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Social pulse

The effects of mediated heartbeat communication on social connectedness, liking and pro-social behaviour.

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Preface

This report marks the end of my (admittedly long) time spent at Eindhoven University. Having started at Industrial Design, I enjoyed the topic taught there but longed for a bit more academic depth. In the past years spent pursuing the Human-Technology Interaction master courses and projects I found this, plus I truly enjoyed my time doing so. For that I want to thank the staff and fellow students. In particular I would like to thank both my supervisors, Wijnand IJsselstein and Daan van Bel, for their insight and assistance in shaping the project and especially crafting the experiment. Of course running the experiment would not have been possible without all participants and the help of two student-assistents, Marlies Wesselink and Anna Broers, so I'd like to thank all of you for your help and time spent in the lab.

Finally, I hope you will enjoy reading this report.

Summary

People are social beings. We desire to have meaningful, intimate relationships with other people. Most of this social fabric is woven in face-to-face communications. Because in face-to-face communication there is no obstruction in conveying disclosure of signals, it is often held as the highest form of communication. It offers the ultimate experience in verbal and non-verbal affective information for all parties involved. However such affective qualities are less well conveyed in forms of communication where partners are in different locations. Currently available technologies for mediated communication are often considered suboptimal for expressing intimacy which leaves room for improvements.

This topic resonates with the philosophy of affective computing and more specifically intimacy through technology; the technology enabling the mediation of intimate signals to another person. This thesis builds on the work of Joris Janssen and others, and follows the idea that one way to make people feel closer is to communicate something about them that is closely related to emotions, namely physiology. Emotions have both a cognitive and a physiological component thus any emotional experience is reflected in physiological responses; think sweat and fear, or a raging heartbeat for something exciting. The heart and heartbeats are often regarded as a very emotional part of our bodies, so the core idea is that communicating this signal can tell us something about the person who the heartbeat belongs to. Normally these signals can only be experienced if one is very close to the physique of the source, which perhaps underlines the intimate character of such cues. Using heartbeats as a communication medium could thus relieve some of the problems associated with mediated communication and lack of social connectedness with other people.

The study reported in this work builds on earlier efforts that show heartbeat communication can indeed be seen as an intimate cue. First of all, giving people false feedback of their own heartbeat can alter impression of an external artefact, because they may attribute the perceived change to this externality (the so-called Valins effect). Janssen et al. (2010) have shown that attribution of an artificial heartbeat to another person made people keep more distance to this person (or virtual avatar in some of the studies), a sign they try to compensate for an increase in apparent perceived intimacy. The main hypothesis is that if physiology-based communication is regarded as a meaningful form of disclosure it should affect mutual appraisal in similar fashion to other forms of (non-)verbal disclosure. Previous studies indeed seem to confirm this hypothesis although the duration in those studies was in the order of minutes which is short in comparison to social relations. Perhaps the effects found thus far are limited to the short timeframe as a kind of novelty effect.

This study tries to shine a light on the question whether mediated heartbeat communication can also show effects on perceptions of disclosure, social connectedness, liking and pro-social behaviour when people are interacting for a longer period of time. More specifically, this study assesses the merits of using mediated heartbeat communication in a text-based conversation. This study used a mediated text-based chat format through which people will get to know each other. We conducted a laboratory experiment using a 2 (personal topics of conversation versus small talk) x 2 (attributed to other versus non-attributed heartbeat cue) between-subjects design.

Participants were randomly assigned to one of the four conditions and participated in one condition only. More personal, sensitive topics of conversation were hypothesised to increase perceived disclosure, social connectedness and closeness – similar in reasoning to the expected effects for heartbeat communication. Participants were matched with one of the two female confederates. Couples would not meet before they engaged in a text-based chat session for fifteen minutes. The participant was assigned to ask predetermined questions while the confederate disclosed her answers. This asymmetric setup allows for scripting the conversation, hereby increasing control over the discussed content. The audio stimulus heard was the same across conditions, namely an artificially constructed but realistic heartbeat sound. Dependent variables of the study are self-report measures on disclosure, social connectedness, closeness, liking and pro-social behaviour.

Results did not confirm the expectations. While the manipulations appear to have registered as intended, the expected beneficial effects of more personal conversation and heartbeat communication were mostly absent. Because self-reports alone may be subject to cognitive biases, a measure of pro-social behaviour was included as well. Results on this Dictator game fell short of expectations, as the majority of participant decided to split the endowment equally. In short this means for all predictions the null hypotheses cannot be refuted. Thus in this study no general effects were found for mediated heartbeat communication nor for different levels of interpersonal closeness (except for a partial measure on relationship quality). This also means there is no cumulative effect of both manipulations, at least not within the limitations of this study.

Limitations include some of the design choices made. The rigid structure of using a confederate to disclose scripted answers can be seen as a negative influence for natural conversation. All participants within the same interpersonal closeness condition were exposed to approximately the same content but quite a few participants expressed their discontent at the imposed limits to their input. Participants were (mostly) strangers at the beginning but the expectation that marginal gains in closeness would thus be higher seems incorrect. Perhaps the lack of a pre-chat real life introduction kept participant too far removed from each other, hereby outdoing the supposed benefit of limiting pre-study impressions. There is a possibility people do not have absolute evaluations for their experiences but rather those are relative to other experiences. This would imply one measure such as taken in a between-subjects design as was used here cannot capture the relative value people attach to an experience.

It may be that initially the impact of hearing someone's heartbeat can be higher and then wane off or drown amid other social cues. Since no discernible effects were found after the 15 minutes of chatting this novelty effect could be a reasonable explanation. Because no intermediate measures were taken it cannot be determined whether there would have been effects at the beginning. In that sense the current methodology was insufficient. However, if this would be true a novelty effect would go against the anticipated, positive effect of familiarity or such an advantage does not pay off within a quarter of an hour.

The heartbeat stimulus employed was not based on a live signal from the conversation partner. Although having a constant stimulus across conditions has methodological benefits, there are potential benefits to a live signal. Ecological validity would the prime argument as the stimulus would broadcast any cardiovascular response. It would allow for interpretation of the changes in

light of what happens between participants, in this study the ongoing conversation. Some of the participants gave feedback indicating they were looking for such effects. Although the stimulus incorporated more variability than in previous studies it was still perceived as quite monotonous, perhaps to the detriment of perceived realism and believability of the mediation. Most participants admitted to not really paying attention to the heartbeat stimulus which may explain the modest strength of the manipulation. People felt the stimulus was a "background sound," and for some it may have escaped their attention as it seemed to contain little information.

It appears for heartbeat communication to be a valuable source of information it must lend itself to interpretation. Without interpretation it is likely to carry less meaning. Such interpretation hinges on context and familiarity with the source of the heartbeat signal. This study illustrates that without such familiarity and a clearly interpretable relation between the influence (i.e., the action, thought, or emotion) and the state of this signal (i.e., heart rate [variability]), there is no easily discerned effect of its communication.

From the outset this work has leaned more towards a focus on the value that can be offered by mediated heartbeat communication. While this work aims to help the development of intimate technologies, the investigation of relationship formation between strangers is only a precursor to intimacy. Intimate acts are often nuanced, having acquired meaning through development of mutual interactions. If one thing can be taken from the results of this study it is that just adding a (mediated) heartbeat signal does not work wonders, as it may over time become a background noise. Having purpose and context helps its interpretation, and therefore practical value in aiding bringing people closer together through technology. However, as has been noted in the discussion, the connection itself as a means to maintain rapport may also be what lends intimacy rather than the content. Follow-up studies could opt for a different methodology to study the same effects in a different way, and try to alleviate some of the limitations of this study.

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1. Introduction

Tim Burton's movie "Corpse bride" (2005) tells the tale of a bride killed during the night before her wedding. Unable to find rest she remains to dwell on Earth. She falls in love with a young man rehearsing his vows in the forest the night before his own wedding. The bride takes his vows as meant for her and gladly accepts the offer. As their relationship is off to a peculiar start she wonders if she can love him like any other living girl, since her heart cannot beat for him.

The doubt about true love without a beating heart is a small element in the storyline but it points at the special role the heart takes in the human view of social relationships and emotion. In this thesis I will argue why mediated intimacy is valuable but hampered by our current means of communication. Using heartbeats as a communication medium could relieve some of the problems associated with mediated communication and lack of social connectedness with other people. This topic resonates with the philosophy of affective computing (Picard, 1997), and more specifically it relates to what Bell, Brooke, Churchill and Paulos (2003, p. 2) describe as intimacy through technology; the technology enabling the mediation of intimate signals to another person. Joris Janssen labelled it physiosocial technology in his doctoral thesis (2012), and his work provides a backdrop for the work reported here. This thesis aims to address the question whether mediated heartbeat communication can prove its worth in dyadic social interactions that are of a longer duration than previous work has covered.Aron

1.1. Mediated communication

Mediating intimacy is important because humans are social beings and need company. People have a strong desire to belong, foster relationships with others and keep such bonds intact (Baumeister & Leary, 1995). It is however not enough to just have some interaction with others; those interactions need to be meaningful and personal. Not having frequent, meaningful social interactions with other people can lead to feelings of loneliness, negative psychological effects and, in turn, serious health issues (Cacioppo & Patrick, 2009). Close relationships which incorporate affective exchange are thus vital to our wellbeing. Field illustrates in her book 'Touch' (2003) the various detrimental effects of a lack of being touched as a young child for development and health issues. Although this study is not about touch, but rather about mediated communication of (normally intangible) physiological signals, the book by Field underlines that having an intimate relationship with a close other can indeed be very pervasive – independent of how affect in a relationship is expressed.

It is then not surprising people have developed myriad ways to stay in touch with others. Letters, telephony, and text messaging are not just tools to communicate about factual matters but serve as means to keep social bonds alive. Social media such as Facebook, Twitter and even social, mediated games such as FarmVille and Wordfeud are examples of technologies that gained popularity primarily so people can keep in touch with their social network across distances (Wohn, Lampe, Wash, Ellison, & Vitak, 2011). Photographs of loved ones are another simple way people stay in touch with dear ones. While there is no interaction a photo serves as a reminder of the other person (Gardner, Pickett, & Knowles, 2005). As shown in experiments involving pain, being shown a picture of a loved one can reduce the experience of distress (Eisenberger et al., 2011).

These examples illustrate that relating to other people is about awareness and interaction. Having a plethora of communication technologies does not alter the need to belong and be emotionally bonded with other – it just gives different ways of doing so. Each medium has its own strengths and weaknesses: what is communicated changes, the content changes and as a result the intentions people have to use any of these change. These channels of communications are able to serve different needs (e.g., sharing experiences or emotional support) as discussed in (amongst others) Shklovski, Kraut and Cummings (2008). Beyond the observable content of a medium lies another important part of communication, namely the emotional content: a less tangible but equally important component of effective communication and meaningful exchange with others (Hudlicka, 2003; Laurenceau, Barrett, & Pietromonaco, 1998; Picard, 1997).

1.2. Importance of emotion, intimacy and connectedness

Emotion is so important to us because it helps us to evaluate and make sense of events that are relevant to our goals or concerns (Frijda, 1986). Emotions concern the origin of any appraisal and are relatively acute and short in duration (as compared to mood or lifelong traits). Although scholarly interpretation of the nature of emotion and its psychological mechanisms varies widely (cf. Calvo & D'Mello, 2010), no one disputes the importance of affect for living life as a sociable being (a.o. Picard, 1997). Affect is what helps us to empathise with others, feel close with others, and regulate relationships by mutual exchange of emotions in a social context (Marinetti, Moore, Lucas, & Parkinson, 2011, p. 31). Marinetti et al. put special emphasis on the social context which shapes emotional exchange between interaction partners. While there is emotional exchange between strangers (e.g., a shop owner and his customer) such interactions lacks the depth and breadth of more intimate relationships. It is this added intimacy that is closer to the topic at hand.

Intimacy can be defined as a characteristic of a relationship or conversation between communicating partners and is a function of "proximity, eye-contact, smiling, and personal topics of conversation, etc.," (Argyle, 1969, p. 95, quoted in Biocca, Harms, & Burgoon, 2003). Other authors relate intimacy to an interconnectedness of self and other (Aron, Melinat, Aron, Vallone, & Bator, 1997, p. 364), or "a [cumulative] process in which each feels his or her innermost self validated, understood, and cared for by the other" (Reis & Shaver, 1988). Among other elements, developing a close relationship depends on sustained, escalating self-disclosure regarding personal topics and perceived partner responsiveness (Aron et al., 1997). In addition, emotional self-disclosure affects intimacy (Laurenceau et al., 1998), underlining the importance of emotions for social life.

When people are in separate places they have to use tools to reduce this distance to communicate, not just in physical terms (e.g., making their voice reach the other) but also in a psychological sense. This psychological distance relates to the perceived presence of the conversational partner, thus the ability to relate to and understand this person. Presence, as outlined in Biocca and colleagues' (2003) review, is considered to be about two interrelated phenomena: telepresence (i.e., having the sense of being together in the same place) and social presence, that is having a "sense of being together" with another social being (de Greef, IJsselsteijn, & Wesselink, 2000). Simplifying the theory on presence a bit, it makes sense to think of social presence as a scale for perceived (mutual) awareness.

Awareness alone is not enough to create an affective connection. A sense of social connectedness is necessary to relate to the other on an intimate level. Social connectedness, as defined by Van Bel, Smolders, IJsselsteijn and de Kort (2009a), relates to a short-term experience of belonging and relatedness with another person. It is based on quantitative and qualitative social appraisals, and relationship salience. Therefore it extends beyond mere perceived presence or time spent together and rather entails a subjective experience of having a connection with another being, that is being involved with others and sharing knowledge and feelings. Different communication media facilitate different impressions of social presence and connectedness, as perceived by users of these media.

1.3. Inadequacy of mediating emotive content

Because in face-to-face communication there is no obstruction in conveying verbal and non-verbal signals, it is often held as the highest form of communication. It offers the ultimate experience in terms of access to affective information for all parties involved. However such affective qualities are less well conveyed in forms of communication where partners are in different locations. In part this is because physical co-presence is qualitatively different from mediated presence (Biocca et al., 2003), and crucial to this study, because currently available technologies for mediated communication are often considered suboptimal for expressing intimacy which leaves room for improvement.

There are broadly speaking two reasons for this suboptimal experience. First, quite some of the information that is normally picked up on in unmediated communication, which is relevant to intimacy, is lost. Small, hardly consciously noticeable facial expressions are one example of such losses. Alex Pentland (2008) argues that people are very sensitive to such conversational social cues. In his book 'Honest Signals' he claims people are not so much individually shaping their lives and social connections at their own will, but rather people are inherently part of a larger social network. Behaviour, both verbal and non-verbal, is guided by the social graph they find themselves in. The core argument in his book is that people do so by adjusting to many subtle signals during social interactions. Pentland makes clear that having a relation with other people is what drives much of our behaviour, and consequently underlines the value that should be attached to (nearly) subconscious signals.

Second, less than perfectly synchrony in mediated communication causes a drop in the successful exchange of intimate signals. Technical limitations or problems in mutual (non-)verbal feedback interrupt the natural conversational turn-taking (Parkinson & Lea, 2011). As a result of limited emotional and physical interaction bandwidth, as well as lessened temporal synchrony frustrations arise, development of shared emotions may be reduced and overall positive affect suffers. Marinetti et al. (2011, p. 39) view such negative effects in relation to a decreased ability for emotional contagion. Such contagion is a phenomenon whereby interactants tend to share each others emotional state over time through synchrony of affective behaviours. Mimicry and cognitive appraisal of mutual behaviour play a crucial role in facilitating emotional contagion, which illustrates that interpersonal processes and thereby the communication of these have a role in shaping one's internal emotional state (Marinetti et al., 2011, pp. 40-41).

The limitations of current communication media to fully support social awareness and social connectedness is thus frequently ascribed to their limitations in conveying intimate and affective cues. The views expressed above could be summarised as follows: having less bandwidth for (non-) verbal cues will degrade the perceived quality of interaction. This is the view this study will take from the next section on but it is important to note that this need not be the only viewpoint. Joseph Walther opposes this vision by arguing that less rich mediated interactions (e.g., text messaging) leaves more room for other social cues. His work on 'hyperpersonal' communication (Tidwell & Walther, 2002; Walther, 1996) suggests a less information-rich medium could benefit mutual impressions and perceived intimacy. This would work because limited availability of information leads to positive impressions based on amplification of what is available combined with self-presentation biases (1996, p. 18).

While Walther's view on mediated communication is clearly at odds with the views explained earlier, others argue that what needs to be communicated changes in mediated scenarios. While it appears a strong sense of social connectedness is recommendable for intimacy to flourish, this does not imply the most information-rich media (e.g., virtual reality, video) are preferable over simple but meaningful interactions. Vetere, Smith and Gibbs (2009) dub this kind of interaction "phatic" and reason establishing and/or maintaining rapport is what provides value, not so much the content (p. 173) (a similar point is made by Gaver, 2002). This could also be taken to mean that any communication mechanism or design is not intrinsically intimate. Rather it is only conducive to intimacy when used, stressing usage above its manifestation (Battarbee et al., 2002).

These differing views all accept that mediated communication is different in nature to real life encounters. The directions for improving mediated communication diverge. Walther's theory helps to explain phenomena in bandwidth sparse mediated communication (e.g., chat sessions) but as a guide for improvement it seems less informative: giving less yields more (positive perceptions), so improvement would require a spartan approach (taking away information to interpret). Although the resulting predictions differ between Walther and the 'more-is-better' line of thought, both theories argue that information (as compared to just the act of exchange) does matter for the perception of a mediated other person. This study will indeed look at understanding the phenomenon of mediated physiological communication from the viewpoint that information is important for interpretation. The addition of mediated physiology is believed to be beneficial because its interpretation and meaning are very likely to relate to inherently intimate phenomena.

1.4. Potential of physiology-based efforts

The earlier parts of this text have shown the importance of emotion in communication and the next parts intend to show how physiology can be used to improve the emotional communication between partners. It has long been known that physiology and emotion are strongly interrelated (James, 1894). A scholarly definition of emotion labels it a psychophysiological experience, affecting the cognitive and physical state of being (cf. Picard, 1997). Although basic emotions such as fear may originate in more 'ancient' parts of the brain (the so-called limbic system), there is no easy disentangling of emotive processing from higher level cognition. Even disentangling mind and body is difficult, if not impossible, considering the effects experiencing an emotion has on neurotransmission and bodily functions (e.g., consider fear and a cramped stomach). It is

important to note that emotion in current theories is not the same as the resultant effects on a person, such as altered respiratory rate, heart rate, blood pressure, and cognitive alterations (Calvo & D'Mello, 2010), thus a certain physiological change does not directly translate to a clearly identifiable emotional state. This makes it even harder to define what an emotion and its related physiology is (see also Kreibig, 2010).

