2 = 0.36$) with increases in emoticon quantity. Means and SEs are presented in Fig. 1.

3.2.3. Response behavior

To test if the effects on perceived intimacy could have been confounded with the effects of participants’ behavior in receiving increased numbers of emoticons, we analyzed three characteristics of the response behavior. We calculated the response ratio by dividing the number of responses by the number of received emoticons (per participant). In addition, we calculated the ratio of responses with the same valence as the received emoticon (i.e., response congruence), which indicates for how many of the responses the valence was congruent with the valence of the received emoticon. Also, we calculated the ratio of responses with the same valence as the slider value that the participants used to indicate their own emotional state (i.e., response honesty), which indicates how many of the responses were in line with what the participant was feeling at that moment. Means and SEs over all conditions are $M=0.93$ ($SE=0.02$) for response ratio, $M=0.76$ ($SE=0.02$) for response congruence, and $M=0.79$ ($SE=0.02$) for response honesty. We submitted the response ratio, response congruence, and response honesty to a 4
(Emoticon quantity) × 2 (Gender) repeated measures MANOVA, with repeated measures on the first factor. No effects were found on any of the multivariate or univariate tests (p-values > 0.10). Hence, the effects of emoticon quantity on perceived intimacy are unlikely to be due to changes in response behavior between the four conditions.

To see if the response behavior did have an effect on intimacy ratings (independent of the emoticon quantity), we ran a linear regression analysis on the IOS ratings with response ratio, response congruency, and response honesty as predictors. The result showed a significant regression (F(3, 175) = 7.58, p < 0.001, R² = 0.12). Predictor weights were significant for response ratio (B = 1.7, p < 0.03) and response congruency (B = 2.6, p < 0.01), but not for response honesty (B = 0.1, p > 0.10). In line with the interpersonal process model of intimacy, this showed that both increases in response ratio (i.e., increases in self-disclosure) and increases in response congruency (i.e., validation through partner responses) increased self-reported intimacy.

To make sure that the effects of quantity on perceived intimacy were not due to response behavior we ran a linear regression analysis in the IOS ratings with emoticon quantity, gender, response ratio, response congruency, and response honesty as predictors. The results showed a significant regression (F(3, 175) = 10.46, p < 0.001, R² = 0.23). Predictor weights were significant for emoticon quantity (B = 0.49, p < 0.01), response ratio (B = 1.6, p < 0.03), and response congruency (B = 2.6, p < 0.01). No significant effects were found for gender (B = 0.06, p > 0.10) or response honesty (B = 0.30, p > 0.10). This shows that the effects of emoticon quantity were not due to response behavior.

3.2.4. Slider behavior

To check if the participants indeed engaged with the experiment by using the slider, we extracted the means and standard deviations of the slider values (ranging from 0 to 100, with a neutral starting position of 50) of all participants. The mean of the average slider values of all participants is 60.3. Furthermore, the mean standard deviation of all participants is 14.4. This showed that participants did engage in using the slider.

Subsequently, we checked if slider behavior was the same over all conditions by submitting the individual standard deviation and mean values of the slider to a 4 (Emoticon quantity) × 2 (Gender) repeated measures MANOVA, with repeated measures on the first factor. The multivariate test showed significant effects and very small effect sizes for Emoticon quantity (F(6, 38) = 0.67, n.s., partial η² = 0.02), Gender (F(6, 38) = 0.03, n.s., partial η² = 0.02) or Emoticon quantity × Gender (F(6, 38) = 0.75, n.s., partial η² = 0.02). Follow-up univariate tests were also not significant (all p-values > 0.10). Hence, there were no differences in slider behavior between the four conditions of Emoticon quantity.

3.2.5. Summary

In summary, manipulation checks confirmed that participants perceived differences in the number of emoticons. Furthermore, as expected, the intimacy ratings confirm H1: increases in the number of communicated emoticons result in higher levels of self-reported intimacy. Moreover, this effect cannot be attributed to changes in response behavior or to participants’ feelings as indicated by a slider, as these did not differ between the four conditions.

4. Experiment 2: attribution of emoticons

In the second experiment, we investigated the effect of automated emotion communication as opposed to user-initiated emotion communication. We expected that automated communication would be experienced as less intimate than user-initiated communication (Hypothesis 2). We tested this by exposing half of the participants to communication in which emoticons were shared with someone else at random times selected by the computer (automatic communication), and exposing the other half of the participants to communication in which emotions were only shared at times indicated by the participants (user-initiated communication). In both cases, participants themselves manually express how they are feeling. Hence, the difference between the conditions is not the detection or recognition of emotions, but only the selection of moments at which the emotions are communicated.

4.1. Method

4.1.1. Participants and design

Thirty-four participants (17 female, 17 male; age M = 23.1, SD = 8.3) took part in the experiment. Most participants were undergraduates of a Dutch university. Informed consent was obtained from all participants before the start of the experiment. Participants were randomly assigned over the two levels of Communication Type (Automatic/User-initiated) so that there were an equal number of participants in each condition. Participants received 7.50 Euros for their participation.

4.1.2. Materials

As with Experiment 1, the current experiment was performed in a movie watching context. This proved to be a good setting in Experiment 1 because of the emotion eliciting properties of movies and because movies are often watched in social contexts (Luminet et al., 2000). For this experiment we used one of the 8 min excerpts of the nature documentary that was also used in Experiment 1. All participants saw the same movie and received exactly the same stimuli. The treatment from study 1 in which 16 emoticons were received by the participant during the 8 min movie excerpt was used.

4.1.3. Confederates

All participants thought that they were interacting with another participant of the opposite sex during the experiment. The other participant was actually one of our confederates. This was done instead of using eight participants in parallel (as done in Experiment 1) because of scheduling convenience.

We had one male and one female confederate, so that each participant could be coupled to a confederate of the opposite sex. We pretested the attractiveness of the confederates through an online questionnaire that showed a passport-type photo of the two confederates and twelve other individuals. Seventeen volunteers (9 male, 8 female) rated the attractiveness of the person on each photo on a 7-point scale ranging from “Extremely unattractive” to “Extremely attractive”. Paired samples t-tests showed no significant difference between the attractiveness of the two confederates. Means were 4.9 for the female confederate and 4.2 for the male confederate.

4.1.4. Procedure

The experimenter met the participant and the confederate at a waiting area, introduced them to each other, and led them to the lab space in which the experiment would be conducted. The confederate and the experimenter acted as if the confederate was a regular participant. Both the confederate and the participant signed an informed consent form and were then led to different experimentation rooms. The experimenter left the participant alone to go through the experiment at his/her own pace. As soon as the participant was in the separate experimentation room and had started the experiment, the confederate left.

The entire experiment was presented on a computer screen, including instructions stating that participants would be watching...
an 8 min movie and that during the movie they would communicate with the other participant by sharing emoticons. Participants in the user-initiated condition were instructed that they could send each other emoticons by pressing the up (happy) or down (sad) key on the keyboard. Participants in the automatic condition were instructed to continuously keep track of their emotional state on a 3-point slider ranging from sad to happy via neutral. They could move the slider to the left by pressing the left key and to the right by pressing the right key. In addition, they were told that, at random moments, the state on the slider would be shared with the other participant in the form of an emoticon.

As a cover story for the fact that the participants were never sending but always replying to the other’s emoticons, the participants were told that one of them would be in “Condition A” and the other would be in “Condition B”. For the user-initiated condition, the participant in “Condition A” could initiate sending an emoticon and the participant in “Condition B” could respond each time an emoticon was sent by the other. For the automatic condition, emoticons would be shared when the participant in “Condition A” had indicated a non-neutral feeling. After that explanation, all participants were told that they were in “Condition B”. Hence, none of the participants could initiate the communication, but instead, they could only reply to messages disclosed by the other.

A 2 min practice session ensured that participants understood the study procedure. When the practice session was finished, a fake connection screen appeared, telling the participant to wait for the other to be ready to start. After about 40 s, the 8 min movie excerpt started. During the movie, 16 emoticons were communicated at the same moments as in the previous experiment (see Section 2.1). In the user-initiated condition, the emoticon appeared in the bottom of the screen with the text: “The other sent:” and “You can respond by pressing the up (happy) or down (sad) key”, in the same way as in Experiment 1. In the automatic condition, the text accompanying the emoticon said “The other feels:” and “This was sent to the other:”, with the accompanying emoticons. In other words, in the user-initiated condition both the sending and the receiving of emoticons were done manually, and in the automatic condition both the sending and the receiving of emoticons were done automatically.

After the movie finished, the participants filled out the IOS and the SCI. In addition, as a manipulation check we included three items in the survey that assessed how participants perceived the method of interaction. For this, participants answered the question “What did you think of the method of interaction? The method of interaction was …” on a 7-point scale ranging from unsociable to sociable (item 1), very cold to very warm (item 2), and impersonal to personal (item 3). Finally, they were probed for suspicion, and paid. Two participants had doubts about the interaction and were excluded from further analyses. The entire experiment took about 35 min.