Despite such difficulties the communicative value is readily available. Most people will likely interpret sweat drops on the forehead of an interviewee during a job interview as a sign of stress (that is, if the context does not suggest potential other external factors such as heat). Similarly meaningful, though less overt physiological signals have also found appreciation in empirical studies (cf. Fairclough, 2009). One study mentioned in Fairclough's review stands out in particular because of its relevance to this work. Wiens, Mezzacappa and Katkin (2000) have shown a relation between heartbeat perception and experience of emotion (extending the earlier known Valins effect (Parkinson, 1985; 1966)). Their study had participants rate movie clips on pleasantness and intensity. Those who were well able to detect their own heartbeat reported more intense emotions, showing a link between visceral self-perception and emotional experience. A related but older study by Fenigstein and Carver (1978) shows self-directed attention increases when people are exposed to their own heartbeat in auditory fashion. Weisz, Bálazs and Ádám (1988) support that finding by demonstrating that the introduction of such a heartbeat stimulus leads to increased attention paid to the self, at the cost of the environment (perhaps due to limited cognitive capacity). It seems reasonable similar effects would result from paying attention to someone else's heartbeat, although this has not been tested yet (related work on heartbeat communication has focused on intimacy effects rather than attention effects (e.g., Janssen, Bailenson, IJsselsteijn, & Westerink, 2010)). In other words, extrapolating from the studies mentioned above it would be a worthwhile step to assess the influence of perception of someone else's physiology and see how it affects emotional experience. Indeed the next section will discuss several examples and earlier work in this direction.

Especially for communication partners who have a high level of affective bonding (e.g., romantic partners, close friends, parents and their children) communicating mutual affect may enrich their mediated experiences. The perceived psychological distance between partners could be reduced by communicating physiological signals beyond the observable verbal and non-verbal cues; such as one's heartbeat, skin conductance levels and respiration. These cues have a potential for connecting emotionally, increasing emotional awareness, closeness and empathy across distances and other boundaries (Janssen, Westerink, IJsselsteijn, & van der Zwaag, 2011). Normally these signals can only be experienced if one is very close to the physical origin, which perhaps underlines the intimate character of such cues. If physiology-based communication is regarded as a meaningful form of information about a person, it should affect social perceptions in similar fashion to other forms of (non-)verbal disclosure. This reasoning stands at the core of this thesis. The next section will discuss several such examples on physiosocial communication, especially where it concerns heartbeats.

1.5. Related work on physiology communication

This work is definitely not the first to deal with emotion communication. There is a wide array of examples in scientific circles and the arts. Some of these were created to stir debate (e.g., the

Bench Object by Dunne and Raby (1995) which introduced potentially undesired intimacy), while most focus on the communicative value (Bailenson & Yee, 2007; Battarbee et al., 2002; Goodman & Misilim, 2003; Lotan & Croft, 2007; Mueller, Gibbs, & Vetere, 2010; Thieme et al., 2011; a.o. Vetere et al., 2005). One such example by McCaig and Fels (2002) demonstrates a music system which based its output on the heartbeat information of two interacting persons. Being influenced by their emotions (via physiological measures) the musical output could in turn affect those people as it provides an auditory reflection of their current relationship. Both interactants in that study were in the same location, but United Pulse (Werner, Wettach, & Hornecker, 2008) is an example of mediated communication. A finger-worn ring lets its wearer feel the pulse of a partner through the use of a heartbeat sensor, networking technology, and a small vibrating motor mounted on the ring. More than signalling useful content, both designs mediate a sense of intimacy. Noteworthy is the often tangible qualities of such design proposals. This relates to Gaver's view (2002) that experience of use is perhaps more meaningful and therefore valuable than the actual information communicated (similar to the reasoning on "phatic" interactions (Vetere et al., 2009), see also §1.3). This would give a more visceral design an edge over conventional HCI designs (p. 483). Symbolic values that people attach to artefacts and rituals are related in nature to this vision, and perhaps also to the role mediated heartbeat communication could take within a relationship. This study will not explore the symbolic direction but it is worthy to point out such different views.

Work by Janssen, Bailenson, IJsselsteijn and Westerink (2010) demonstrates that heartbeat communication affects participants in similar ways as other non-verbal cues do. In a virtual environment people were seated to face a same-sex avatar (resembling a real-life confederate) in different conditions. The experiment compared the effect of playing heartbeat audio with silence on post-trial intimacy ratings, as well as gaze and distance measures. They found an effect of heartbeat communication similar in effect size to gaze and interpersonal distance effects, two established non-verbal communication cues (p. 75). In a follow-up study the results suggest this effect is only shown if participants indeed attribute the auditory signal to the communication partner (see also Parkinson & Manstead, 1986). No difference was found with a silence condition if people were told the auditory heartbeat signal was prerecorded and bore no relation to events during the trial (p. 77). A real-world replication by Kuling, Janssen and IJsselsteijn (2010) underlines the findings, thus attribution of an auditory heartbeat stimulus to the other person led to more interpersonal distance kept by a participant.

In my research project (2012) preceding this thesis I extended the aforementioned experiments by assessing the effect of heartbeat stimulus modality on interpersonal distance to a virtual avatar representing a real-life confederate. Both attribution of the stimulus to the other person and modality (auditory/visual/haptic) were subjected to manipulation. The measures included kept interpersonal distance and self-reports on social presence and perceived closeness to the other person. Although results were not as clearcut as earlier studies the evidence is in line with those findings. Attribution indeed remains important, while modality differences may be ascribed to specific choices made for the construction of these modalities. One of the most interesting results is that the belief in the 'realness' of the other person was affected by attribution. Some caution must be taken but it seems nonetheless promising that heartbeat communication can increase belief in the authenticity of a person while she is virtually represented. No differences were found

in social presence and closeness ratings, suggesting that either heartbeat cues are not appropriate or the methodology was insufficient to draw such conclusions.

The mediated heartbeat communication studies considered physiology as the driver for potential intimacy change, but there is also evidence for the reverse direction. Changes in social connectedness can affect one's physiology, as shown in Cwir, Carr, Walton, and Spencer (Cwir, Carr, Walton, & Spencer, 2011). In this study participants were introduced to another person, and made to experience high or low social connectedness with this person. For those who felt more similar to the other, physiological measures reflected their increased connectedness and sharing of emotions. This strengthens the argument that emotions, physiology and social relationships are interrelated, and that mediating any of these can influence the others; this includes using physiology to stimulate perceptions intimacy.

1.6. Limitations of related work

The studies on heartbeat communication performed so far focused on determining its value as an intimate cue. For other potential physiological cues (e.g., respiratory rate, skin temperature, skin conductance) any such effect is yet unknown although such physiology is also known to be strongly related to affect and/or empathy (cf. Fairclough, 2009). It stands to reason that communicating such signals may indeed affect communication between partners and perhaps influence perceptions of intimacy. In contrast to a heartbeat signal the knowledge (or folk psychology) about relevance of such physiological cues to intimacy is less strongly established in society, which may influence the interpretation, effect and desirability of communicating such signals. Because of the additional unknowns the current work remains focused on heartbeat signals.

In part the uncertainty is due to the unknown mechanism in which a heartbeat signal influences perceptions of intimacy (Janssen et al., 2010, p. 78). As mentioned earlier, Weisz et al. (1988) illustrate a link with increased self- or other-attention. Another explanation holds that it is due to heartbeat entrainment, thus the matching of one's own heartbeat to the received stimulus (i.e., elevation of heart rate if stimulus beats-per-minute is higher). This implies it is the cognitive appraisal of self-perception of one's own, altered heartbeat which in turn alters the emotional state (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Wiens et al., 2000, p. 481). This mechanism predicts effects of heartbeat communication would depend on availability of a clear link between stimulus and self-perception. People can perceive their own heartbeats via auditory and haptic feedback but not visually, hence influence of a visual stimulus would not affect the emotional state (something the results of my research project hinted at). An alternative explanation for heartbeat communication effects points to auditory heartbeat stimuli often being found in movies and games in moments of high stress or suspense. The sound percept could thus affect emotions and feelings of intimacy due to associations with arousing situations, for example erotica (as used by Valins (1966) and Parkinson & Manstead (1986) or fear. It must be noted that not all studies on heartbeat stimuli found results in all circumstances. Parkinson et al. (1986) argue that perhaps the presence of an attribution effect is contingent on the kind of emotion appraisal of the things shown, with positive appraisals more likely to lead to affects.

Another limitation of earlier experimental work is that employing short experiments means a lack of duration and interaction. These involve short experiences, something unlikely in future applications for intimate physiological communication. Some of the measures (e.g., on social connectedness (van Bel, Smolders, IJsselsteijn, & de Kort, 2009a)) are thought to be less suited for studies in which people only briefly experience interacting with someone else, and lack a means to compare such interactions with other experiences (i.e., a relative standard to compare with). If so, it may explain the lack of clear differences on social presence and connectedness measures in aforementioned studies. Incorporating more social interaction would create a more natural communication scenario, allowing for better assessment whether a cue affects social communication and appraisal. Some evidence in this direction exists for skin conductivity, a solid physiological proxy for arousal. In a pilot study by Kuikkaniemi and Janssen (2010) guidance of a challenged driver was improved when a guide was aware of live galvanic skin responses of the driver. Literature has yet to show such beneficial effects of heartbeat communication on increased social connectedness and interpersonal affect in a longer, interactive scenario. A field study on mediated heartbeat communication by Slovák, Janssen and Fitzpatrick (2012) overcomes many of the aforementioned limitations, using a ecologically valid setting with romantic partners in their daily lives. As a probe study it does lack the experimental rigour necessary to quantitatively assess effects of manipulations, something this study can contribute.

1.7. Present research and hypotheses

This thesis aims to address the question whether mediated heartbeat communication can prove its worth in dyadic social interactions that are of a longer duration than previous work has covered. This is a sensible next step to determine physiology communication's practical value for improving intimacy and social connectedness between people. While further work on the yet to be uncovered mechanism is important (as discussed in the previous section), this study aims to show clear effects in a different scenario from previous studies to support the existence of a general heartbeat communication effect. It tries to answer whether heartbeat cues are able to affect social perceptions of a communication partner (e.g., social connectedness and feelings of closeness). Because earlier work has shown heartbeat communication to be effective as a non-verbal signal, it is expected that effects are to be seen in this study as well.

This study will use a mediated text-based chat format through which people will get to know each other, hereby staying close to the methodology of Aron, Melinat, Aron, Vallone and Bator (1997), as well as Van Bel, Smolders, IJsselsteijn and de Kort (2010). In their work physiology was not incorporated but rather it studied different levels of interpersonal closeness. More personal, sensitive topics of conversation were hypothesised to increase perceived disclosure, social connectedness and closeness – similar in reasoning to the expected effects for heartbeat communication. This study manipulates attribution of a mediated heartbeat stimulus, thus people are told a heartbeat stimulus either belongs to a conversation partner or is merely artificial. The second manipulation is similar to the interpersonal closeness manipulation in the aforementioned work; participants are given either personal or non-personal topics of conversation. This interpersonal closeness manipulation is included for two reasons. First, since this study is somewhat exploratory in nature, no directly applicable prior data on expected levels of closeness are available. Thus to avoid getting stuck on potential ceiling or floor effects for heartbeat communication for one level of interpersonal closeness, an extra level is introduced. Second, when

both conversation content and heartbeat communication affect impressions of another person it would allow for some preliminary comparison of both forms of 'more engaged' communication.

Based on the theory laid out in the introduction, several hypotheses can be formulated. First, it is expected that being able to hear the heartbeat of a partner during a conversation is regarded as intimate information, and that it will positively affect impressions of partner-disclosure:

> *H_1: If heartbeat communication is considered as disclosing intimate information by a partner perceptions of partner-disclosure are expected to be higher.*

In the experiment that follows mediated heartbeat communication is added to a text-based conversation. In his work on hyperpersonal communication theory Walther (1996) argues that people readily form impressions of a partner, and that limited impressions lead to positive (over) estimation of partner characteristics. Addition of a mediated heartbeat stimulus would fill in some of the blanks, perhaps leading to less positive estimates or attributions. This work follows a different philosophy (as discussed in section §1.3): when a heartbeat stimulus is considered a signal from which personality information can be extracted, its addition is here expected to positively affect impressions of another person (that is, the source of the signal) due to increased perceived intimacy. This results in the following hypothesis:

> *H_2: Communicating a partner's heartbeat positively affects impressions of this partner's personality.*

Besides personality judgements also perceptions of the communication quality and connectedness with the partner are predicted to be affected, in a positive direction:

> *H_3: Communicating a partner's heartbeat positively affects impressions of social connectedness with this partner.*

The above statement can be split in several smaller, more specific sub-hypotheses:

> *H_{3a}: Feelings of contact quality are perceived higher compared to a non-heartbeat communication interaction.*
>
> *H_{3b}: Discrepancy between actual and desired closeness to the partner is smaller compared to a no-heartbeat condition.*

The aforementioned hypotheses have in common that these are most easily measured with self-reports. Resultant data can however suffer from biases that are common to cognitive subjective judgements involving questionnaire items (Picard & Bryant Daily, 2005). The use of behavioural measures would provide extra insight into affect towards the other while keeping such biases at bay. Generosity is a prime candidate for behavioural measurement. Various ways to do so exist but a form is sought which is not dependent on skill, as for example a game would be. It should also be not dependent on, or influence the appraisal of the co-participant by its mechanism and/or feedback. This excludes iterated, reciprocating games which can be taken over by strategic rather than pro-social concerns and choices (e.g., Van Lange, Ouwerkerk, & Tazelaar, 2002).

A one-shot non-dependent measure of pro-social behaviour can be obtained by presenting a participant with a Dictator game (Eckel & Grossman, 1996; Hoffman, McCabe, & Smith, 1996; Kahneman, Knetsch, & Thaler, 1986). In such a game one party receives an endowment, while the other remains empty-handed. It is solely the choice of the endowed participant to share any of her endowment, the receiving party has no influence and cannot reciprocate. While rational economic theory predicts a fully selfish choice, that is keeping all of the endowment, the Dictator game is widely employed in socio-economic research because people tend to deviate from such rational division. A fair distribution would mean an even 50/50 split of the endowment. It is therefore expected most people will pick a distribution of the endowment between these extremes, although it must be noted 50/50 is not an actual extreme, giving away more or all of it is also possible and sometimes used as a dependent measure (a.o. Bekkers, 2007). Various factors contribute to and moderate altruistic tendencies, such as anonymity, age, education, social status, pro-social tendencies, and social distance (see Engel, 2011 for a meta-study on Dictator games). Perceived social distance is most closely related to the intended manipulations in this work, namely to be reduced by the extra physiological cues. It is therefore expected that if heartbeat communication has positive social qualities, then:

> *H_4: Communicating a partner's heartbeat increases pro-social behaviour towards this partner in a social dilemma.*

The next parts of this report will discuss the methodology of the text-based conversation employed in this study. It is followed by a discussion of the findings and potential for future work.

2. Method

2.1. Design

We conducted a laboratory experiment using a 2 (personal topics of conversation *versus* small talk) x 2 (attributed to other *versus* non-attributed heartbeat cue) between-subjects design. Participants were randomly assigned to one of the four conditions and participated in one condition only. The design is balanced among conditions (see Table 1). Two female confederates assisted in the experiment. Participants were matched with one of two female confederates. The participant did not meet the confederate before they engaged in a text-based chat session for fifteen minutes. The participant was assigned to ask predetermined questions while the confederate disclosed her answers. This asymmetric setup allows for scripting the conversation, hereby increasing control over the content of the discussion.

For each level of interpersonal closeness (personal topics or small talk) attribution of the heartbeat stimulus was manipulated over two conditions. In one condition participants were told the heartbeat stimulus belonged to the other person, while the other conditions the stimulus was presented as merely artificial. The latter condition served as the control condition. A complete silence condition was not used, because a non-attributed condition is deemed more suitable as a control condition, as the only difference between the two conditions is the attribution effect. The audio stimulus heard was the same across conditions, namely an artificially constructed but realistic heartbeat sound. Dependent variables of the study are self-report measures on disclosure, social connectedness, closeness, liking and pro-social behaviour.

Table 1. Experimental design with the number of participants per condition. In between brackets are the number of participants used in the analyses (see also the Results section).

Participants / condition	*Small talk*	*Personal topics*
Non-attributed heartbeat	24 (23)	23 (17)
Attributed heartbeat	24 (19)	22 (20)

2.2. Participants

A total of 93 people participated in this experiment, all of whom received € 5,- in exchange for their time (non-students received € 7,-). Their mean age was 22 years (*SD* = 3.8; range 18-50 years) and 40% were male. Most of the participants were undergraduate students and were recruited on campus through flyers, direct e-mail or in person by the experimenter. Individuals who had previously participated in my research project study were excluded from participating this time because the heartbeat attribution manipulation was the same, hereby avoiding potential contamination.

2.2.1. Confederates

Both confederates were female graduate students (22 and 23 years of age) and somewhat familiar with the research topic, although blind to a participant's heartbeat stimulus condition. Since their

role involved chatting and answering questions they were well aware of the conversational topics manipulation in effect.

2.3. Stimuli and Apparatus

2.3.1. Environment

The study was conducted at the Psychology Lab of Eindhoven University. This lab consists of eight cubicles, a central space and a control room. Participants were seated in one of the cubicles at a table, in front of a computer (see Figure 2.1). On the table were instructions on paper as well as thick paper cards which had questions printed on them. A webcam was placed on top of the computer monitor to aid in convincing participants their heartbeat was measured and transmitted for the other to hear. Although in this study no actual measures were taken, the technology to do so exists (cf. Poh, McDuff, & Picard, 2011) (although it is not yet widely available).

Figure 2.1. Photograph of one of the cubicles used for seating participants. On the table the sets of questions can be seen, a headphone used for the heartbeat stimulus, and a webcam on top of the display.

2.3.2. Software

All actions by participants were done on a computer using a standard mouse and keyboard. The on-screen interactions were handled by a modern web browser displaying webpages full screen (see Figure 2.2). These pages were served by a custom web server running on the same network. Participants navigated through the experiment by clicking 'OK' or 'Next' after each phase or instruction. Chatting was handled by one webpage. This webpage resembles the layout of most instant messaging systems, that is a text box and 'Send' button were placed at the bottom and all received messages above it. New messages were appended at the bottom of this message list. The webpage checked for new messages every three seconds (or directly upon sending out a message).

At its worst three seconds would pass between sending a message and its reception on the other end, making it nearly instant. Participants were also notified of writing activity of their partner, hereby reducing perceptions of non-responsiveness. The experimenter could follow progress through a special status page that showed each session's state but neither the content of the chat nor the questionnaire responses.

Figure 2.2. Screenshot of a chat in progress. Blue fields depict the participant, yellow the confederate.

2.3.3. Interpersonal closeness induction

Manipulating the interpersonal closeness level was done by varying and controlling the content of the discussion. This was accomplished by using two different groups of questions for the Personal topics and Small talk conditions. These questions were based on the sets used by Aron and colleagues (1997) for generating interpersonal closeness on two levels (different groups of questions for personal topics and small talk). The original 72 questions (36 per group, 12 per set) were first translated to Dutch. Then all tasks (e.g., "Each of you gives a word starting with the last letter of the word the partner just gave.") were removed from the sets. Small talk questions such as "What was the best gift you have ever received and why?" were perceived as quite indicative of the partner's personality in a pilot test. Such questions were omitted and vice versa for low disclosure questions in the Personal sets. The personal topics group featured increasingly personal questions for the later sets, thus providing a stepwise increase throughout the session. Within the five minutes allocated per set typically only three to four questions could be discussed during a session. Therefore the most suitable questions have been placed at the beginning of each set. The final sets each had 7 questions, making for a total of 21 per group. Consult Appendix D for a list of questions used.

In practice it meant each cubicle had six stacks of cards on the table, three belonging to package A (Personal topics) and three belonging to package B (Small talk). Each stack was labelled as A (or B) – Set I (or II or III), with each card receiving a number between 1 and 21 indicating its position. Each set had a cover card for easy identification as well as concealment of the questions. This concealment reduced the likelihood participants would correctly guess the interpersonal closeness manipulation just by glancing over the alternative sets (participants were assigned to a condition by the software without experimenter intervention, requiring both sets to be available upon entering the cubicle).

Participants received detailed instructions on paper explaining the intended procedure, translated and adjusted from Aron et al. (Appendix C includes this text). These instructions explained one of the participants will ask questions by typing over the text on a card (to increase agency: the sense that it is them asking, not merely relaying a question), while the other will only answer. The one asking questions could determine when to move on to the next question. To reduce variation in content participants were instructed not to deviate from the given topics and not to dig too deep into one question. Because a balance must be struck between unnatural rigidity and control of the conversation no fixed limits were given, but the confederates were instructed to subtly steer the conversation back to the intended topics (e.g., by asking questions, such as: "Does this answer your question?").

Answers by the confederate were scripted and thus the same across all participants in the same condition. Some adjustments were made to strengthen the manipulation effect, for example no very personal answers were given for the small talk questions.

2.3.4. Heartbeat stimulus

A participant heard audio resembling the typical '*DUM-dum*' sound of a heartbeat through headphones connected to a computer. Presenting the stimulus as an audio signal is preferred over other modalities. Given the intended time frame of 15 minutes of continuous feedback, plus easier comparison with existing literature an auditory stimulus is preferred over other modalities. In keeping with earlier work by Janssen et al. (2010) the heartbeat stimulus is constructed based on typical heartbeat data for a healthy individual engaged in conversation while standing (bpm M = 69, SD = 3.9, range 60–79) (cf. Andersen, Guerrero, Buller, & Jorgensen, 1998). The variance in the sample used here is higher compared to the work by Janssen et al. (bpm M = 69, SD = 2.3, range 72.1–64.7) because using a similar stimulus in my research project was perceived as "flat", "monotonous" and "not really alive." This adjustment was intended to increase believability in the heartbeat stimulus. A second effort towards that goal has been to use a real heart rate recording as the basis (recorded myself while writing down answers to the personal questions discussed above). From this recording the inter-heart rate interval data (i.e., beats per minute) was used to generate a list of timestamped heart rate data for 20 minutes (a sufficient interval, given that the chat session lasts for only 15 minutes). Spikes and other artefacts were removed from this list. The resulting list essentially gave a blueprint for replaying the recording to a participant. Software written in Processing ran in the background and used the list to replay a heartbeat audio sample during the chat session.

2.4. Measures

Nearly all self-report measures reported here are based on several post-experiment questionnaire items. The complete set of items can be found in Appendix E. Appendix F holds information on scale formation for the various measures.

2.4.1. Disclosure

Partner-disclosure is measured with three items based on Laurenceau, Feldman Barrett, and Pietromonaco (1998): *"To what extent did X share [factual information | his/her thoughts | his/her feelings] with you?"* These items had a 7-point response scale ranging from (1) 'absolutely not' to (7) 'to a very large extent.' Measures of self-disclosure and partner responsiveness have been excluded because due to the asymmetric dialogue there is only a negligible amount of disclosure involved from the participant. The item on disclosure of facts did not correlate well with the other two and has been omitted from a summated scale. The remaining two items on partner-disclosure had an internal consistency of α = .74.

2.4.2. Social connectedness

Connectedness is tapped into with items from the Social Connectedness at the individual level scale (van Bel, Smolders, IJsselsteijn, & de Kort, 2009a). Not all components of this instrument are deemed relevant (i.e., 'Relationship Salience' is an unlikely factor for unfamiliar couples and has been excluded). From the latest version (SCEQ-S) two factors are included: 'Relationship Quality' (α = .75; e.g., *"I often know what X thinks."*) and 'Interaction Quality' (α = .54; e.g., *"I get little satisfaction from my contact with X."*). A partial Relationship Quality scale was created omitting three items that tapped into how the participant thought the partner perceived them (although hardly any such information was communicated during the chat, giving low variance on those items). Reliability for this partial measure is α = .66.

The factor 'Feelings of closeness' was omitted from SCEQ-S compared to an earlier revision but its items (e.g., *"I have the feeling I can discuss everything with X."*) are retained in this study. All items are answered with a 7-point response scale, having labels from (1) 'completely disagree' to (7) 'completely agree.' Internal consistency of this factors was α = .65.

2.4.3. Closeness

Closeness was measured in two ways. The last two items of the 'Feelings of closeness' factor (see also paragraph above) are similar to the Subjective Closeness Index (SCI; Berscheid, Snyder, & Omoto, 1989) and were used for another scale item (Cronbach's α = .89). Because an ideal version of this SCI was also used, another measure capturing the discrepancy between the SCI and ideal SCI item was created as well.

Closeness was also measured with a variation on the Inclusion of Other in Self scale (Aron, Aron, & Smollan, 1992). Two circles were shown per item, one depicting the participant and one depicting the other person (see Fig. 2.3). One circle (the self) could then be moved towards the other circle, providing a visual, continuous scale of self/other overlap which is a proxy for closeness. This scale is shown twice, once asking to *"Move the left circle as to have the circles describe your current relationship to the other,"* and the second instance replaced "current relationship" with

"desired relationship." Measurements are taken in percentages of overlap of the circles. A third measure of discrepancy between the current and the desired relationship was derived by subtracting one from the other.

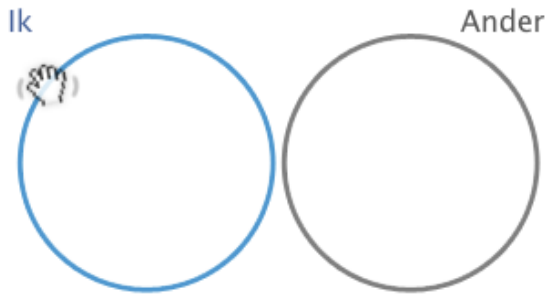

Figure 2.3. Closeness was measured using a continuous variation on the visual Inclusion of Other in Self scale. Participants could drag the blue circle (depicting them) towards the other (depicting by a black circle).

2.4.4. Liking

To measure liking of the partner participants were asked to indicate agreement with five statements, such as *"I like X"* and *"I can imagine becoming friends with X."* For each item, participants rated their agreement on a seven-point response scale ranging from (1) 'strongly disagree' to (7) 'strongly agree.' The items were adopted from Pinel and colleagues (2006) although no formal validation of the items is available. Other scholarly articles (e.g., Bailenson & Yee, 2007; Sedikides, Campbell, Reader, & Elliot, 1999) employ similarly worded questions, giving confidence in the items beyond face validity. When two items are removed which show low correlations with the remaining three this scale had an internal consistency of α = .692.

2.4.5. Pro-social behaviour

A variation on the widely used Dictator game (Bekkers, 2007; Engel, 2011; Hoffman et al., 1996) is used to tap into pro-social behaviour. The basis of such a game is to introduce a certain amount of something valuable to only one participant, and ask how much of the endowment she is willing to give away to the other. In this study the game was introduced as follows: *"You and your partner both receive the regular payment for participation. For one in every 10 couples an additional bonus of € 10,– is available. You get to decide how this amount is split among the two of you. You can decide to share nothing, a part, or all of the amount with your partner. The partner has no influence on and will not be informed of your decision. How much money are you willing to give away to your partner?"* The caveat that only one in ten couples actually receive payment was introduced for financial reasons, since potentially paying € 10 to all participants could triple the running costs of the study (and not having found a pot of gold at the end of several rainbows I tried didn't help matters). People tend to give away more if the stakes are lower according to a meta-study by Engel (2011, p. 592), but the same study has shown there is no clear difference in mean scores between hypothetical and paid variants of the Dictator game. Ben-Ner, Kramer and Levy (2008) however show that personality interactions can be hidden among apparently similar mean scores. The idea to pay € 10 to a part of the couples strikes a balance between introducing 'tangible' benefits and costs on the other hand.

Figure 2.4. Screenshot of the pro-social behaviour measure in the form of a Dictator game. A slider was used to adjust the amount given away to the other participant. The legend below the slider shows the amounts that will befall each of the chat partners (in blue the participant herself, in yellow the other).

A participant's intention was measured using a horizontal slider which could be dragged using the mouse (see Figure 2.4). Labels to the left and right indicated the extreme ends of options (giving away respectively € 0 and € 10). Because initially the dictator starts with € 10, the slider is set to € 0 by default (i.e., giving away nothing). A participant could adjust the outcome in steps of € 0,10. This granularity of € 0,10 (instead of the more common integer steps of € 0, € 1, € 2, and so forth) was used for improved resolution in answers, which in previous studies (cf. Engel, 2011) have shown to tend towards small percentages. Had a range of integer values between € 0 – € 10 been used, some of the most desired answers could fall between two values, making the data potentially dependent on the response limitations.

2.4.6. Manipulation checks

To make sure the participant had understood the instructions and manipulations correctly and was not aware of the intent of the study, manipulation check questions were administered after the experiment. These questions aimed to check for understanding of the true purpose of the study and its measures of interest, the extent to which they believed the other participant was truly another participant (i.e., not a chatbot or confederate with a script) and whether their beliefs about the heartbeat stimulus were in line with our manipulation. Using a funnelled debriefing format, answers were given orally and it was up to the experiment leader to determine whether the participant was aware of the goals of the study. Participants were given a ranking based in this insight; (1) those who reported no awareness of the bogus elements of the study, (2) those who reported that they might have had a clue (perhaps at a late point), and (3) those who reported a strong sense about the manipulations and goals of the study.

To support the verbal reports on the funnelled debriefing with quantitative data several self-report items were included in the post-experiment questionnaire as well (and were thus read and answered before the verbal checks). Two items aimed to check for the interpersonal closeness manipulation in effect ("The topics discussed were personal," and "The topics discussed gave me good insight in the other."). These two items had an internal consistency of .60. Four items were used to gauge heartbeat stimulus manipulation effectiveness, of which two were combined in a summated scale with a reliability statistic of .75 (see Appendix F for more detailed information on the scale formation).

2.5. Procedure

One participant took part per session. Upon entering the lab spaces a participant was welcomed and told that the study was about audio distractions during chat communication. She was further explained that another participant was present to chat with them. A participant would not see the other participant (a confederate) to keep from forming impressions based on the confederate's appearance (and vice versa). Instead they were told another participant was already waiting for them in another cubicle. Before continuing all participants signed a form of informed consent explaining their rights, which can be read in Appendix A.

Participants were seated in a cubicle in front of a computer. On-screen instructions further explained the procedure to the participant (Appendix B). In the attribution condition participants were told that they would hear the live heartbeat of the other person. Participants in the non-attribution control conditions were told this stimulus was a prerecorded artificial signal, bearing no relation to events during the experiment (although it may be recognised as a heartbeat signal such as heard in movies). This audio was only played during the chat session, not during any other phases of the experiment. Using a test stimulus it was confirmed each participant was able to perceive audio as intended. During the experiment the experiment leader remained in a control room, only able to monitor a participant's progress through the phases of the experiment. This means that the experimenter was blind to both experimental manipulations for a participant until the participant had been seated in a cubicle.

Participants were explained that the chat session followed a structure whereby one party only asked predetermined questions in a given order and the other only answered these questions (see the written instructions in Appendix C). Although people were made to believe this task division happened randomly, all participants were asking questions and the confederate always had the answering role, giving scripted answers. The questions were printed on paper cards and arranged in six sets (two groups for each interpersonal closeness manipulation, with each group having three sets of questions). On-screen instructions informed the participant about the sets of questions to use (A or B). The chat session was divided in three parts of five minutes each, making for a total of fifteen minutes. The time started once both chat partners had left a message. After each five minute part participants had to move on to the questions of the next set, hence the three sets per group. A participant would thus start with set 1, question 1 of the designated group of cards and work through the questions of the set until an on-screen message indicated they had to move on to the next set. After 15 minutes a final message would indicate the end of the chat session and hide its interface.

A participant would go on to fill out self-report items on a final webpage resembling an online questionnaire. For all relevant items participants were instructed to base their responses on how they have experienced their social relationship and contact with the other participant during the past 15 minutes, that is the chat session. After returning from their cubicle the experimenter asked questions per the funnelled debriefing format to check for suspicion of the manipulations in effect and the purpose of the study. To avoid potential cross-over effects for later participants people were not informed on the role of their co-participant as a confederate, unless a participant had expressed doubts. If no more questions arose, a participant was paid and thanked for her time. Each experimental trial lasted for about thirty minutes in total.

3. Results

3.1. Exclusion of cases

Fourteen participants have been excluded from the analyses reported below, leaving in data from 79 participants. Seven of those participants were excluded due to misunderstandings and/or awareness of the manipulations and variables of interest (based on quantitative criteria discussed in the next paragraph, and those who verbally reported a strong sense of awareness). All chat transcripts were analysed; three participants which deviated too much were excluded (i.e., asking too much questions not in the sets, straying from the intended topics and/or not progressing through the sets; see Appendix F for exact criteria). Two participants indicated they did know the confederate before engaging in this experiment. Effects of such familiarity cannot be determined from the data available but in my previous study on heartbeat communication (van Gennip, 2012) such familiarity was shown to affect results. To avoid contamination these two cases have been excluded from further analysis. Finally, two more participants were excluded due to their responses on (some) of the dependent variables registering as outliers (Z-scores >= 3 or <= -3).

3.2. Manipulation check

The interpersonal closeness induction appears to have worked as intended. An ANOVA on a interpersonal closeness manipulation measure with Interpersonal Closeness and Heartbeat Attribution as between-subject factors is significant for the Closeness variable ($F(2,93) = 36.19$, $p < .000$, *partial* $\eta^2 = .29$) but not for Attribution ($F(2,93) = .42$, $p < .52$, *partial* $\eta^2 = .01$) nor the interaction between both ($F(2,93) = 1.48$, $p < .23$, *partial* $\eta^2 = .02$). This analysis explains 27,7% (*adjusted* R^2) of the variance in the data. Given these clear results, the Interpersonal Closeness manipulation is regarded as successful. One participant was excluded based on the following rationale: cases in the small talk condition with a Z-score >= 3 and cases in the personal condition with a Z-score of <= -3 were excluded. This means those who differ by a large margin in the wrong direction are excluded from further analyses because the manipulation was not effective for them (compared to the majority). This brings the total count of excluded participants to fourteen.

Heartbeat stimulus manipulations are also successful based on the summated self-report measure. An ANOVA on a summated scale of this manipulation check's self-report items with Interpersonal Closeness and Heartbeat Attribution as between-subject factors gave the expected significant effect for Attribution ($F(2,93) = 12.65$, $p < .001$, *partial* $\eta^2 = .12$), a marginally significant effect for Closeness ($F(2,93) = 3.92$, $p < .051$, *partial* $\eta^2 = .04$) but not for the interaction effect ($p = .709$). The results of the analysis indicate the heartbeat attribution was understood correctly across participants (except for a few), although it is a small effect: responses in the Attributed condition are still below the halfway mark on the 7-point scale.

3.3. Hypothesis testing

All subsequent analyses reported are analyses of variance (ANOVA) on the dependent variable of interest with Interpersonal Closeness (Small talk / Personal topics) and Attribution (Artificial heartbeat / Attributed heartbeat) as between-subject factors. Sex (Female / Male) was included in preliminary analyses but did not to affect results and was not included in the reporting except for

a few noted cases. For sake of brevity a repetition of the above is sometimes omitted. In a similar vein, all test statistics can be found in Table 2, making the text more readable and data easily comparable.

*Table 2. Results of ANOVA on various dependent measures with Interpersonal Closeness and Heartbeat Attribution as between-subject factors. Please read all F statistics as F(1,75), and η^2 refers to partial η^2 effect sizes. P-values with a ** denote a chance less than .01, and *** a chance less than .001.*

ANOVA Factors	*Interpersonal Closeness*			*Heartbeat Attribution*			*Interaction Closeness * Attribution*		
Dependent measures	F	$p <$	η^2	F	$p <$	η^2	F	$p <$	η^2
Partner-disclosure	29.32	.000***	.28	.26	.61	.00	.04	.83	.00
Relationship Quality	1.83	.18	.02	.00	.99	.00	.16	.69	.00
Rel. Quality (partial)	9.19	.003**	.11	.47	.50	.01	.00	.98	.00
Interaction Quality	.59	.44	.01	.00	.97	.00	.01	.91	.00
Feelings of closeness	.13	.71	.00	.33	.57	.00	.18	.67	.00
SCI	.15	.70	.00	.03	.86	.00	.14	.71	.00
SCI – Discrepancy	.67	.42	.01	.01	.91	.00	.18	.67	.00
Inclusion of Other in Self	.48	.49	.01	.38	.54	.01	1.13	.29	.02
IOS – Ideal	.55	.46	.01	.00	.96	.00	.09	.77	.00
IOS – Discrepancy	.17	.69	.00	.10	.75	.00	.10	.75	.00
Liking	.35	.55	.01	2.36	.13	.03	.91	.34	.01

3.3.1. Partner-disclosure

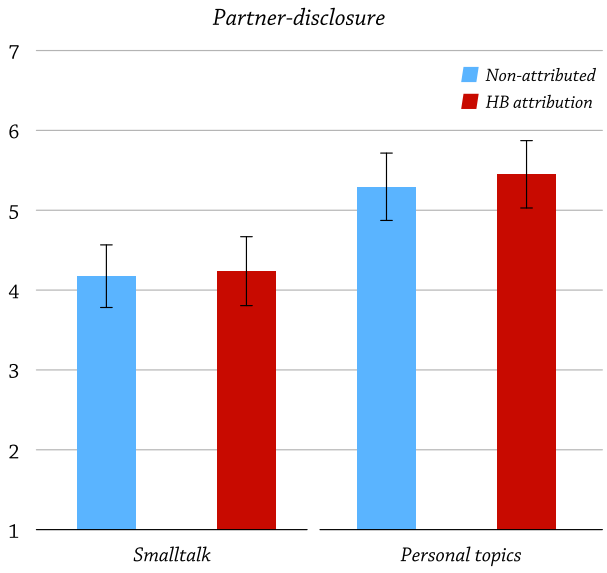

Figure 3.1. Graph of ANOVA on partner-disclosure with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

The perceived partner-disclosure was submitted to an ANOVA with Interpersonal Closeness and Heartbeat Attribution as between-subject factors. The Interpersonal Closeness factor significantly affected results ($p < .000$) but Attribution did not (see Fig. 3.1). The interaction between both factors had no significant effect on partner-disclosure either. An analysis which included Sex (full factorial model) was not different from the sans-sex results and is thus not reported here.

3.3.2. Social Connectedness

Relationship Quality (the full summated scale) was neither affected by Interpersonal Closeness nor by Attribution nor by the interaction between both in an analysis of variance (see Fig. 3.2a). Including Sex in the analysis (full factorial model) gave no results different from the sans-sex results. The partial measure of Relationship Quality (omitting three irrelevant items which relate to how the partner felt about the participant; see also §2.4.2) did show Interpersonal Closeness to significantly affect the measure ($p < .003$), but neither Attribution nor the interaction factor between both did significantly affect the responses (see Fig. 3.2b).