4.2. Results

4.2.1. Method of interaction

To check if the method of interaction was perceived differently in the user-initiated or automatic condition, we analyzed the three items about the method of interaction (i.e., answers to “The method of interaction was…” on scales ranging from/to: unsociable/sociable, very cold/very warm, and impersonal/personal). Ratings of these items were averaged (Cronbach’s α = 0.81) and submitted to an ANOVA with Communication Type (Automatic/User-initiated) and Gender (Male/Female) as between-subject factors. As expected, results showed a significant effect of Communication Type (F(1,36) = 6.68, p < 0.05, partial η² = 0.12), but not of Gender (F(1,36) = 0.37, n.s., partial η² = 0.01) or Communication Type × Gender (F(1,36) = 0.37, n.s., partial η² = 0.01). Means show that ratings were higher (i.e., more personal, warm, and sociable) in the user-initiated condition (M = 3.9, SE = 0.29) than in the automatic condition (M = 3.2, SE = 0.29). This confirms that participants did perceive differences in the method of interaction.

4.2.2. Intimacy questionnaires

The scores on the two items of the SCI were averaged (Cronbach’s α = 0.86). Subsequently, the IOS and the SCI were submitted to a MANOVA with Communication Type (Automatic/Manual) and Gender (Male/Female) as between-subject factors. Results of the multivariate test show a significant effect of Communication Type (F(2,27) = 7.73, p < 0.002, partial η² = 0.36) but not of Gender (F(2,27) = 0.95, n.s., partial η² = 0.07) or Communication Type × Gender (F(2,27) = 0.61, n.s., partial η² = 0.04). Subsequent univariate tests showed effects of Communication Type on both the IOS (F(1,31) = 6.09, p < 0.02, partial η² = 0.18) and the SCI (F(1,31) = 15.97, p < 0.001, partial η² = 0.36). Means and SEs are depicted in Fig. 2. These results confirm Hypothesis 2 that automated communication is experienced as less intimate than user-initiated communication. Effect sizes for this effect were large and found across two different measures.

![Fig. 2. Self reported ratings on (a) the Inclusion of Other in Self scale (IOS) and (b) the Subjective Closeness Index (SCI) after automatic or user-initiated communication. Error bars depict ± 1 SE. (a) IOS and (b) SCI.](image-url)
4.2.3. Response and slider behavior

In the automatic condition, each of the 16 messages was answered with an automatic response. In the user-initiated condition, the number of responses was influenced by the participant. So, as manipulation check, we also analyzed the response behavior in the user-initiated condition to make sure it was similar to the automatic condition. The average number of responses was 15.7 in the user-initiated condition. An independent samples t-test confirmed that this was not significantly different from 16 in the automatic condition ($t(16) = -1.10; p = 0.10$). Hence, the effects of the communication type on the intimacy ratings cannot be attributed to changes in the quantity of the response behavior. Moreover, this shows that the persons in the user-initiated condition did engage in communication.

In the automatic condition, participants could change their emotional state on a slider (ranging from 0 to 100), as input for the communication. We analyzed the slider values to see if participants indeed engaged in changing the slider. The starting value of the slider was 50. The mean of the average slider values of all participants is 54.9. Furthermore, the mean standard deviation of all participants was 41.3. This confirms that participants did engage in using the slider to indicate how they felt. We did not add the slider in the manual condition as it might interfere with the manual emoticon communication. This notion is in line with the relatively small SDs in Experiment 1 for the slider behavior, which suggests that participants indeed used the slider less often when combined with manual emotion communication.

5. General discussion

Affective computing provides ways to communicate emotions within our intimate social network in an effortless and automatic fashion (Cowie et al., 2001; Picard, 1997). This could help us create deep intimate connections and reduce loneliness. Our goal was to investigate the effects of two parameters that are likely to influence the perceived intimacy of our interactions through affective technology. First of all, affective technology would allow communication devices to keep partners emotionally in touch by making it easier to communicate emotions in an effortless manner. Following the strong link between self-disclosure and perceived intimacy (e.g., Laurenceau et al., 2004), we expected that communicating more emotions would increase perceived intimacy between the users (Hypothesis 1). Second, affective technology can capture, transform, and transmit affective signals in an automatic or semi-automatic fashion. Although this can have several advantages, it discards the intention that is associated with an individual’s decision to communicate (or not), which can be regarded as a meaningful part of that communication act (Romero et al., 2007). In other words, attributing the self-disclosure to interpersonal or situational factors depends on the way the technology is implemented. If the affective computing technology selects whether or not the emotions are communicated, these forms of self-disclosure are likely to be attributed to situational factors. Therefore, we expected that automatic communication of emotions would be experienced as less intimate than user-initiated communication of emotions (Hypothesis 2).