Interaction Quality data was submitted to the same ANOVA (see Fig. 3.3a). Neither the main factors on Interpersonal Closeness and Attribution nor the interaction effect were shown to affect the outcome. An analysis which included Sex (full factorial model) was not different from the sans-sex results, thus there were no significant effects found.

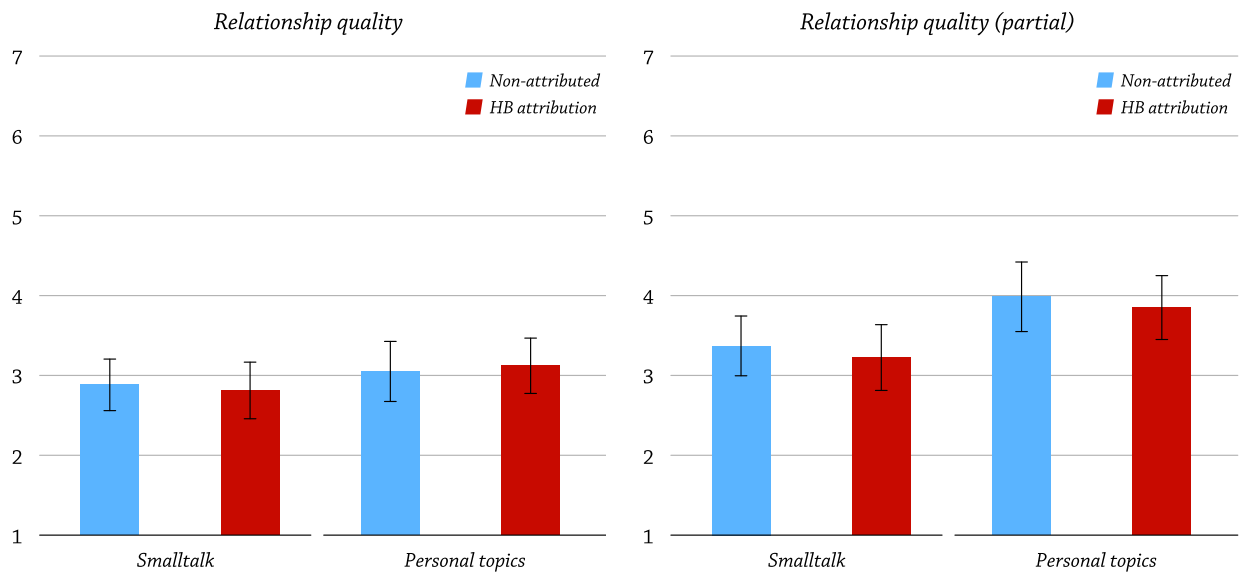

Figure 3.2. Graphs of ANOVA on (a) Relationship Quality, and (b) partial Relationship Quality with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

Feelings of closeness also gave no significant results for the same ANOVA model described before, thus neither Interpersonal Closeness nor Attribution significantly influenced the outcome (see Fig. 3.3b). An ANOVA model which including Sex did show a marginally significant effect of Heartbeat Attribution*Sex ($F(1,75) = 3.95$, $p < .051$, *partial* $\eta^2 = .053$) but not of any other (interaction) effects (see Fig. 3.3cd). However, rerunning the analysis with high leverage cases excluded meant eliminating the deviant female cases (six in the Personal topics / Attributed condition) that led to the Attribution*Sex effect (so the effect evaporated).

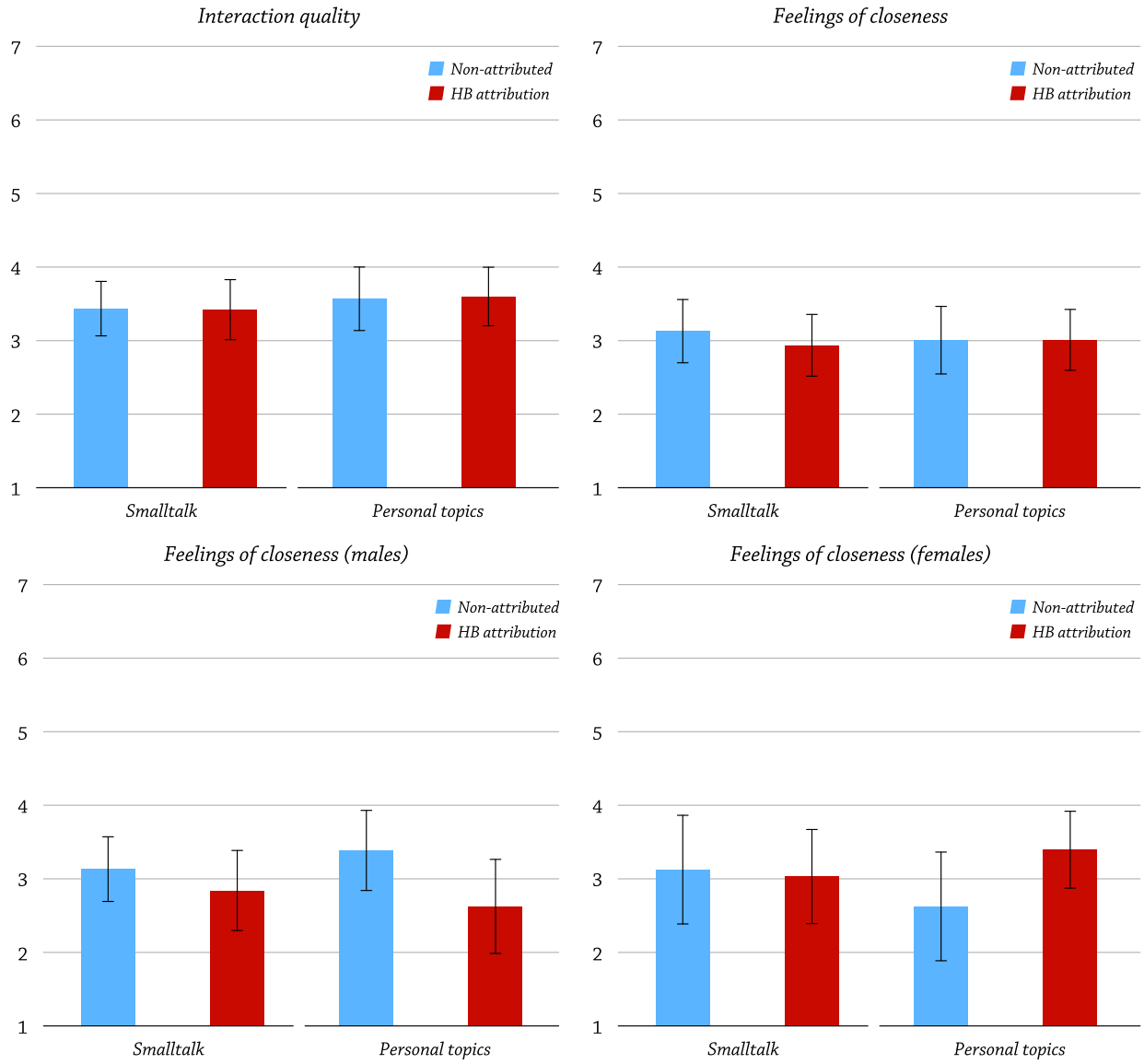

Figure 3.3. Graphs of ANOVA on (a) Interaction Quality, (b) Feelings of closeness, (c) idem for males, and (d) idem for females with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

Feelings of closeness also had a partial measure equal to the Subjective Closeness Index (see Fig. 3.4a), and a discrepancy between the SCI and desired subjective closeness (Fig. 3.4b). Given that the SCI measure was not affected by Interpersonal Closeness nor Heartbeat Attribution (no significant results returned from ANOVA), it is not a surprise that a discrepancy (desired minus the experiences closeness) gave no significant results either. For both measures including Sex as a factor did not affect results.

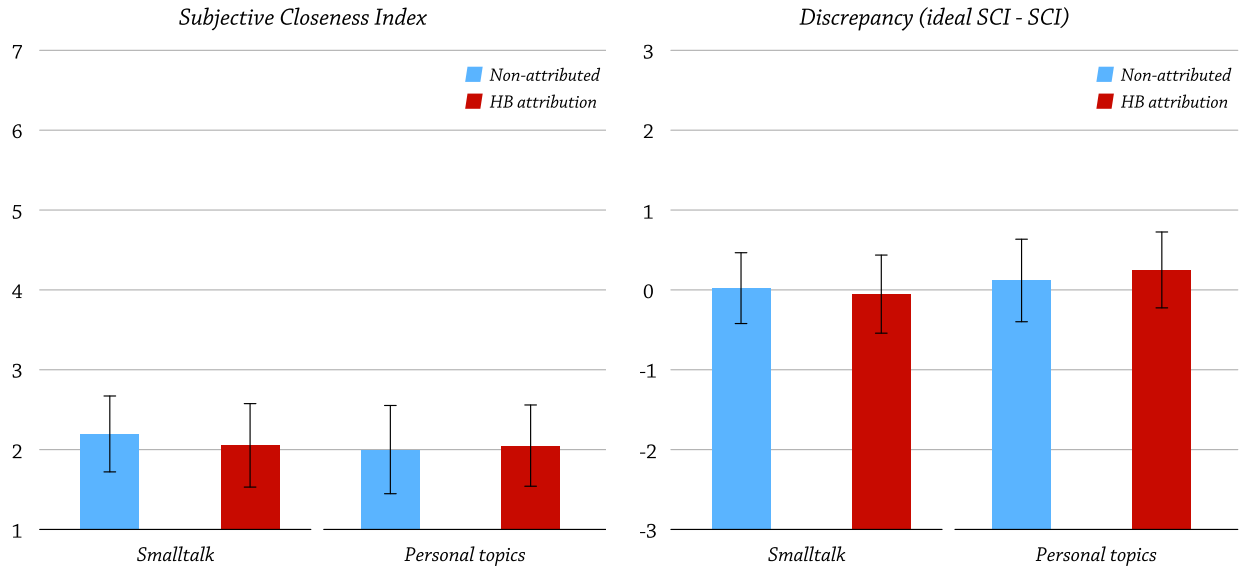

Figure 3.4. Graphs of ANOVA on (a) Subjective Closeness Index, and (b) a discrepancy between ideal SCI and SCI with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

3.3.3. Closeness

The continuous Inclusion of Other in Self scale did not reveal effects of the Interpersonal Closeness and Heartbeat Attribution factors nor the interaction between both in a full factorial ANOVA (see Fig. 3.5a). A similar story can be told for the desired level of inclusion. Both main effects and the interaction effect were insignificant in their contribution to the ANOVA model. It is noteworthy that including Sex as a factor to the model does show a significant effect of Interpersonal Closeness*Sex on the desired inclusion ($F(1,75) = 6.06$, $p < .016$, *partial* $\eta^2 = .08$). All other (interaction) effects were not significant (see Fig. 3.5bcd). Levene's test of equal variances ($p < .018$) indicated problems with normality assumptions. Therefore rerunning the analysis with large leverage cases removed made the significant effect vanish to the fact that the female cases that led to the effect were then excluded.

Similar results are seen for the discrepancy between the desired and experienced closeness. Keeping Sex out of the full factorial ANOVA model shows no significant effects of any (interaction) factor. Including Sex shows the same Interpersonal Closeness*Sex interaction effect to affect the outcome significantly ($F(1,75) = 6.41$, $p < .014$, *partial* $\eta^2 = .08$). The same story applies when excluding data of troublesome (female) participants: the effect is no longer to be seen.

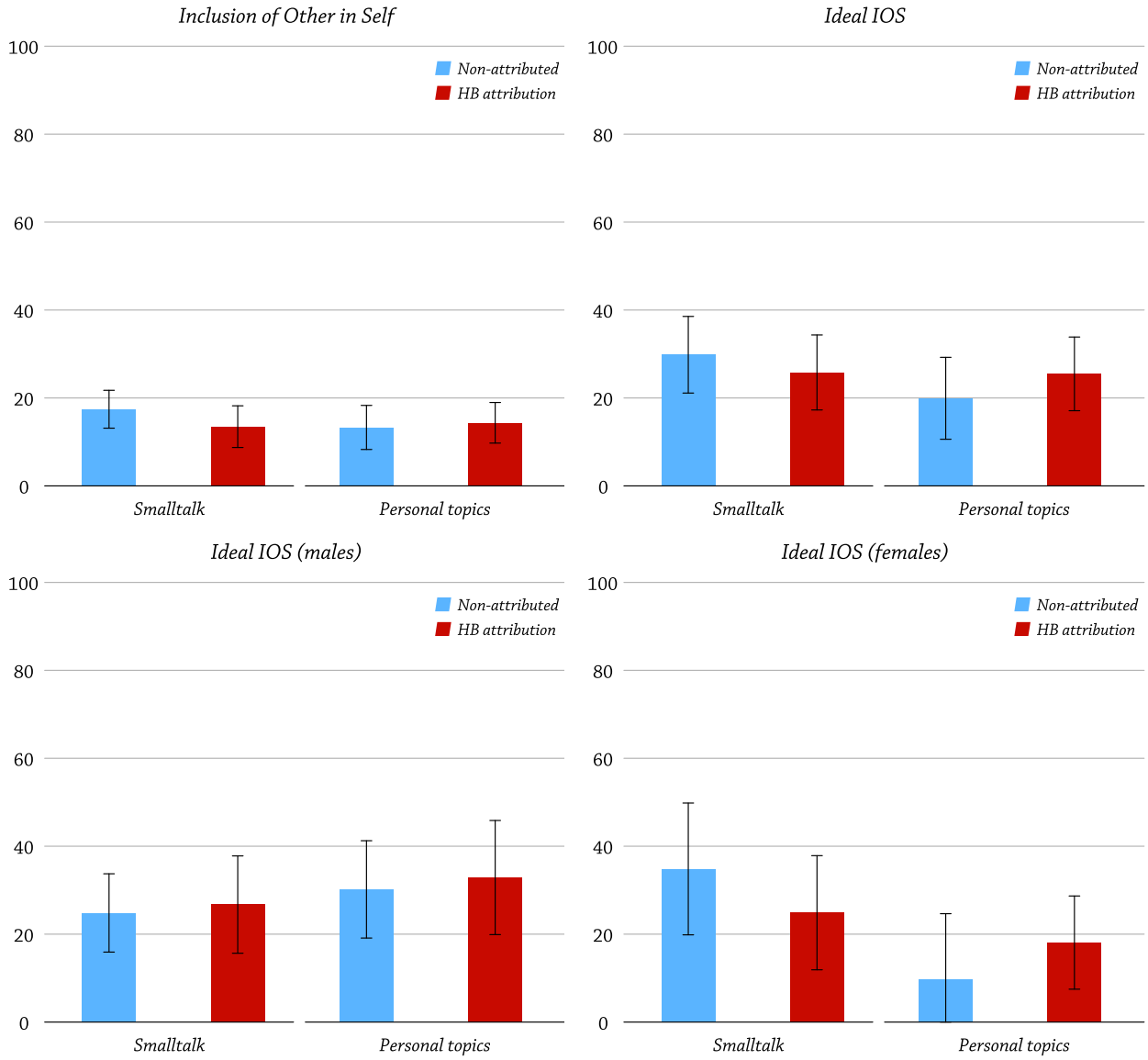

Figure 3.5. Graphs of ANOVA on (a) IOS, (b) ideal IOS, (c) ideal IOS for males, and (d) ideal IOS for females with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

3.3.4. Liking

Liking of the chat partner was similarly unaffected by Interpersonal Closeness, Heartbeat Attribution, and the interaction between both factors in a full factorial ANOVA model (see Fig. 3.6). Including Sex to this model did not alter the outcome, all factors still had an insignificant effect on the liking of the partner. Although no significant differences were found in the analysis of variance, there was a significant correlation between liking the other participant and pro-social behaviour (*Pearson's* $r(77) = .299$, $p < .004$).

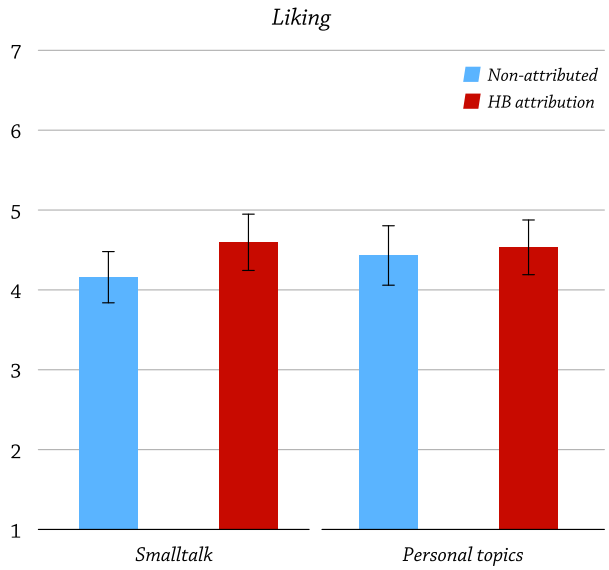

Figure 3.6. Graph of ANOVA on Liking with interpersonal closeness and attribution as between-subject factors. Error bars indicate 95% confidence intervals.

3.3.5. Pro-social behaviour

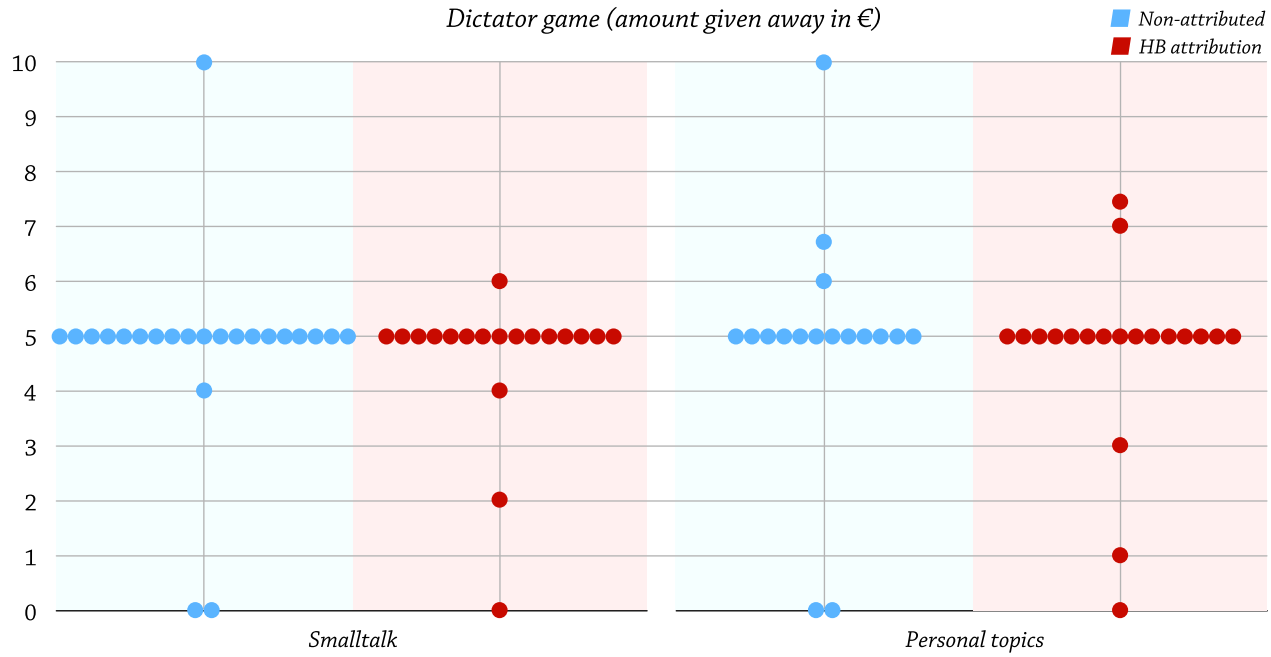

Figure 3.7. Pro-social behaviour as measured with part of € 10,- endowments given away with interpersonal closeness and attribution as between-subject factors in a Dictator game. Each dot marks one participant.

The amounts of € 10,- shared with the other participant were not distributed uniformly nor satisfy normality assumptions (see Fig. 3.7). When comparing the distributions of those who gave 50% or more with those who gave less across conditions no significant differences were found for Interpersonal Closeness ($\chi^2(1, N = 79) = .14$, $p = .71$) nor for Heartbeat Attribution ($\chi^2(1, N = 79) = .01$, $p = .92$). A rather high percentage of participants (75%) gave exactly 50% which is the socially fair choice. Excluding those who gave 50% leaves only data on twenty people, hence it is not surprising a similar χ^2 analysis yields no significant results. Differences between male and

female participants were present (83% of males gave away 50% or more, compared to 90.6% of females), but this difference was not significant.

4. Discussion

Traditional communication media are known to be limited in their capacity to transmit intimate social signals. Previous research (Janssen et al., 2010) has provided first evidence that conveying physiological signals, in particular heartbeat information, in a communication context is processed as an intimate cue, on par with eye contact or interpersonal distance. The current study aims to extend this paradigm by investigating whether mediated heartbeat communication is also considered an intimate cue after a more extensive period of time, as compared to previous work. This study had people chat with a stranger for fifteen minutes, while they were exposed to the mediated heartbeat sound of the stranger. Participants were coupled to a confederate who disclosed her answers to predefined questions. The expectation was that heartbeat communication would be seen as a intimate cue and influence the perceptions of the confederate by the participant. The various measures on disclosure, social connectedness, liking and pro-social behaviour aimed to reveal such effects. In addition the topics of conversation were varied between small talk and more personal issues. It was expected more personal conversation would affect perceptions in similar, positive direction as mediated heartbeat communication, leading to potentially cumulative effects.

While the manipulations appear to have registered as intended, the expected beneficial effects of more personal conversation and heartbeat communication were mostly absent. The results for partner-disclosure confirm the manipulation check analysis: a more personal discussion did lead to a higher level of perceived partner-disclosure. Relationship quality was also shown to be higher in the more personal conditions, albeit only for the partial measure. Whereas for any other measure interpersonal closeness and the attribution of a heartbeat stimulus appeared not to affect social perceptions. Because self-reports alone may be subject to cognitive biases (Picard & Bryant Daily, 2005), a measure of pro-social behaviour was included as well. Results on this Dictator game fell short of expectations, as the majority of participant decided to split the endowment equally. While a socially fair outcome in itself is positive and perhaps more than normally seen in studies (Engel, 2011), it did not reveal differences between the conditions. In short this means that for all predictions, the null hypotheses cannot be refuted. Thus in this study, no general effects were found for mediated heartbeat communication nor for different levels of interpersonal closeness. This also means there is no such thing as a cumulative effect of both manipulations, at least not within the limitations of this study. The positive correlation between Liking and pro-social behaviour is not unexpected (see also Engel, 2011) but adds little to the understanding of the phenomena of interest.

Observed differences between males and females across some of the measures warrant further investigation. These differences vary not in effect size but in apparent direction of the effect. Partially this may be ascribed to the lower number of female participants and thus larger variance in the data. One possible explanation for this phenomenon is a different sensibility for social cues (or lack thereof) between sexes (Dindia & Canary, 2006; Maccoby & Jacklin, 1974). Perhaps females attach different cognitive significance to certain social cues and interactions, as was the case in my research project with gender-specific responses to heartbeat stimulus modalities. For example, inclusion or, put differently, self/other confusion effect is thought to be a cognitive process (Aron, Aron, Tudor, & Nelson, 1991). In the case of the ideal Inclusion of Other in Self

measure where closeness effects are opposite in direction such a difference might be at play. Responses to the Dictator game were fairly similar, although a male/female would not have been a surprise (Eckel & Grossman, 1998). Most participants stuck with the fair option (50/50) so this is likely the reason why no clear differences arose between the sexes.

4.1. Limitations

There are several limitations which may have handicapped the study from finding the expected results. Before diving into alternative explanations, it must be noted that results may not generalise to a wider population. Participation was (mostly) limited to university students, who often participate and are perhaps more aware of the broad aims of studies done at our lab. Still, such arguments can be made for comparable studies with which the results found here are not in harmony.

The rigid structure of using a confederate to disclose scripted answers is both a blessing for experimental rigour as a negative influence for a natural conversation. All participants within the same interpersonal closeness condition were exposed to approximately the same content but quite a few participants expressed their discontent at the imposed limits to their input. The asymmetric role division in which they were not allowed to disclose things themselves "was not fun" and "weird, given the quite personal questions (I) asked." This lack of self-disclosure can indeed influence, and in this case lower, the experienced intimacy (Aron et al., 1997, p. 364; Laurenceau et al., 1998). A less rigid format can improve the flow of conversation and mutual disclosure at the cost of control over the content.

The limited self-disclosure due to the one-way-confederate disclosure can be regarded as a confound of this experiment. Apart from this important difference, the methodology has many elements in common with another study on mediated text-based chats between strangers by Van Bel, Smolders, IJsselsteijn and de Kort (van Bel et al., 2010). Their results cannot confirm that more personal (disclosing) topics of conversation lead to more connectedness (despite the more equal turn taking in conversation), as was replicated here. They argue partner responsiveness is more important than disclosure for mediated intimacy (p. 8), perhaps an inherent characteristic of mediated text-based communication compared to face-to-face and/or telephone conversations (Aron et al., 1997; Laurenceau et al., 1998). Partner responsiveness was not measured in this study but was in all likelihood constant across conditions (dependent on scripted confederate disclosure) which may give another reason for low variety in the responses given between conditions. On the topic of low variance in the data, the lack of clear patterns in the data meant scale formation was difficult (that is, if based solely on the current data, and not prior literature which had shown the reliability of the instruments). This was especially true for the Social Connectedness scale. While in previous studies (van Bel, Smolders, IJsselsteijn, & de Kort, 2009b; 2009a) this scale proved reliable in discerning different levels of connectedness, here it fell short of expectations.

The basis for the interpersonal closeness manipulation as used here stems from the aforementioned study by Aron, Melinat and others (1997) gave. The interaction in their study was performed face-to-face with somewhat familiar student couples and was able to yield results on measures of closeness (IOS). Here no such differences in closeness were found while participants

were strangers at the beginning (the participant and confederate did not meet before the chat). Perhaps the lack of a pre-chat real life introduction and basic information on the other participant (e.g., name, sex, age) kept participant too far removed from each other, hereby outdoing the supposed benefit of limiting pre-study impressions (which could have confounded results). Familiarity of participants was not the only difference between the study by Aron et al. and this one: the format of the conversation was altered (i.e., one-way disclosure), and the time spent together was shorter. Reducing the time together from fifty minutes to only fifteen (similar to van Bel et al., 2010) may have limited the development of impressions of the partner, and affect the responses. Changing the conversation from face-to-face to a mediated text-based format is probably the strongest difference between the two studies, and it is likely to have affected the impressions. The different outcomes can also indicate inherent differences between face-to-face and mediated communication (a point also raised by van Bel et al., 2010).

The unfamiliarity of couples points to an alternative explanation for the lack of measurable differences on the Social Connectedness scales. It might be that this instrument is not very sensitive for capturing relationships between (near) strangers. Van Bel et al. (2010), who also employed a mediated chat format with a very similar interpersonal closeness manipulation, found similar null-results for some of their Social Connectedness measures. This cannot explain why data on other measures such as liking, IOS, and pro-social behaviour follow a similar no-difference pattern, unless the same logic extends to those measures. There is a possibility people do not have absolute evaluations for their experiences but rather those are relative to other experiences. This would imply one measure such as taken in a between-subjects design as was used here cannot capture the relative value people attach to an experience. A within-subjects design – while a less conservative test due to potential demand characteristics – would be a sensible way to verify this explanation.

Earlier studies on mediated heartbeat communication (Janssen et al., 2010; Kuling et al., 2010) could not distinguish between the attributed and non-attributed conditions for Social Connectedness measures either. It was expected the increased longevity would make a difference in this regard. The effect of psychophysiology-based feedback during social interactions could also be limited to a novelty effect. One of the reasons for performing this experiment was to determine whether effects would still be found after a longer time frame than most earlier experimental studies have used (usually no more than a few minutes). It may be that initially the impact of hearing someone's heartbeat can be higher and then wane off or drown amidst other social cues. Such a novelty effect could explain why no discernible effects were found after the 15 minutes of chatting. Another way to look at the non-effects found for the heartbeat stimulus is to regard it not as a novelty effect, but rather as a perceptual adaptation process. Similar to other stimuli, human perception may adapt to a heartbeat sound after some time (cf. Mather, 2006). The rather monotonous, constant nature of heartbeats does not help in this regard to keep salience of above a threshold, such that it can affect responses. Because no intermediate measures were taken (e.g., after five minutes) it cannot be determined whether there would have been effects at the beginning. In that sense the current methodology was insufficient. However, if this would be true a novelty effect or perceptual adaptation would negate the anticipated, positive effect of spending time together, that is, become more familiar (cf. Bickmore & Picard, 2005). Becoming more familiar with the other (partially through the mediated heartbeat) was expected to lead to more

positive social appraisal. This expectation appears to not be validated here, or at least signal such an advantage does not pay off within a quarter of an hour. Future research could try to shed a light on these hypotheses.

Although the non-differences for attribution of the heartbeat stimulus is at odds with related work (Janssen et al., 2010; Kuling et al., 2010), there may be an alternative explanation in work on false heart rate feedback. Studies which included the same manipulation of a seemingly unrelated stimulus and its attributed version do not always produce results either. In one such study which showed erotic, arousing imagery the attribution of a false (own) heart rate led to higher levels of arousal but skin disease imagery gave no such effect (Parkinson & Manstead, 1986). Parkinson et al. argue perhaps the presence of an attribution effect is contingent on the kind of emotion appraisal of the things shown. For the current work this distinction of content appears a less plausible but still a possibly valid explanation. The related studies (Janssen et al., 2010; Kuling et al., 2010; van Gennip, 2012) also had a participant meet someone unfamiliar in a real or virtual environment. The text-only environment employed here could have been less (positively) exciting or arousing in a different way (e.g., because the other is not seen or visually represented during the chat). The mostly 50/50 responses to the Dictator game hint at such an issue. The fact that the mediated heartbeat communication was automatic (i.e., no distinctive choice to disclose or receive it) and not a part of the conversation (but rather an audible backdrop to the conversation) may have limited its impact as well. Future work could improve on this potentially negative aspect.

4.1.1. Cardiac activity

In this study cardiac activity information has not been used but there are good reasons to do so. First, there is benefit in believability. Some participants were sceptical about the use of a webcam for heart rate measures – which indeed was a cover-up due to unavailable ECG equipment, although this story has merit (cf. Poh, McDuff, & Picard, 2010). If this skepticism dampened the expected effects of a mediated heartbeat stimulus, showing people a live conversion of their heart rate to an audible stimulus could heighten the perceived realism and strength of the manipulation (see also §3.2). When such a live conversion is only shown before the actual experiment it would not complicate and affect a participant's impressions during the experiment, but rather aid the believability. By doing so the manipulation can become more effective, and hopefully result in clearer differences between conditions.

Second, cardiovascular measures could reveal effects of any manipulation on a participant through her physiology (and need not be limited to heart rate data but can include galvanic skin response, etc.). A higher level of arousal due to a manipulation could mediate other measures, if following the predictions of self-perception theory (Valins, 1966; Wiens et al., 2000). For example a potential shift of one's own heart rate toward a stimulus frequency can be accounted for with inclusion of cardiovascular data, as well as a relation between affect intensity (due to a mediated stimulus) and one's own cardiac arousal (see also Blascovich et al., 1992). In particular the onset of heart rate data after the start of exposure to a heart rate stimulus could reveal interesting data if the effect would diminish over time (i.e., initial cardiac entrainment to the stimulus, or a novelty/perceptual adaptation effect as discussed in the Introduction). A recent study by Cwit, Carr, Walton, and Spencer (Cwir et al., 2011) has indeed found that initial social connectedness

between strangers can affect their physiological states (in tandem with self-report measures). Of course cardiovascular data can only be related to levels of arousal, for a more complete picture the valence (i.e., positive of negative appraisal of the arousal) would be required as well. Interpretation of just the arousal is still valuable to see if it changes over time, and perhaps wanes off after initial excitement. Valence may not follow such a pattern, but would require different ways of measurement. This partiality of heartbeat communication, requiring additional interpretation, is also how a received of a mediated heartbeat has to deal with the signal (Slovák et al., 2012).

The heartbeat stimulus employed was thus not based on a live signal from the conversation partner. Although having a constant stimulus across conditions has methodological benefits, there are potential benefits to a live signal. Ecological validity would be the prime argument as the stimulus would broadcast any cardiovascular response (heart rate or heart rate variability). It would allow for interpretation of the changes in light of what happens between participants, in this study the ongoing conversation. Some of the participants gave feedback indicating they were looking for such effects (e.g., "Sometimes I tried to listen if the sound changed, got faster or else, although I did not really discern strong or clear changes."). Although the stimulus incorporated more variability than in previous studies (Janssen et al., 2010), it was still perceived as quite monotonous, perhaps to the detriment of perceived realism and believability of the mediation. A variant signal is considered more emotive than a rather constant one (see review by Kreibig, 2010), although evidence for affect and contentment related emotions show heart rate need not increase or alter (Janssen, IJsselsteijn, Westerink, & De Vries, in press, p. 15; Kreibig, 2010, p. 406). Most participants admitted to not really paying attention to the heartbeat stimulus, perhaps explaining the modest strength of the manipulation (see also §3.2). People felt the stimulus was a "background sound," and for some it may have escaped their attention, as it seemed to contain little information (e.g., "the sound did not change after asking a very personal question, so I figured it would not reveal much [although I had some expectations it would]"). As one participant put it: "the sound was clearly audible and not annoying, but if you now told me it had been turned off for five minutes sometime during the conversation, I would believe you." A combination of little apparent information and the attention required for the chatting task may have limited the use of the heartbeat stimulus as a source of information about the other. As explained earlier in this text, the neglect of the auditory heartbeat stimulus could be because of perceptual adaptation. A fade-out from attention would result from the continued exposure and consequent diminishing of its salience. It would lower the potential affective benefits expected from heartbeat communication. Reducing the monotony and/or focusing attention on the heartbeat cue could improve salience by reducing adaptation effects. The Conductive Chat project (DiMicco, Lakshmipathy, & Fiore, 2002) shows a very overt implementation of live mediated physiology communication, using galvanic skin responses (GSR) to alter font size and colour in a chat message. Although no formal evaluation is available initial responses indicate the live mediation really added to the experience. Even though GSR may be more volatile and responsive than are cardiovascular measures, it illustrates the potential benefit of using live data.

A related limitation of the heartbeat stimulus as used here is that it was automatically disclosed with no deliberate choice of participants. From the perspective of the sender, the source of the heartbeat, here the automaticity could reduce the feeling that it is truly self-disclosure, as no there

was no control. Usage of a confederate may render the argument moot for this particular study, but in general it is something to take into account. The interpersonal attribution of partner-disclosure – the intention of the partner to disclose something specifically to the receiver – has been shown to influence the perception of intimacy in both face-to-face and even more pronounced in mediated interactions (Jiang, Bazarova, & Hancock, 2011). A suggestion for future adaptations to the current method would thus be a way to instil such intended attribution (either real or fake), because it alters how a receiver makes sense of the communication (Jiang et al., 2011, p. 59).

4.2. Implications for future work and applications

In this study participant and confederate couples were unfamiliar with each other, because familiarity has been shown to affect perceived disclosure, liking and connectedness (see Bickmore & Picard, 2005 for a discussion of literature). Perhaps some familiarity between couples is necessary to achieve observable differences between conditions. Put differently, this study might have been unable to get connectedness with the other up to a level where differences can be detected. This reasoning goes some way towards explaining the negligible differences found. Walther's hyperactive communication theory (Tidwell & Walther, 2002; Walther, 1996) predicts that a lean communication medium does not need to be a deficiency for perceived levels of intimacy, as compared to richer media. Following that theory, one would expect that the lean text-based chat medium should have resulted in detectable differences, as it has been shown before to support intimacy mediation.

The unfamiliarity does make this work a study about relationship formation, not about maintenance. As this study set out to validate a positive effect of heartbeat communication on social connectedness it must be noted this connectedness between strangers can only serve as a guidance for later work on intimacy. Real intimacy is very unlikely to occur between strangers within the time spent together during an experiment, as it is intrinsically different from the social exchange between non-intimate friends and colleagues (a point made by a.o. Vetere et al., 2005, p. 472). It would be odd to start a relationship with such intimate disclosure and this is perhaps a reason no effects were found. It can be worthwhile to study the experiences of relatives or friends in a similar setup. A field study with romantic couples by Slovák, Janssen and Fitzpatrick (2012) confirms that people may indeed be wary to share their heart rate information with strangers, although their participants noted that without context to a signal others may not be able to decipher private matters (p. 863).

It appears for heartbeat communication to be a valuable source of information it must lend itself to interpretation, that is have something to offer beyond a mere 'Dum-dum' sound. Without interpretation it is likely to carry less meaning (cf. Slovák et al., 2012). Such interpretation hinges on context and familiarity with the source of the heartbeat signal. This study illustrates that without such familiarity and a clearly interpretable relation between the influence (i.e., the action, thought, or emotion) and the state of this signal (i.e., heart rate [variability]), there is no noticeable effect of its communication. The results suggest that any mediated heartbeat communication effect as demonstrated in previous studies is quite small and relatively easily overblown by other, stronger social cues. In this study the heartbeat stimulus might have taken a backseat to the chatting task for most participants.

Future studies (and applications) could benefit from investigating ways to solve this issue, for example by having participants make active use of a heartbeat stimulus for completion of a task. It would give purpose as well as context in a usage scenario. One such example is demonstrated by Kuikkaniemi and Janssen (2010) in which a driver is guided by a physiology-aware operator. This operator paces her guidance based on the mediated (strongly arousal related) galvanic skin responses of the driver, hence the physiology information has a clear usage here: evaluating arousal. Another example is a study on travel planning (Balaam, Fitzpatrick, Good, & Harris, 2011) which used (implicit) feedback based on non-verbal cues to foster empathy. Another option would a methodology whereby a participant controls an avatar (having a virtual beating heart) in a game environment with tasks to complete and challenges to 'arouse' the avatar. The mediation of virtual heartbeats may alter the perceived immersion in the game.