The first experiment tested Hypothesis 1, and shows that increases in the number of communicated emotions do indeed result in higher perceived intimacy. This was true despite the fact that only two very simple emoticon representations were used. Manipulation checks further confirmed that our experimental manipulations were successful. These findings are in line with the findings that increases in emotional self-disclosure lead to increases in intimacy (Laurenceau et al., 2004; Reis and Shaver, 1988) and are in line with Walther’s hyperpersonal communication theory (Walther, 1996), which argues that communication in CMC does not have to be less intimate than face-to-face communication. Most of all, these results show the power of sharing emotions mediated by technology for creating a feeling of intimacy.

The second experiment confirms Hypothesis 2 and shows that automatic emotion communication results in less perceived intimacy than user-initiated communication. User-initiated communication is more intimate than automated communication, because user-initiated communication not only communicates the emotional information, but also that the sender intends the receiver to have this information. Hence, with user-initiated communication, the communication is attributed to interpersonal factors instead of situational factors.

Our results have a few limitations. First of all, we used a sample of undergraduate students because they are easily accessible and this group is most likely to be the first to adopt new technologies like the ones investigated here. Thus, it is unclear how these results translate to older or younger people. Furthermore, we used only two types of emoticons in our experiments to allow control over the communicated messages. However, it might be interesting for future research to investigate other types of emoticons or more extensive sets of emoticons, to see if there are differences in perceived intimacy with different types of shared emotions.

Second, in our experiment we choose not to differentiate between effects of sending or receiving emotions as we thought it would be more ecologically valid to keep the interaction symmetrical with respect to the automaticity of sending and receiving. Furthermore, we expected that this would help the participants to understand how the process for sending emotions was done for the person they were interacting with. Nonetheless, future research might separate these effects by allowing participants to only send or only receive emoticons and see if the effects that we have found in the current experiments are due to acts of sending, receiving, or both. Based on the interpersonal process model of intimacy (Reis and Shaver, 1988), it can be expected that perceived intimacy is influenced by both sending and receiving, and that their effects are, at least somewhat, cumulative.

Third, there might have been a potential effect of cognitive load on perceived intimacy because participants had to use a slider and/or keys to input their emotional state in the communication system. We have tried to balance the load of the different interface elements by using either the slider or the response keys in the different conditions in Experiment 2, and not both at the same time. Nonetheless, it might be useful for future research to explicitly investigate the effect of cognitive load generated by the interface on the effects of sharing emoticons. This could further direct guidelines for the design of affective communication systems.

Fourth, we chose a movie watching setting as this corresponds to a social activity that is often done together and generates emotions. It offered a relatively controlled and ecologically valid environment for our investigations. Congruent with diary studies and because of the large effect sizes we found, we expect these effects can also be found in settings other than movie watching, although that remains a topic for further research as well.

Finally, we focused on relationship formation. Although our manipulations have clear effects on relationship formation, it needs to be seen if these findings are also applicable to relationship maintenance. Congruent with diary studies we would expect similar effects for relationship maintenance regarding emotion quantity (Laurenceau et al., 2005). Furthermore, the difference between automatic and user-initiated communication might be less prevalent when the users are very familiar with each other (i.e., share more common ground), in which case their communications might be assumed to be for interpersonal reasons also when automatically communicated (Reis et al., 2004). In addition, our results illustrate the effect of full automation versus full control, but more subtle distinctions can be
made along the control-automation dimension (Parasuraman et al., 2000). Further research should investigate the effects of the range of semi-automatic modes of communication that lay between full automation and full user control, on perceived intentionality and intimacy.

5.1. Implications and applications

The results from the first experiment (i.e., increased user-initiated emoticon communication results in increased perceived intimacy) imply that for successful affective communication applications it is not essential to use very rich or elaborate emotion symbols. Instead, increased communication with simple but clear emoticons can already increase perceived intimacy. This also means that the design of affective communication systems can probably use very simple ways of signaling what is communicated. This might make it easier to design unobtrusive interfaces that are integrated with our surroundings or other devices. It might, for instance, be sufficient to simply use a red or green colored LED to indicate someone else’s emotion. As long as the meaning of the communication symbols is clear, sharing simple emotion symbols will likely be sufficient for increasing perceived intimacy.