The previous paragraphs argue interpretation requires context. This begs the question whether it is absolutely necessary to get additional (contextual) clues about the source. Thus, can a heartbeat signal on its own be enough? Is there inherent information about a person in her heartbeat signal that another person can distill? Janssen, IJsselsteijn, Westerink and de Vries (in press) have investigated the perceived emotional intensity of a variety of heartbeat stimuli. They conclude people can interpret heartbeat cues to some extent, especially linking the perceived heart rate to arousal (p. 97). The interpretation of changes (e.g., heart rate fluctuations) in a mediated signal has not yet been studied in relation to social perceptions, although in this study it was sometimes mentioned by participants that they tried to put use to the heartbeat stimulus, listening for such changes. It would implicate people do seek to evaluate emotional responses of their conversation partner through the mediated heartbeat, in accordance with the relation between emotional intensity and heart rate as discussed by Kreibig (2010).

When it comes to assigning meaning, culture is another component, which – as far as I am aware – has not yet been considered. Sure, every person alive has a heartbeat and self-perception is therefore likely to be universal, but not much is known about the cross-cultural associations resulting from such perception or being aware of someone else's heartbeats. Nearly all related studies are performed in Western cultures, which perhaps feature the same connotations regarding the heart, heartbeats and emotion (Ma-Kellams, Blascovich, & McCall, 2012; Wierzbicka, 1999; Yu, 2009). Other cultures may have different views which could alter the resultant affect of mediating heartbeat signals.

The results point to a conclusion where heartbeat communication seems a rather weak effect, which might be quickly drown out by stronger social cues. Or, alternatively, it is a signal that, although affectively meaningful after a short exposure, may be fairly easy to perceptually adapt to in the longer run – in part, perhaps, because of its relatively monotonous nature. Both interpretations may question the applicability and potential value of heartbeat communication in relationships between (romantic) partners. Active usage and interpretability is not all that counts though. Being able to interpret a heartbeat signal may be important if people use it as a way to get to know something about the other. It is far less so, if it is something people use to feel in touch with the other, similar to a function of a picture frame as a reminder. The feeling of having a connection could be enough, or in other words the act of communicating is what provides value. This heartbeat as a connection idea would fit in with the philosophy of "phatic

interactions" (Gaver, 2002; Vetere et al., 2009, p. 173) (see also Slovák et al., 2012). Similar in tone, Battarbee et al. (2002) conclude: the communication of such a signal is not intimate by itself, but is only conducive to intimacy when it is appropriated as such by communication partners. In other words, the fact that someone decides to disclose her heartbeats is what counts, as well as the appraisal of the partner regarding her disclosure. If such exchange would be thoughtless, automatic even, the meaning may be lost. It might be one of the pitfalls of sharing heartbeats.

The continuous nature of a heartbeat signal as used in this study might be useful from an information perspective, as it can be attended to at any time if so desired. Its continuous presence may however also drive away attention (to its meaning) because it gets monotonous and risks becoming an undesired distraction (Janssen et al., 2011, p. 4). In a TED conference presentation titled "Connected, but alone?" (2012), Sherry Turkle discusses the potentially negative effects of always-on communication. Her argument is that we have more and more means to communicate and micromanage our communication with others. It can lead to avoiding real connections in favour of multiple, more superficial connections to other people that would deprive us from really getting in touch with someone, according to Turkle. In contrast, other scholars (Fischer, 2012; Ryan & Xenos, 2011) see no such risk in data that people are losing touch at the hands of new technology.

While the 'lonely–but–communicating' debate may be undecided, most work on heartbeat communication seems to indicate people do consider it a very private matter (see also Slovák et al., 2012; Werner et al., 2008) and will not share it with a wide social network (as they might do with less sensitive matters (Wohn et al., 2011)). The ultimate criterion for the desirability and success of heartbeat communication could be the extent to which it helps someone to relate and truly empathise with another person. As of yet this question cannot be answered. The potential and pitfalls of heartbeat communication in relations have been illustrated in one field study (Slovák et al., 2012) but more such studies can further the insight and especially try to put into perspective its potential value.

4.3. Conclusions

This study aimed to investigate effects of heartbeat communication in mediated social interactions. The goal was to establish such effects in a scenario with more longevity in a controlled experiment. In the lab experiment no effects of an interpersonal closeness manipulation and heartbeat stimulus attribution could be shown. These null-findings cannot be satisfactorily explained with the current understanding of psychological processes regarding (mediated) physiology perception. This difficulty lies in the fact that it is a combination of bodily and cognitive interactions which are difficult to disentangle. A straightforward advice for future studies is therefore to shed a light on such mechanisms and to extend knowledge in this respect.

From the outset this work has focused on the value that can be offered by mediated heartbeat communication. While this work aims to help the development of intimate technologies, the investigation of relationship formation between strangers is only a precursor to intimacy. Intimate acts are often nuanced, having acquired meaning through development of mutual interactions. If one thing can be taken from the results of this study, it is that just adding a

(mediated) heartbeat signal does not work wonders, as it may over time become a background noise. Having purpose and context helps its interpretation, and therefore practical value in aiding bringing people closer together through technology. However, as has been noted in the discussion, the connection itself as a means to maintain rapport may also be what lends intimacy rather than the content. Follow-up studies could opt for a different methodology to study the same effects in a different way, and try to alleviate some of the limitations of this study.

Whilst this study did not confirm its hypotheses, all signs still point towards a conclusion where it is a socially sensible thing not to marry a corpse bride.

5. References

Andersen, P., Guerrero, L., Buller, D. B., & Jorgensen, P. F. (1998). An empirical comparison of three theories of nonverbal immediacy exchange. *Human Communication Research*, *24*(4), 501–535. doi:10.1111/j.1468-2958.1998.tb00429.x

Aron, A. P., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*, *63*(4), 596–612. doi:10.1037/0022-3514.63.4.596

Aron, A. P., Aron, E. N., Tudor, M., & Nelson, G. (1991). Close Relationships as Including Other in the Self. *Journal of Personality and Social Psychology*, *60*(2), 241–253. doi: 10.1037/0022-3514.60.2.241

Aron, A. P., Melinat, E., Aron, E. N., Vallone, R. D., & Bator, R. J. (1997). The Experimental Generation of Interpersonal Closeness: A Procedure and Some Preliminary Findings. *Personality and Social Psychology Bulletin*, *23*(4), 363–377. doi:10.1177/0146167297234003

Bailenson, J. N., & Yee, N. (2007). Virtual Interpersonal Touch and Digital Chameleons. *Journal of Nonverbal Behavior*, *31*(4), 225–242. doi:10.1007/s10919-007-0034-6

Balaam, M., Fitzpatrick, G., Good, J., & Harris, E. (2011). Enhancing interactional synchrony with an ambient display. *Proceedings of the 2011 CHI*, 867–876.

Battarbee, K., Baerten, N., Hinfelaar, M., Irvine, P., Loeber, S., Munro, A., & Pederson, T. (2002). Pools and satellites: intimacy in the city. Presented at the DIS '02: Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques, ACM. doi:10.1145/778712.778746

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497–529. doi: 10.1037/0033-2909.117.3.497

Bekkers, R. (2007). Measuring Altruistic Behavior in Surveys. *Survey Research Methods*, The All-or-Nothing Dictator Game, *1*(3), 139–144.

Bell, G., Brooke, T., & Churchill, E. (2003). Intimate ubiquitous computing. *Proceedings of UbiComp 2003*.

Ben-Ner, A., Kramer, A., & Levy, O. (2008). Economic and hypothetical dictator game experiments: Incentive effects at the individual level. *Journal of Socio-Economics*, *37*(5), 1775–1784. doi:10.1016/j.socec.2007.11.004

Berscheid, E., Snyder, M., & Omoto, A. M. (1989). The Relationship Closeness Inventory: Assessing the closeness of interpersonal relationships. *Journal of Personality and Social Psychology*, *57*(5), 792–807. doi:10.1037/0022-3514.57.5.792

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. doi:10.1145/1067860.1067867

Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence-Teleoperators and Virtual Environments*, *12* (5), 456–480. doi:10.1162/105474603322761270

Blascovich, J., Brennan, K., Tomaka, J., Kelsey, R. M., Hughes, P., Coad, M. L., & Adlin, R. (1992). Affect intensity and cardiac arousal. *Journal of Personality and Social Psychology*, *63*(1), 164.

Burton, T. (2005). *Corpse Bride*. Warner Brothers.

Cacioppo, J. T., & Patrick, W. (2009). *Loneliness*. human nature and the need for social connection (p. 317). W. W. Norton & Company.

Calvo, R. A., & D'Mello, S. (2010). Affect Detection: An Interdisciplinary Review of Models, Methods, and Their Applications. *Affective Computing, IEEE Transactions on*, *1*(1), 18–37. doi: 10.1109/T-AFFC.2010.1

Critchley, H., Wiens, S., Rotshtein, P., Öhman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience*, *7*(2), 189–195. doi:10.1038/nn1176

Cwir, D., Carr, P., Walton, G., & Spencer, S. J. (2011). Your heart makes my heart move: Cues of social connectedness cause shared emotions and physiological states among strangers. *Journal of Experimental Social Psychology*, *47*(3), 661–664. doi:10.1016/j.jesp.2011.01.009

de Greef, H. P., IJsselsteijn, W. A., & Wesselink, J. W. (2000). Social presence and emotional attitude in the PhotoShare tele-application. *IPO Annual Progress Report*, *35*, 29–37. Retrieved from http://alexandria.tue.nl/campusonly/Metis144366.pdf

DiMicco, J. M., Lakshmipathy, V., & Fiore, A. T. (2002). Conductive Chat: Instant messaging with a skin conductivity channel. Presented at the Proceedings of Conference on Computer Supported Cooperative Work.

Dindia, K., & Canary, D. J. (2006). *Sex differences and similarities in communication* (p. 442). Mahway, New Jersey: Lawrence Erlbaum.

Dunne, A., & Raby, F. (1995, December 13). Fields and Thresholds. *Architects in Cyberspace*, 60–65.

Eckel, C. C., & Grossman, P. J. (1996). Altruism in anonymous dictator games. *Games and Economic Behavior*, *16*, 181–191.

Eckel, C. C., & Grossman, P. J. (1998). Are Women Less Selfish Than Men? Evidence From Dictator Experiments. *The Economic journal*, *108*, 726–735.

Eisenberger, N. I., Master, S. L., Inagaki, T. K., Taylor, S. E., Shirinyan, D., Lieberman, M. D., & Naliboff, B. D. (2011). Attachment figures activate a safety signal-related neural region and reduce pain experience. *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1108239108

Engel, C. (2011). Dictator games: a meta study. *Experimental Economics*, *14*(4), 583–610. doi: 10.1007/s10683-011-9283-7

Fairclough, S. H. (2009). Fundamentals of physiological computing. *Interacting with Computers*, *21* (1-2), 133–145. doi:10.1016/j.intcom.2008.10.011

Fenigstein, A., & Carver, C. S. (1978). Self-focusing effects of heartbeat feedback. *Journal of Personality and Social Psychology*, *36*(11), 1241–1250. doi:10.1037/0022-3514.36.11.1241

Field, T. (2003). *Touch*. Cambridge, Massachusetts: MIT Press.

Fischer, C. S. (2012, April 23). The Loneliness Scare. Isolation Isn't a Growing Problem. *Boston Review*. Retrieved May 11, 2012, from http://www.bostonreview.net/BR37.3/claude_s_fischer_loneliness_facebook.php

Frijda, N. H. (1986). *The Emotions. Studies in emotion & social interaction*. Cambridge University Press.

Gardner, W., Pickett, C., & Knowles, M. (2005). Social "snacking" and social 'shielding': Using social symbols, selves, and surrogates in the service of belongingness needs. In K. D. Williams, J. P. Forgas, & W. Von Hippel (Eds.), *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 227–241). New York: Psychology Press: The social outcast: Ostracism, social exclusion, rejection, and bullying.

Gaver, W. (2002). Provocative Awareness. *Computer Supported Cooperative Work*, *11*(3), 475–493. doi:10.1023/A:1021277326673

Goodman, E., & Misilim, M. (2003). The Sensing Beds. *UbiComp 2003 Workshop*.

Hoffman, E., McCabe, K., & Smith, V. L. (1996). Social distance and other-regarding behavior in dictator games. *The American Economic Review*, *86*(3), 653–660.

Hudlicka, E. (2003). To feel or not to feel: The role of affect in human-computer interaction. *International Journal of Human-Computer Studies*, *59*, 1–32.

James, W. (1894). The physical basis of emotion. *Psychological review*, *1*(5), 516–529. doi:10.1037/h0065078

Janssen, J. H. (2012). *Connecting people through physiosocial technology*. (C. J. H. Midden, W. A. IJsselsteijn, & J. H. D. M. Westerink, Eds.). Technische Universiteit Eindhoven, Eindhoven.

Janssen, J. H., Bailenson, J. N., IJsselsteijn, W. A., & Westerink, J. H. D. M. (2010). Intimate Heartbeats. Opportunities for Affective Communication Technology. *IEEE Transactions on Affective Computing*, *1*(2), 72–80. doi:10.1109/T-AFFC.2010.13

Janssen, J. H., IJsselsteijn, W. A., Westerink, J. H. D. M., & De Vries, G. J. (in press). The tell-tale heart. *International Journal of Synthetic Emotions*, Perceived emotional intensity of heartbeats.

Janssen, J. H., Westerink, J. H. D. M., IJsselsteijn, W. A., & van der Zwaag, M. D. (2011). The role of physiological computing in counteracting loneliness (pp. 1–4). Presented at the CHI 2011.

Jiang, L. C., Bazarova, N. N., & Hancock, J. T. (2011). The Disclosure-Intimacy Link in Computer-Mediated Communication. An Attributional Extension of the Hyperpersonal Model. *Human Communication Research*, *37*(1), 58–77. doi:10.1111/j.1468-2958.2010.01393.x

Kahneman, D., Knetsch, J., & Thaler, R. H. (1986). Fairness and the Assumptions of Economics. *Journal of business*, *59*(4), S285–S300.

Kreibig, S. (2010). Autonomic nervous system activity in emotion: A review. *Biological psychology*, *84*.

Kuikkaniemi, K., & Janssen, J. H. (2010). Calling safely through haptic biosignal transfer (pp. 1–3). Presented at the BioSignals Workshop at Fun and Games, Leuven, Belgium.

Kuling, I. A., Janssen, J. H., & IJsselsteijn, W. A. (2010). The intimacy of heart beat communication. *CHI EA '10: Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems*, 1–4.

Laurenceau, J.-P., Barrett, L. F., & Pietromonaco, P. R. (1998). Intimacy as an interpersonal process. The importance of self-disclosure, partner disclosure, and perceived partner responsiveness in interpersonal exchanges. *Journal of Personality and Social Psychology*, *74*(5), 1238–1251. doi:10.1037/0022-3514.74.5.1238

Lotan, G., & Croft, C. (2007). imPulse. Presented at the CHI '07 extended abstracts (pp. 1983–1988), New York, New York, USA: ACM Press. doi:10.1145/1240866.1240936

Ma-Kellams, C., Blascovich, J., & McCall, C. (2012). Culture and the body: East–West differences in visceral perception. *Journal of Personality and Social Psychology*, *102*(4), 718–728. doi: 10.1037/a0027010

Maccoby, E. E., & Jacklin, C. N. (1974). *The Psychology of Sex Differences*. Stanford University Press.

Marinetti, C., Moore, P., Lucas, P., & Parkinson, B. (2011). Emotions in Social Interactions: Unfolding Emotional Experience. In *Emotion-Oriented Systems* (pp. 31–46). Berlin: Springer-Verlag.

Mather, G. (2006). *Foundations Of Perception* (p. 394). Psychology Press (UK).

McCaig, G., & Fels, S. (2002). Playing on heart-strings: experiences with the 2Hearts system. Presented at the NIME '02: Proceedings of the 2002 conference on New interfaces for musical expression, National University of Singapore.

Mueller, F., Gibbs, M. R., & Vetere, F. (2010). Towards understanding how to design for social play in exertion games. *Personal and Ubiquitous Computing*, *14*(5), 417–424.

Parkinson, B. (1985). Emotional Effects of False Autonomic Feedback. *Psychological Bulletin*, *98*(3), 471–494.

Parkinson, B., & Lea, M. (2011). Video-linking emotions. In A. Kappas & N. C. Krämer (Eds.), *Face-to-Face Communication Over the Internet*. Cambridge: Face-to-Face Communication over the Internet: Emotions in a Web of Culture, Language, and Technology (Studies in Emotion and Social Interaction).

Parkinson, B., & Manstead, A. S. R. (1986). False autonomic feedback: Effects of attention to feedback on ratings of erotic stimuli. *Motivation and Emotion*, *10*(1), 11–24. doi:10.1007/BF00992147

Pentland, A. (2008). *Honest Signals. How They Shape Our World.* Cambridge, Massachusetts: MIT Press.

Picard, R. W. (1997). *Affective Computing*. Cambridge, Mass: MIT Press.

Picard, R. W., & Bryant Daily, S. (2005). Evaluating affective interactions: Alternatives to asking what users feel. *CHI Workshop on Evaluating Affective Interfaces: Innovative Approaches*.

Poh, M.-Z., McDuff, D. J., & Picard, R. W. (2010). Non-contact, automated cardiac pulse measurements using video imaging and blind source separation. *Optics Express*, *18*(10), 10762–10774.

Poh, M.-Z., McDuff, D. J., & Picard, R. W. (2011). Advancements in Noncontact, Multiparameter Physiological Measurements Using a Webcam. *IEEE Transactions on Biomedical Engineering*, *58*(1), 7–11. doi:10.1109/TBME.2010.2086456

Reis, H. T., & Shaver, P. (1988). Intimacy as an interpersonal process. *Journal of Personality and Social Psychology*, *24*, 367–389.

Ryan, T., & Xenos, S. (2011). Who uses Facebook? An investigation into the relationship between the Big Five, shyness, narcissism, loneliness, and Facebook usage. *Computers in Human Behavior*, *27*(5), 1658–1664. doi:10.1016/j.chb.2011.02.004

Sedikides, C., Campbell, W., Reader, G., & Elliot, A. (1999). The relationship closeness induction task. *Representative Research in Social Psychology*, *23*, 1–4.

Shklovski, I., Kraut, R., & Cummings, J. (2008). Keeping in touch by technology: maintaining friendships after a residential move. *CHI '08*, 807–816.

Slovák, P., Janssen, J. H., & Fitzpatrick, G. (2012). Understanding heart rate sharing: towards unpacking physiosocial space. Presented at the CHI '12: Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems. doi: 10.1145/2207676.2208526

Thieme, A., Wallace, J., Thomas, J., Chen, K. L., Krämer, N., & Olivier, P. (2011). Lovers' box: Designing for reflection within romantic relationships. *Int. J. Human-Computer Studies*, *69*, 283–297. doi:10.1016/j.ijhcs.2010.12.006

Tidwell, L. C., & Walther, J. B. (2002). Computer-Mediated Communication Effects on Disclosure, Impressions, and Interpersonal Evaluations. Getting to Know One Another a Bit at a Time. *Human Communication Research*, *28*(3), 317–348. doi:10.1111/j.1468-2958.2002.tb00811.x

Turkle, S. (2012, April). Connected, but alone? *TED*. Retrieved from http://www.ted.com/talks/sherry_turkle_alone_together.html

Valins, S. (1966). Cognitive effects of false heart-rate feedback. *Journal of Personality and Social Psychology*, *4*(4), 400–408. doi:10.1037/h0023791

van Bel, D. T., Smolders, K. C. H. J., IJsselsteijn, W. A., & de Kort, Y. A. W. (2009a). Social connectedness: concept and measurement. *International Conference on Intelligent Environments*, 67–74.

van Bel, D. T., Smolders, K. C. H. J., IJsselsteijn, W. A., & de Kort, Y. A. W. (2009b). I-sharing promotes social connectedness (pp. 54–58). Presented at the MobileHCI09 : 11th international conference on human-computer interaction with moblie devices and services, Bonn.

van Bel, D. T., Smolders, K. C. H. J., IJsselsteijn, W. A., & de Kort, Y. A. W. (2010). How intimate mediated interaction affects social connectedness. *Proceedings of the 2010 Dutch Communication Science Conference*.

van Gennip, D. A. P. (2012, January). Intimate Heartbeats 2. Effect of heartbeat communication modality on perceived intimacy. HTI research project.

Van Lange, P. A. M., Ouwerkerk, J. W., & Tazelaar, M. J. A. (2002). How to overcome the detrimental effects of noise in social interaction: The benefits of generosity. *Journal of Personality and Social Psychology*, *82*(5), 768–780. doi:10.1037/0022-3514.82.5.768

Vetere, F., Gibbs, M., Kjeldskov, J., Howard, S., Mueller, F., Pedell, S., Mecoles, K., et al. (2005). Mediating intimacy: designing technologies to support strong-tie relationships (pp. 471–480). Presented at the CHI '05: Proceedings of the SIGCHI conference on Human factors in computing systems.

Vetere, F., Smith, J., & Gibbs, M. (2009). Phatic Interactions: Being Aware and Feeling Connected. In P. Markopoulos, W. Mackay, & B. De Ruyter (Eds.), *Awareness Systems: Awareness Systems, Advances in Theory, Methodology and Design* (pp. 173–186). London: Springer-Verlag.

Walther, J. B. (1996). Computer-Mediated Communication. Impersonal, Interpersonal, and Hyperpersonal Interaction. *Communication Research*, *23*(1), 3–43. doi: 10.1177/009365096023001001

Weisz, J., Bálazs, L., & Ádám, G. (1988). The Influence of Self-Focused Attention on Heartbeat Perception. *Psychophysiology*, *25*(2), 193–199.

Werner, J., Wettach, R., & Hornecker, E. (2008). United-pulse: feeling your partner's pulse. *MobileHCI '08: Proceedings of the 10th international conference on Human computer interaction with mobile devices and services*, 535–538.

Wiens, S., Mezzacappa, E. S., & Katkin, E. S. (2000). Heartbeat detection and the experience of emotions. *Cognition & Emotion*, *14*(3), 417–427. doi:10.1080/026999300378905

Wierzbicka, A. (1999). *Emotions Across Languages and Cultures. Diversity and Universals*. Cambridge: Cambridge University Press.

Wohn, D. Y., Lampe, C., Wash, R., Ellison, N., & Vitak, J. (2011). The "S" in Social Network Games: Initiating, Maintaining, and Enhancing Relationships. Presented at the System Sciences (HICSS), 2011 44th Hawaii International Conference on. doi:10.1109/HICSS.2011.400

Yu, N. (2009). *The Chinese Heart in a Cognitive Perspective*. *Culture, Body, and Language*. The Hague: De Gruyter Mouton.

6. Appendices

6.1. Appendix A: Informed consent form

Ondergetekende verklaart het volgende;

De onderzoek(st)er heeft mij schriftelijk en mondeling geïnformeerd over de aard, het doel en de procedure van dit onderzoek. Ik ben geïnformeerd over mijn rechten tijdens dit onderzoek. Al mijn vragen zijn naar tevredenheid beantwoord.

Ik geef hierbij toestemming dat de data (audio, video en/of schriftelijk) uitsluitend voor onderzoek gebruikt mag worden. De data zal anoniem en vertrouwelijk behandeld worden, dat wil zeggen: de opgeslagen data kan niet worden herleid naar mij als deelnemer.

Ik ben geïnformeerd over het afnemen en opslaan van medisch gevoelige data (fysiologische gegevens zoals hartslag), waarvoor dezelfde voorwaarden gelden als de hierboven genoemde data. Het is mij tevens duidelijk dat indien uit de gegevens mogelijke problemen aan het licht komen die medische aandacht verdienen de onderzoek(st)er mij hiervan op de hoogte dient te stellen.

Ik kan mijn toestemming en deelname aan dit onderzoek ten allen tijde intrekken, zonder opgaaf van reden of hieruit voortvloeiende consequenties.

Ik heb na afloop een vergoeding van € 7,– (TU studenten € 5,–) ontvangen als compensatie voor mijn deelname.

[ ] Ja, ik geef hierbij toestemming voor deelname aan dit onderzoek.

[ ] Ja, ik wil geïnformeerd worden over de uiteindelijke resultaten van deze studie.

Eindhoven, datum: _____

Naam deelne(e)m(st)er:	Naam onderzoek(st)er:
	Doménique van Gennip
_____	_____
Handtekening deelne(e)m(st)er:	Handtekening onderzoek(st)er:
_____	_____

6.2. Appendix B: On-screen instructions prior to chat

Dit is een studie naar afleiding tijdens tekst-gebaseerde communicatie met een medeparticipant. Jouw taak is om de ander beter te leren kennen tijdens een chatsessie.

Tijdens het experiment wordt jouw hartslag opgenomen. Dat gebeurt door middel van een webcam welke boven het computerscherm gemonteerd is. Deze meet minimieme verschillen in huidskleur waaruit je hartslag af te leiden is.

<*Doorgaan*>

Tijdens de chatsessie hoor je op de achtergrond een signaal.

[Attributed conditions] Dit signaal representeert de actuele hartslag van de medeparticipant. Deze wordt net als bij jou opgenomen en omgezet in een hoorbaar signaal. Omgekeerd hoort de medeparticipant hetzelfde.

[Non-attributed conditions] Het geluid dat je zal horen is een kunstmatig geluid welke van internet is gehaald, en wellicht herkenbaar als een hartslag zoals gebruikt in films en games. Dit signaal heeft geen relatie tot hetgeen er gebeurd tijdens het onderzoek, noch tot jezelf of tot de medeparticipant.

<*Doorgaan*>

Het is de bedoeling dat je nu alvast de koptelefoon opzet. Het echte signaal zal starten zodra de chatsessie begint, maar je zou nu al een testgeluid moeten kunnen horen. Het kan enkele seconden duren voordat dit start.

<*Doorgaan*>

Als je dit testgeluid niet hoort, waarschuw dan de experimentleider. Hoor je het testgeluid wel dan kan je doorgaan.

<*Doorgaan*>

Het testsignaal zal nu weer stoppen. Tot slot zijn er nog aanvullende instructies op papier. Je kan deze nu doornemen. [see Appendix C]

<*OK, ik heb de instructie gelezen*>

Jij bent uitgekozen voor de vragende rol tijdens de chatsessie.

Dat betekent dat jij in principe de vragen stelt tijdens de chatsessie en de ander die zal beantwoorden.

Als een onderwerp naar jullie mening genoeg besproken is kan je doorgaan naar de volgende vraag.

<*OK*>

Je kan nu het pakket vragen met het label **A** openen.

Begin zometeen met Set I, vraag 1.

<*Beginnen*>

6.3. Appendix C: Interpersonal closeness induction task instructions

This appendix includes the complete instructions (in Dutch) given to participants on paper, see the next section (C) of the Appendix Gor the questions used. Instructions are adapted from: Aron, A. P., Melinat, E., Aron, E. N., Vallone, R. D., & Bator, R. J. (1997). The Experimental Generation of Interpersonal Closeness: A Procedure and Some Preliminary Findings. Personality and Social Psychology Bulletin, 23(4), 363–377. Please refer to the Method section for further details on its construction and usage.

* * *

(gelieve deze instructie volledig door te nemen voordat je aan de taak begint)

Dit is een studie naar afleiding tijdens tekst-gebaseerde communicatie met een medeparticipant. Jouw taak is om de ander beter te leren kennen tijdens een chatsessie. Om jullie daarbij te helpen hebben we een lijst met vragen voorbereid. Na de chatsessie, die ongeveer een kwartier duurt, krijg je een vragenlijst over jouw ervaringen tijdens deze taak.

Naast deze instructietekst heb je twee pakketten met daarin vragen voor je liggen. Zometeen zal op het computerscherm de letter verschijnen (A of B) van het pakket dat je dient te gebruiken. In een pakket zitten drie sets met vragen. Het is de bedoeling dat je straks begint met Set I, vraag 1.

Eén van jullie zal een vragende rol hebben, de ander een meer antwoordende rol. Wie welke rol krijgt wordt automatisch en willekeurig bepaald. Dat wordt eveneens zometeen op het computerscherm bekend gemaakt. De gesprekspartner in de vragende rol zal beginnen met het stellen van de vraag, waarna de ander die vraag zal beantwoorden. Dit proces herhaalt zich voor iedere vraag, de rollen wisselen dus niet om.

Stel alle vragen alsjeblieft in volgorde en sla geen vragen over. Het is niet belangrijk om alle vragen te behandelen binnen de tijd. Om te voorkomen dat jullie te lang bij één vraag blijven hangen willen we jullie verzoeken niet teveel door te vragen. Diegene in de vragende rol kan beslissen om door te gaan naar een volgende vraag indien de huidige vraag beantwoord is. Na vijf en na tien minuten zal het systeem aangeven dat jullie kunnen wisselen naar de vragen van Set II of Set III.

Jullie teksten worden kort opgeslagen voor een analyse (welke niet herleid kan worden naar de deelnemende personen). Na deze analyse worden alle teksten verwijderd.

Je mag nu beginnen. Veel plezier!

6.4. Appendix D: Interpersonal closeness induction task questions

The following questions (in Dutch) were used for the interpersonal closeness induction task as explained in Appendix C. Participants were assigned either to personal questions (this page) or small talk questions that have less personal relevance (next page). Each question was printed on a thick paper card and stacked with other questions of the same set, so participants could take a card as they went about the chatting task. See also the Method section for further details on construction of the lists of questions.

Persoonlijke vragen

Set I

1. Zou je beroemd willen zijn? Op wat voor manier?
2. Voordat je iemand belt, oefen je wel eens wat je gaat zeggen tijdens het gesprek? Waarom?
3. Als je negentig jaar oud zou worden en het lichaam danwel de geest van een dertigjarige zou kunnen behouden, welke van de twee zou je kiezen?
4. Als je morgen op zou kunnen staan met één extra kwaliteit of vaardigheid, wat zou dat zijn?
5. Heb je stiekem een idee over hoe je zal sterven?
6. Indien je wie dan ook in de wereld mag kiezen, wie zou je aan tafel willen hebben tijdens een diner?
7. Waarvoor ben je het meest dankbaar in je leven?

Set II

8. Indien een kristallen bol jou de waarheid zou kunnen vertellen over jezelf, je leven, de toekomst, of iets anders, wat zou je willen weten?
9. Als je wist dat je over een jaar plotseling komt te overlijden, zou je iets veranderen aan de manier waarop je nu leeft? Waarom?
10. Wat waardeer je het meest in een vriendschap?
11. Is er iets waar je al lange tijd van droomt om te doen? Waarom heb je het nog niet gedaan?
12. Wat is je meest dierbare herinnering?
13. Wat is de grootste prestatie in jouw leven?
14. Welke rol spelen liefde en affectie in jouw leven?

Set III

15. Vertel me over een gênant moment uit je leven?
16. Stel dat je vanavond plotseling zou overlijden zonder nog de mogelijkheid te hebben met iemand te communiceren, wat zou je het meest spijten dat je het nooit hebt kunnen vertellen? Waarom heb je dat nu nog niet verteld?
17. Jouw huis/kamer gaat in vlammen op, met daarin alles wat je bezit. Nadat je geliefden en huisdieren hebt gered heb je nog de tijd om nog één ding te redden uit de vuurzee. Wat zou dat zijn? En waarom?
18. Wanneer was de laatste keer dat je huilde in het bijzijn van anderen? En wanneer alleen?
19. Maak de volgende zin af: “Ik zou willen dat ik iemand had waarmee ik … kon delen.”
20. Als je een hechte vriend zou worden met je gesprekspartner, vertel hem of haar iets wat belangrijk is voor diegene om te weten.
21. Van alle familieleden, wiens dood zou je het meest aan het hart gaan? Waarom die persoon?

Oppervlakkige vragen

Set I

1. Wanneer heb je voor het laatst meer dan een uur gewandeld? Beschrijf waar je bent geweest en wat je gezien hebt?
2. Als je een nieuwe smaak schepijs uit kan vinden, wat zou die smaak zijn?
3. Lees je vaak de krant en welke krant heeft je voorkeur? Waarom?
4. Wat is een goed aantal personen in een studentenhuis, en waarom?
5. Hoe heb je het meeste recente carnaval gevierd?
6. Wat is het beste cadeau dat je ooit hebt mogen ontvangen en waarom?
7. Beschrijf je laatste huisdier?

Set II

8. Beschrijf de laatste keer dat je naar de dierentuin bent geweest.
9. Waar kom je vandaan? Noem alle plaatsen waar je ooit hebt gewoond?
10. Wat heb je afgelopen zomer gedaan?
11. Vind je het prettig om vroeg op te staan of juist laat naar bed te gaan?
12. Wat is tot nu toe je favoriete vak aan de TU (of een andere onderwijsinstelling)?
13. Wie is je favoriete acteur (van je eigen geslacht)? Beschrijf je favoriete scène waarin deze persoon speelde?
14. Wat was je eerste indruk van de TU Eindhoven toen je hier voor de eerste keer kwam?

Set III

15. Waar ben je naar de middelbare school gegaan? Vertel iets over die school.
16. Hoe vaak ga je naar de kapper of laat je je haar doen? Wie laat je dit doen? Heb je ooit een vervelende ervaring gehad met een knipbeurt?
17. Heb je een abonnement op bepaalde magazines? Zo ja, welke? En in het verleden?
18. Wat is het laatste concert dat je hebt bijgewoond? Bezit je albums van deze artiest/band? Heb je de artiest/band ooit eerder zien optreden? Zo ja, waar?
19. Wat zijn volgens jou de voor- en nadelen van kunststof kerstbomen?
20. Heb je ooit meegedaan aan een toneelstuk (bijvoorbeeld op school)? Wat was jouw rol? Wat was het verhaal? Is er ooit iets grappigs/merkwaardigs gebeurd terwijl je op het toneel stond?
21. Welk land zou je het liefste bezoeken? Wat is het dat je trekt aan dit land?

6.5. Appendix E: Post-manipulation questionnaire items

The following items were used in the on-screen questionnaire participants filled out after chatting.

6.5.1. Questionnaire items

Construct	Question	Scale	minLabel	maxLabel
Partner-disclosure	In hoeverre deelde X feitelijke informatie met jou?	Likert 1-7	absoluut niet	in zeer hoge mate
Partner-disclosure	In hoeverre deelde X zijn of haar gedachten met jou?	Likert 1-7	absoluut niet	in zeer hoge mate
Partner-disclosure	In hoeverre deelde X zijn of haar gevoelens met jou?	Likert 1-7	absoluut niet	in zeer hoge mate
Relationship quality	Ik weet vaak wat X denkt.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik heb het gevoel dat X vaak weet wat ik voel.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik heb het gevoel dat ik veel gemeen heb met X.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik weet vaak wat X voelt.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik heb het gevoel dat ik op dezelfde golflengte zit als X.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik heb het gevoel dat X me goed kent.	Likert 1-7	geheel oneens	geheel eens
Relationship quality	Ik heb het gevoel dat X vaak weet wat ik denk.	Likert 1-7	geheel oneens	geheel eens
Interaction quality	Het contact met X is oppervlakkig.	Likert 1-7 R	geheel oneens	geheel eens
Interaction quality	Ik heb het gevoel dat X mij niet goed begrijpt.	Likert 1-7 R	geheel oneens	geheel eens
Interaction quality	Ik haal weinig bevrediging uit mijn contact met X.	Likert 1-7 R	geheel oneens	geheel eens
Feelings of closeness	Ik heb het gevoel dat ik met de andere persoon alles kan bespreken.	Likert 1-7	geheel oneens	geheel eens
Feelings of closeness	Ik heb het gevoel dat de ander en ik goed met elkaar communiceren.	Likert 1-7	geheel oneens	geheel eens
Feelings of closeness	In vergelijking met al je andere relaties (zowel die met mannen als met vrouwen), hoe hecht is je relatie met de andere persoon?	Likert 1-7	absoluut niet hecht	zeer hecht

Construct	Question	Scale	minLabel	maxLabel
Feelings of closeness	In vergelijking met wat je weet van relaties van anderen (zowel die met mannen als met vrouwen), hoe hecht is je relatie met de andere persoon?	Likert 1-7	absoluut niet hecht	zeer hecht
Inclusion of Other in Self	Geef door het verschuiven van de cirkel aan hoe intiem je je zojuist voelde ten opzichte van de andere persoon?	IOS continue		
Inclusion of Other in Self	Geef door het verschuiven van de cirkel aan hoe je zou WENSEN dat je relatie geweest was aan het einde van de chatsessie?	IOS continue		
(Ideal) Subjective Closeness Index	In vergelijking met een IDEALE relatie (zowel die met mannen als met vrouwen), hoe hecht is je relatie met de andere persoon?	Likert 1-7	absoluut niet hecht	zeer hecht
Liking	Ik mag X graag.	Likert 1-7	geheel oneens	geheel eens
Liking	Ik kan me voorstellen dat X en ik vrienden zouden kunnen worden.	Likert 1-7	geheel oneens	geheel eens
Liking	Ik zou me op mijn gemak voelen als ik X zou ontmoeten.	Likert 1-7	geheel oneens	geheel eens
Liking	Ik zou X graag ontmoeten.	Likert 1-7	geheel oneens	geheel eens
Liking	Ik heb het gevoel dat X hetzelfde is als ik.	Likert 1-7	geheel oneens	geheel eens
Personal topics check	De besproken onderwerpen waren persoonlijk van aard.	Likert 1-7	geheel oneens	geheel eens
Personal topics check	De besproken onderwerpen gaven me een goed inzicht in de andere persoon.	Likert 1-7	geheel oneens	geheel eens
Stimulus experiences	Het signaal was duidelijk aanwezig.	Likert 1-7	geheel oneens	geheel eens
Stimulus experiences	Ik heb het signaal als storend ervaren.	Likert 1-7	geheel oneens	geheel eens
Stimulus experiences	Ik heb het gevoel dat het signaal mij iets vertelde over de andere persoon.	Likert 1-7	geheel oneens	geheel eens
Stimulus experiences	Op bepaalde momenten richtte ik mij op het signaal om de ander beter te begrijpen.	Likert 1-7	geheel oneens	geheel eens
Familiarity check	Kende je de andere participant voordat je deelnam aan dit experiment?	Likert 1-7	geheel niet	zeer goed
Age	Je leeftijd?	(open)		
Sex	Geslacht: je bent een?	M / F	Man	Vrouw
Comments	Heb je wellicht nog op- en/of aanmerkingen? Zo ja, dan kan je die hieronder kwijt.	(open)		

6.5.2. Manipulation check questions

Manipulation checks followed a laddered format and were administered orally by the experimenter. The questions below served as a guidance for a short post-experiment interview, thus not all may have been used for each participant (e.g., because it was no longer necessary or applicable). Subjective ratings by the experiment leader ranked each participant on three categories: understanding of experiment manipulations, understanding of using a (script following) confederate, and correct interpretation of the heartbeat stimulus. Participants were given a ranking based in this insight; (1) those who were unaware, (2) those who might have had a clue (perhaps at a late point), and (3) those who had a strong sense about the manipulations in effect. These rankings were recorded by the experimenter on paper in a simple table and later combined with the rest of the data.