The results from the second experiment show that user-initiated communication is perceived as more intimate than automatic communication. This implies that it might be very useful for the design of affective communication systems to focus on using some manual component to send emotion messages. At the very least, the receiver should have the idea that the sender took some initiative or intentional action to communicate the received message. Given the attention that automated emotion recognition is getting in the affective computing literature (e.g., Zeng et al., 2009; Janssen et al., 2013), it can be important to realize that not all applications might actually benefit from a purely automated approach. Future research and design can focus on how to optimally design and integrate a user-initiated way of communication, so that there are few barriers for users to engage in the sharing of emotions (as sharing more emotions increases perceived intimacy).

The combined results of the two experiments might provide designers of affective communication technology with a possible paradox. On the one hand, one should try to maximize the amount of emotion sharing which can be done by automating the communication. On the other hand, the communication should not be automated too much, as automated emotion sharing has a lower impact on perceived intimacy than user-initiated communication. It is important to note that we have not explicitly tested the impact of the interaction between increases in the number of shared emoticons and the automaticity of this communication. Therefore, when communication would be completely automatic it is at this moment unclear which effect is stronger: the increase in intimacy due to increased communication or the decrease in intimacy due to a reduction in user-initiated communication.

Future experiments can be used to manipulate both factors and test their interaction effects on perceived intimacy.

Although the interaction between automaticity of and increases in emotion sharing is at the moment unclear, it is good to note that lowering automation and increasing emotion sharing are not necessarily mutually exclusive. One way of approaching this combination might be for applications using automated emotion communication to incorporate different levels of automation. For instance, a manual communication mechanism could be incorporated in addition to the automated communication. Another way of dealing with this could be to give the user control over when the emotions are communicated, while the system detects the emotions and makes suggestions to the user of when to send them. More specifically, this could be implemented by having the automatic part of the system continuously measuring users emotional expressions. Whenever a strong emotion is measured, the system could suggest the user to communicate it. Then, the user can manually confirm the communication. This implies a certain level of intentionality to the receiver, if the receiver is aware of this. Hence, making the receiver aware of implied intentionality could potentially increase perceived intimacy as well. Also, including a manual response system for the receiver of the emotions can leverage the power of partner responses. In summary, there are different possibilities for creating hybrid systems using both automatic and manual communication. Such hybrid affective communication systems may have a promising future as connectedness devices. This provides a clear opportunity for designers to think about how to integrate automatic and user-initiated communication mechanisms in a seamless manner.

Finally, when designing communication applications based on affective technology there are other factors to consider as well. First of all, automatically measured emotions can be communicated as a stand-alone communication tool. This is similar to the way we applied it in our studies and can be used as an awareness system. An example of this is the Affective Diary by Stahl et al. (2009), when used as a communication tool. In the Affective Diary, users can track their emotional state throughout the day with bodily measurements and personal annotations. Such systems have the advantage that they can be used both synchronously and asynchronously between the communicators. As this offers novel ways of interaction, it is likely to have a large impact on perceived intimacy through increases in self-disclosure. Second, affective technology can be added to current communication devices, such as a phone, to improve emotion communication (Ickes, 1997; Janssen, 2012) and increase perceived intimacy. As humans are not so good at recognizing others’ emotions, especially in mediated settings with limited information (Zaki et al., 2009), affective communication technologies could also focus on sharing emoticons to improve emotion communication.

The fact that there will be many different possible operationalizations of the principles that we have outlined in this section also stresses the need to move out of the lab and test affective communication technology in a more ecologically valid context. This way, it can be tested how well the technology integrates with the every day lives of users. Furthermore, the effect of emotion sharing can be compared against other forms of communication that are present in every day lives, testing the added value of affective communication technology. Finally, we believe it will be important to test such systems over longer periods of time to see how persistent their effects are, and how persistent users will be in using the system.

5.2. Conclusion

This research has provided a step in the study of the advantages and disadvantages of using affective technology in communication devices, namely that the perceived intimacy of mediated emotion communication increases with the number of shared emotions and perceived intentions of the sender. These insights can help developers and practitioners to make a more informed choice between the different effects affective technologies have to offer. Through well informed design choices, affective technology can play an important role in the future of connectedness devices and awareness systems. Once this comes to fruition, affective technology has the power to enhance our social connectedness and, thereby, improve our health and well-being.

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