I. Waar denk je dat dit experiment over gaat?
   - Wat denk je dat we proberen te onderzoeken?
     - Heb je een idee welke dingen we proberen te variëren?

II. Is je iets opgevallen tijdens het chatten met de ander?
   - Denk je dat de ander tijdens het chatten eerlijk antwoord gaf?
     - Denk je dat de ander zijn of haar eigen antwoorden gaf?
       - Denk je dat de andere participant op de hoogte is van het experiment?
         - Denk je dat de andere participant onderdeel was van het experiment?

III. Je hebt tijdens het experiment een signaal gehoord. Wat stelde dit volgens jou voor?
   - Heeft het signaal je ergens aan doen denken, bv. een bepaalde associatie?
     - Denk je dat het signaal dat je hoorde de hartslag van de ander was?

6.6. Appendix F: Content analysis, data reduction and criteria for exclusion

This appendix aims to aid the understanding of the measures as explained in the Method section, as well pre-analysis documentation, which should the reader to evaluate the measures and results as portrayed in this report.

6.6.1. Chat content analysis

- All chat transcripts were analysed and compared to the original scripts written for the chat sessions. Per question (i.e., as written on a card) the actual number of questions asked were counted (e.g., an additional 'why?' question counted as well, even it was on the card). Extra non-card questions were counted as well. On average participants asked 14 (sub)questions (M = 13.9, SD = 2.8, range 7–21) or about one per minute (given the duration of 15 minutes).
- Those that deviated too much from the average chat's contents were excluded. Specifically participants who deviated from the given questions more than twice (1 case) and/or asked more than two further questions per topic (a question card) on more than one occasion (0 cases) were excluded.
- Based on a subjective experimenter rating of strictness in adhering to the intended script 3 cases were excluded (the objective measures above were also taken into account, as well as verbal comments from the confederates). A negative would for example be caused by misunderstanding of the instructions or (repeated) self-disclosure of the participant (i.e., giving one's own answers). In total 3 cases were excluded due to chat content anomalies.

6.6.2. Data reduction

Finding factors and reducing items into new summated scales has been performed on the complete set of data, including cases that may be dropped for some (other) reasons. This has been done to include as many cases as possible, expecting that those extra cases are consistent in inter-item ratings (thus while perhaps off, consistently off).

The questionnaire items were meant to be reduced into less variables. Partner-disclosure and the Social Connectedness derived items are have been used as factors before. To check the validity common factor analysis was used to see if factors can indeed be extracted as intended. Factors are extracted with Eigenvalues above 1. The analysis method used is Principal Axis Factoring with oblimin rotation (as extracted variables are very likely related). See Figure E.1 for a pattern matrix on partner-disclosure, relationship quality, interaction quality, feelings of closeness and liking.

The factor analysis did not immediately reveal the intended factors, perhaps caused by relatively low variance in the underlying data.

Pattern Matrix[a]

	Factor							
	1	2	3	4	5	6	7	8
Ik heb het gevoel dat ik op dezelfde golflengte zit als X	.764							
Ik heb het gevoel dat ik veel gemeen heb met X	.727		.210					
Ik heb het gevoel dat X hetzelfde is als ik	.633							
Ik heb het gevoel dat ik met de andere persoon alles kan bespreken	.279				-.236			
Ik heb het gevoel dat X vaak weet wat ik voel		.812					-.215	
Ik heb het gevoel dat X vaak weet wat ik denk		.527				.208		
Het contact met X is oppervlakkig		-.441	-.297			.246	-.247	
Ik heb het gevoel dat X me goed kent	.239	.410		.225	-.294		.274	
Ik weet vaak wat X denkt		.351				.207		
In hoeverre deelde X zijn of haar gevoelens met jou?			.905	.210				
In hoeverre deelde X zijn of haar gedachten met jou?			.678					
Ik heb het gevoel dat X mij niet goed begrijpt				.762				
Ik haal weinig bevrediging uit mijn contact met X				.466		.236		
In vergelijking met wat je weet van relaties van anderen (zowel die met mannen als met vrouwen), hoe hecht is je relatie met de andere persoon?					-.946			
In vergelijking met al je andere relaties (zowel die met mannen als met vrouwen), hoe hecht is je relatie met de andere persoon?					-.886			
Ik weet vaak wat X voelt		.298	.292		-.314			
Ik zou me op mijn gemak voelen als ik X zou ontmoeten						-.545		
Ik mag X graag	.306			-.317		-.542	-.296	
Ik kan me voorstellen dat X en ik vrienden zouden kunnen worden	.421					-.452		
Ik zou X graag ontmoeten							.605	
In hoeverre deelde X feitelijke informatie met jou?								.577
Ik heb het gevoel dat de ander en ik goed met elkaar communiceren	.419	-.240		-.222				.466

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 28 iterations.

Figure E.1. Pattern matrix (Principal Axis Factoring with oblimin rotation) of partner-disclosure, relationship quality, interaction quality, feelings of closeness and liking. Ordered to group related items.

6.6.2.1. *Partner-disclosure*

Partner self-disclosure was based on Laurenceau et al. (1998) and can be considered a validated instrument. However the internal consistency for the three items was subpar (α = .186), due to low and negative inter-item correlation with the first item (-.121 and -.159). Excluding this item ("In hoeverre deelde X feitelijke informatie met jou?") improves the consistency of the two remaining items to a useful level (α = .738). Content-wise the difference appears to be between disclosure of facts and thoughts & feelings.

Indeed when looking at box plots (Fig. E.2) this first item is ranked higher among small talk participants, while the two other items are ranked lower for those in the small talk conditions. Considering the available data a summated scale [partner_disclosure] was created by taking the mean of only the last two items which are consistent with each other (and expectations).

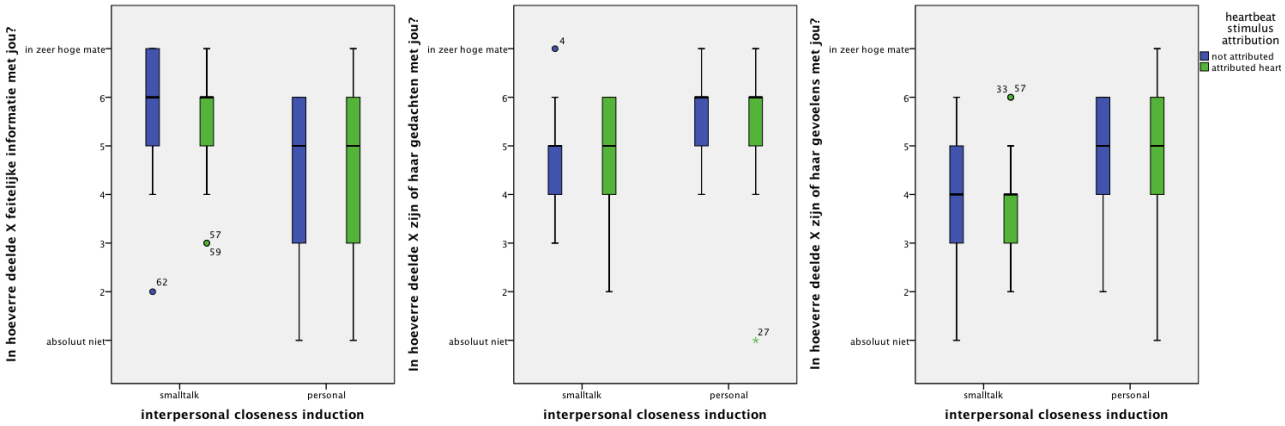

Figure E.2. Box plots for all three Partner-disclosure items with Interpersonal closure and Attribution as between-subject factors.

6.6.2.2. *Relationship quality*

Inter-Item Correlation Matrix

	Ik weet vaak wat X denkt	Ik heb het gevoel dat X vaak weet wat ik voel	Ik heb het gevoel dat ik veel gemeen heb met X	Ik weet vaak wat X voelt	Ik heb het gevoel dat ik op dezelfde golflengte zit als X	Ik heb het gevoel dat X me goed kent	Ik heb het gevoel dat X vaak weet wat ik denk
Ik weet vaak wat X denkt	1.000	.374	.157	.433	.179	.194	.256
Ik heb het gevoel dat X vaak weet wat ik voel	.374	1.000	.094	.279	.285	.311	.497
Ik heb het gevoel dat ik veel gemeen heb met X	.157	.094	1.000	.284	.673	.286	.173
Ik weet vaak wat X voelt	.433	.279	.284	1.000	.226	.349	.319
Ik heb het gevoel dat ik op dezelfde golflengte zit als X	.179	.285	.673	.226	1.000	.333	.248
Ik heb het gevoel dat X me goed kent	.194	.311	.286	.349	.333	1.000	.379
Ik heb het gevoel dat X vaak weet wat ik denk	.256	.497	.173	.319	.248	.379	1.000

Figure E.3. Inter-item correlation matrix for Relationship Quality items.

Cronbach's α = .747 (with 7 items) is considered acceptable but not great. Perhaps this is because items 2, 6, and 7 relate to how participant perceives the other feels about them (e.g., "Ik heb het

gevoel dat X vaak weet wat ik voel.") (see Fig. E.3). However, excluding those items gave no improvement for the reliability coefficient (α = .655). A summated scale [relationship_quality] was thus created using the mean value of all items per participant. Another scale [relationship_quality_partial] was created omitting the three troublesome items. Both scales are reported in the Results section.

6.6.2.3. Interaction quality

Cronbach's α = .544 of the three items is very low, which is not surprising given the low inter-item correlations. The graphs of the individual items do not reveal a clear pattern either, so it was chosen to stick with the previously validated way of creating a summated scale from all three items: [interaction_quality].

6.6.2.4. Feelings of closeness / Ideal closeness

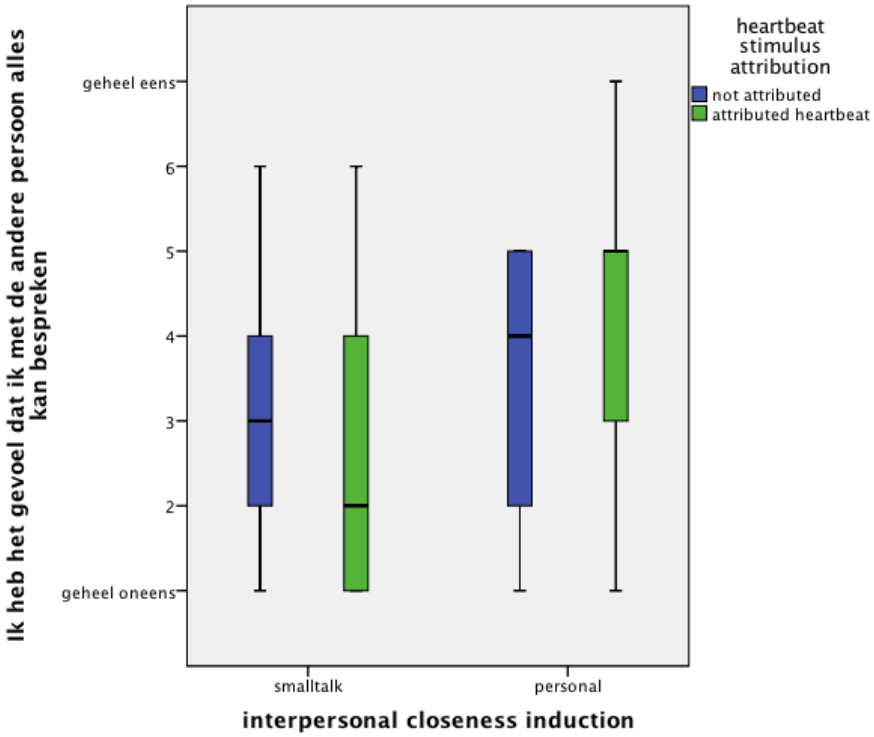

Figure E.4. Box plot for one Feelings of closeness item with Interpersonal closure and Attribution as between-subject factors. This was the only item with clearly observable variance across conditions.

Combining the four items gives a reliability coefficient of α = .650. Inter-item correlations do not reveal an obvious weak item so, given its previous use, a summated scale was created based on all four items [feelings_closeness]. It must be noted only the first item (shown in Fig. E.4) reveals visible differences. The last two items are similar to the Subjective Closeness Index and were used for another scale item [feelings_closeness_sci] (Cronbach's α = .890). Because an ideal version of this summated scale was used, another one capturing the discrepancy between the SCI and ideal SCI item was created [closeness_sci_discrepancy].

6.6.2.5. *Liking*

Inter-Item Correlation Matrix

	Ik mag X graag	Ik kan me voorstellen dat X en ik vrienden zouden kunnen worden	Ik zou me op mijn gemak voelen als ik X zou ontmoeten	Ik zou X graag ontmoeten	Ik heb het gevoel dat X hetzelfde is als ik
Ik mag X graag	1.000	.616	.306	.052	.284
Ik kan me voorstellen dat X en ik vrienden zouden kunnen worden	.616	1.000	.272	.175	.422
Ik zou me op mijn gemak voelen als ik X zou ontmoeten	.306	.272	1.000	.160	.219
Ik zou X graag ontmoeten	.052	.175	.160	1.000	.110
Ik heb het gevoel dat X hetzelfde is als ik	.284	.422	.219	.110	1.000

Figure E.5. Inter-item correlation matrix for all five Liking items.

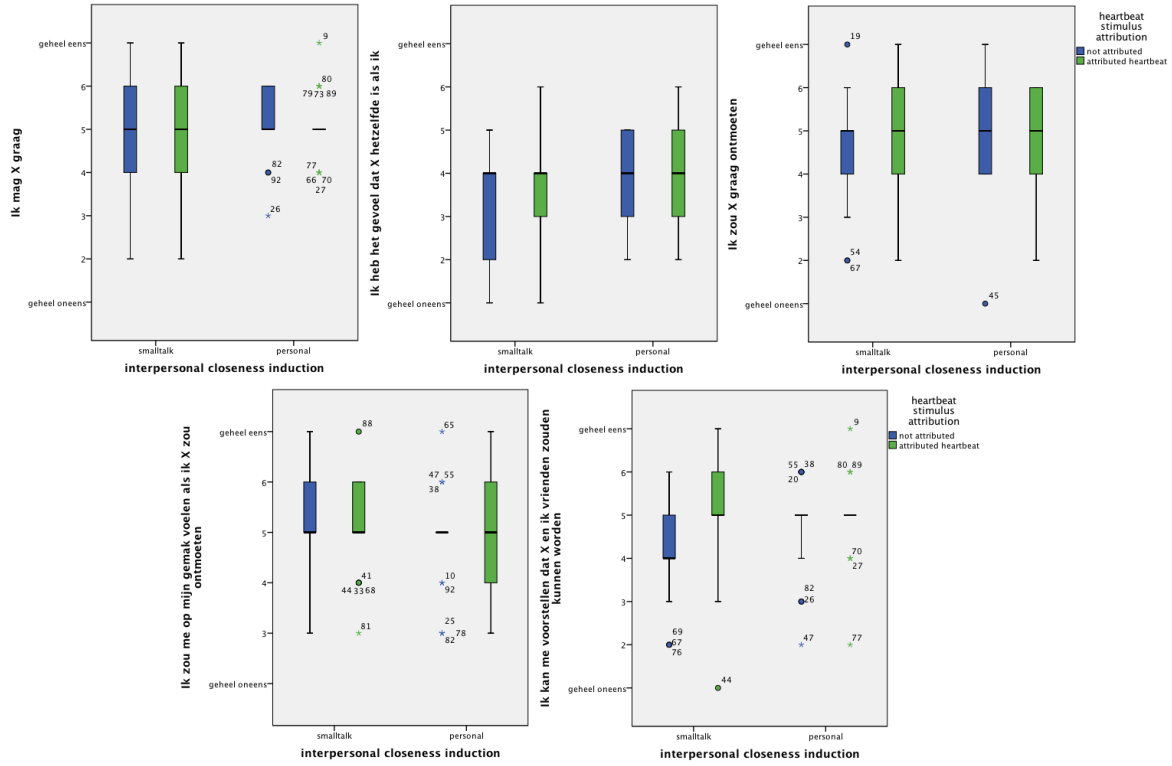

Figure E.6. Box plots for all Liking items with Interpersonal closeness and Attribution as between-subject factors. Clearly visible is the lack of direction and variance in the data, especially for the latter two items.

In contrast to the previous instruments this factor is not based on validated items. A common factor analysis yields two factors with an Eigenvalue >= 1 (second Eigenvalue is .985 so is included). Both the resultant pattern matrix and inter-item correlations (Fig. E.5) show items 3 & 4 are not in tune with the others. Those appear to be about intention to meet the other (curiosity?), a proxy for Liking but not conceptually the same. Cronbach's α = .621 for all items together. Excluding the worst item (4) improves this α to .681, and omitting both 3 & 4 gives α = .692. While the α does not change much, removing items while keeping it stable could be seen as an improvement because adding items tends to inflate the coefficient (cf. Cortina, J. M. (1993).

What is coefficient alpha? An examination of theory and applications. Journal of Applied Psychology, 78(1), 98–104. doi:10.1037/0021-9010.78.1.98.) Only the three best-fitting items are used in a summated scale [liking]. Instead of appearing as fishing for anything that goes, making a choice is not bad considering it is an unvalidated scale. Perhaps because no strong patterns can be found in the data correlations are weak (the graphs in Fig. E.6 suggest it is a possibility). While face-validity appears fine, the scale should be validated in another study with more variant data (e.g., clearly likable people versus those reminiscent of Gargamel).

6.6.3. General criteria for exclusion

- For all participants three subjective experimenter ratings have been included which indicate whether the data should be used or not, due to misunderstandings or awareness of manipulations (dependent variables, use of a confederate, and realism of heartbeat). These ratings are based on verbal answers to laddered questions asked after the experiment session (see Appendix E). These cases (7 in total) are excluded from further analysis.
- Effects of familiarity on the dependent variables cannot be determined from the data (on a 7 point scale only 2 participants indicated a score above 4). In my previous study it was shown to affect the results. To avoid contamination it has been decided to exclude those two cases.
- For each measure the normalised scores are saved. Outliers with a Z-score of abs(3) or higher have been excluded from further analysis for that factor *if* that factor showed a reasonable normality of its sample distribution. This means the SCI based factors, IOS and Dictator game items did not have cases excluded (would have been 2 cases). Disclosure, Relationship quality, Interaction quality, Feelings of closeness and Liking did have cases excluded (2 cases in total, leaving 79).
- Cook's values nor leverage values were sufficiently troublesome to exclude cases.
- Combined with the chat content exclusions, this leaves 79 cases for the analyses of variance.